NUCLEAR REGULATORY COMMISSION

ADVISORY COMMITTEE ON REACTOR SAFEGUARDS

IN THE MATTER OF:

SUBCOMMITTEE ON IMPROVED SAFETY SYSTEMS

Place - Washington, D. C.

Date - Tuesday, June 26, 1979

Pages 1 - 254

Telephone:
(202) 347-3700

ACE - FEDERAL REPORTERS, INC.

Official Reporters

444 North Capitol Street
Washington, D.C. 20001

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UNITED STATES NUCLEAR REGULATORY COMMISSION'S

ADVISORY COMMITTEE ON REACTOR SAFEGUARDS

Tuesday, June 26, 1978

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UNITED STATES OF AMERICA

NUCLEAR REGULATORY COMMISSION

ADVISORY COMMITTEE ON REACTOR SAFEGUARDS

SUBCOMMITTEE ON IMPROVED SAFETY SYSTEMS

Room 1046, Tenth Floor
1717 H Street, Northwest
Washington, D. C.

Tuesday, June 26, 1979

The Advisory Committee on Reactor Safeguards Subcommittee on Improved Safety Systems was convened at 8:30 a.m., Dr. Chester P. Siess, Chairman of the Subcommittee, presiding.

MEMBERS PRESENT: Dr. David Okrent, Dr. Stephen Lawroski, Mr. Harold Etherington.

ALSO PRESENT: Messrs. Richard Savio and Sam Duraiswamy.

C O N T E N T S

P R O C E E D I N G S

DR. SIESS: The meeting will come to order.

This is a meeting of the Advisory Committee on Reactor Safeguards, Subcommittee on Improved Safety Systems.

I am Chester Siess, the Subcommittee Chairman. The other ACRS members present today, starting on my left: David Okrent, Stephen Lawroski, and Harold Etherington.

The purpose of this meeting is to hold discussions with the representatives from the Nuclear Regulatory Commission and the Department of Energy on their program plans for research to improve light-water reactor safety systems, and especially to look at expected chantes in these programs developing from the accident at Three Mile Island Unit 2.

The information gathered in this meeting will be used by the ACRS in its preparation of its report to Congress on the NRC safety research program.

This meeting is being conducted in accordance with the provisions of the Federal Advisory Committee Act and the Government in the Sunshine Act.

Mr. Richard Savio is the Designated Federal Employee for the meeting.

The rules for participation in today's meeting have been announced as part of the notice of this meeting previously published in the Federal Register on June 11, 1979.

A transcript of the meeting is being kept and will be made available as stated in the Federal Register notice. It is requested that each speaker first identify himself for the benefit of the recorder and speak with sufficient clarity and volume so that he can be readily heard. And please use a microphone if you have one.

We have received a request from NucleDyne Engineering Corporation for time to give a brief presentation on their Passive Containment System, and that has been so scheduled on the agenda.

We have received no written comments from members of the public.

I would like to suggest that the principal participants for the NRC and DOE might find it convenient to sit at the large table here. There's no objection. There are microphones there, and I think it might make it a little easier, since we don't have a large contingent here.

As I indicated in the opening statement the principal purpose of this meeting at this time is to get information for the preparation of our report to Congress on the research program; and, more specifically, the Commissioners have asked that we provide them with information regarding the ACRS's recommendation on the FY 81 budget, and we will get them those recommendations about the same time they get the FY 81 budget from the -- I guess -- the Budget Review Group.

It is the intent of the ACRS to present, prepare some sort of a report to the Commissioners at its July meeting, which is, I believe, 10, 11, 12 -- 11, 12, 13 -- July; and this will be our last chance to get that kind of information for them.

The agenda involves basically four separate presentations, first, something from NRC's Office of Nuclear Regulatory Research. Then we will hear from the Department of Energy -- I'm sorry, let me back up a bit.

First a presentation by NRC Research, then some comments on that program by Office of Nuclear Reactor Regulation; and then a presentation by DOE.

Sandwiched in between at ten o'clock, we expect to hear from a representative of the Office of Management and Budget, since that office has made some changes in the current budget with some directions to NRC and DOE as to the way in which work on improved safety systems should be divided.

At our last meeting which was in March, I believe, I think there was still some confusion as to just what the objectives of OMB were, what work was to be divided between the two agencies; so we asked somebody from OMB to come in and give us some background on that.

And we will sandwich that in somewhere into NRC's presentation when Mr. Kearney -- shortly after he arrives at a convenient spot.

And the presentation by NUCLEDUME on the passive containment system is scheduled to be the last item on the agenda.

Are there any questions about the agenda from the subcommittee?

(No response.)

Okay, we'll start with the presentation by Office of Nuclear Regulatory Research; Ray DiSalvo is going to present that.

And I don't know how you plan to start, but if it wouldn't be too inconvenient, I would appreciate it if you would take just two or three minutes to take us back chronologically through the change in the law, the NUREG presenting the program, and the budget history up through FY 81 at least, just to get our perspectives straightened out as to what stage we are in today.

Then you can go on with stating the contract work and et cetera.

MR. DE SALVO: Thank you, Mr. Chairman.

I am Ray DiSalvo I am the Technical Coordinator for NRC's Research for Improved Reactor Safety.

Mr. Levine (phonetic) expressed his regrets that he could not be here today. He's Vice Chairman of CSI and is in Europe at this time. Dr. Budnitz (phonetic), the

Deputy Director of the Offic currently involved with the Budget Review Group, which is also examining the FY 81 budget. He also expresses his regrets, but he may be here at some time later in the day.

With me is Tom Murley, the Director of Reactor Safety Research, and there are several other staff members with me at this time who may be called upon at some point during the day.

I had planned to go through a very brief history, as you requested, Mr. Chairman, and I will do that in the course of the presentation.

I have taken some liberties in organizing my own presentation such that I'll give you some administrative status and an overview of the program, and talk a little bit about the NRC-DOE coordination between now and when Mr. Kearney gets here, and then make time for Mr. Kearney; and then after he's left we can talk in some detail about some of the technical areas. That seems the best way to break up the presentation.

Okay, as I say, I'll spend some time speaking about the administrative status of the program, and I will also cover the history you requested; and I will spend some time talking about NRC-DOE coordination as requested by the Subcommittee. And after Mr. Kearney's discussion, I will talk in more detail about the technical status of the program, in particular, the programs that we have in place right now, the programs that we have pending, meaning those we expect to start before the end of the fiscal year; and, finally, the programs planned when we get into our '80 and '81 planning.

And then I've allowed some room for special topics on the agenda. You requested some time be spent on the status of research on core catchers, and Mel Silverberg from Division of Reactor Safety Research has a presentation on that.

Now, historically the fiscal year 78 authorization for the Nuclear Regulatory lommission requested that the NRC prepare a long-term plan for research to improve the safety of light-water reactors.

It was quite specific in stating that the purpose of such research was to improve the safety of the plants and was not primarily for enhancing the economic attractiveness of nuclear power; there were also some statements about what was contained in the plan, that it was to contain some proposals for research projects and schedules and costs.

Now, that plan was put together by convening a group of consultants, eliciting suggestions from the Staff, from the ACRS, from the industry, from the public; and a collection of some 200 different suggestions was derived for improving safety.

These 200 suggestions were categorized according to some chronology and lumped into 16 groups. I believe in your handout you have a summary page that looks like this (indicating), which indicates the 16 areas that seemed to cover all of the suggestions.

And then the suggestions were ranked according to four rather general criteria the criteria that were used to arrive at priorities were the strength of support or breadth of support -- basically how many people or how many groups supported research in these areas; the second criteria was risk reduction potention, which was rather judgmental and was based on insights from WASH-1400.

The third was generic applicability: how many different plants did we think the concepts might be applied, and also, could it be applied to new plants versus old plants?

And, finally, the fourth criterion was the estimated cost of implementation; and these were, again, judged very roughly, low being, I believe, less than $10 million; medium in the range of $10 to $50 million; and high meaning more than $50 million.

Based on our qualitative judgments, we arrived at a research program which took the top five highest priority items, and those highest priority categories were No. 7, alternate containment concepts; No. 6, alternate decay heat removal concepts; No. 5, alternate emergency core cooling concepts; No. 3, improved in-plant accident response; and No. 12, advanced seismic design.

These turned out to have highest priority in terms of our judgments, in terms of the criteria we used.

The other areas were also judged to be important but either had ongoing research that was applicable, or was judged to have relatively low risk reduction potential; therefore, it was given a lower priority.

These other topics which did not make the "top-five", so to speak, were to be studied a little further in a general study, which was the scoping study of some other concepts.

And then, finally, of course, in doing this evaluation, we recognized that there was a need for better ways to perform these kinds of evaluations, and also to give us some sort of guidance on how we might want to implement the results of this research in the future; so we had another general study which was called "improved methodology", which would help us make some value-impact assessments.

Now, that's how we arrived at the program that we have.

I'll move into how we got to where we are today administratively -- I'm talking about funding:

We sent this report to Congress in April 1978, and we indicated in that report that to do all of the research that was described in there, would cost, I believe, in the vicinity of $15 million over a three-to-four year period.

Since the budget for that year had already been submitted by that time, we made some adjustments in the fiscal year 80 budget; and we also requested some reprogramming authority for 1979, so we could start the work in 1979.

Congress, in its 1979 authorization, authorized $1-1/2 million be spent to start this research. The Appropriations Committee, in their '79 appropriations act, provided no dollars essentially to start this work. So in order to get the work started at all, we were forced to do some reprogramming action.

And we were able to derive some funds from reprogramming at the time.

As of today, we've been able to fund $400,000 worth of work by reprogramming unobligated carryover from 1978. That reprogramming package was sent to Congress I believe in January of '79, and approval from all of the five committees that had to approve the reprogramming package was not received until the first week of April in 1979.

Now, once that reprogramming action was approved, we started our work on vented containment; we also started some work on human error sensitivity studies; and we started some work on shut-down heat removal with funds that were available in the confirmatory research program.

We felt we could do this because there had been user-research requests pending for some time on shut-down heat removal, and had the funds available in RSR. So we started the work.

Now, that reprogramming package allowed us to start work in these areas.

There was a second reprogramming package that involved reprogramming in the '79 funds -- and, remember, this was reprogramming of unobligated carryover for '78. A separate action was necessary to program funds which had already been authorized.

DR. SIESS: And it was the '78 that you couldn't get approval of until April?

MR. DI SALVO: The first week of April; it was after TMI.

DR. SIESS: That was the '78?

MR. DI SALVO: Yes.

Now, in the meantime a second reprogramming package to try to apply '79 funds to nuclear safety was moving its way through the Commission; $400,000 in a package was earmarked for improved safety.

That was approved by the Commission, and notification was sent to Congress of intent to apply that money on April 26, 1979.

DR. LAWROSKI: Excuse me.

MR. DI SALVO: Yes, sir?

DR. LAWROSKI: Did you have money left over from fiscal '78?

MR. DI SALVO: Yes.

DR. LAWROSKI: -- that you could --

MR. DI SALVO: Yes.

MR. MURLEY: It was agency monies. They never came from Research; they came from other parts of NRC.

DR. LAWROSKI: I see.

MR. DI SALVO: Okay.

The second reprogramming action was approved by the Commission and sent to Congress for approval on April 26, 1979. On May 24, '79, the House Appropriations Committee advised the NRC of a decision not to approve the package until the impact of TMI was made clear.

So in effect that reprogramming package has been sent back to the Commission. I am not totally knowledgeable what the reasons it was sent back for, but I believe it had to do with delays in licensing plants while other, what were perceived to be lower priority activities were continuing.

Now that package is back in the Commission and has to be resubmitted to Congress.

DR. LAWROSKI: Refresh my memory: how long did it take Congress, those five Congressional Committees, to approve the use of the reprogrammed 1978 funds?

MR. DI SALVO: I believe between 60 and 90 days.

DR. SIESS: Do they have to approve, or just disapprove within a certain time?

MR. DI SALVO: I believe there's a time period in which if they do not act, it's automatically approved; and I am not sure what that time period is.

DR. LAWROSKI: But 60-to-90 -- it wasn't longer than that?

MR. DI SALVO: Well, Congress was notified of the first reprogramming action on January 23, 1979. We received an approval from the House Appropriations Committee on February 9th, '79, but there were four other subcommittees that had to approve. And we did not receive approval from them until the first week of April.

DR. LAWROSKI: I was under the impression that you had asked much earlier than the 23rd of January; but I must have been mistaken.

MR. DI SALVO: So that's the history, both the history of the program plan, and the administrative-funding history.

We have been able to get some work started, and we do hope that we can get the second reprogramming approved before the end of '79 -- because '79 is already running out.

Okay, --

DR. SIESS: Okay, so as of right now, all you've got that can be obligated is $400,000?

MR. DI SALVO: It's already been obligated.

DR. SIESS: It's already been obligated.

MR. DI SALVO: It's been in the field now for a month and a half.

DR. OKRENT: I have one question.

MR. DI SALVO: Yes?

DR. OKRENT: You said there had been a user request for shutdown heat removal?

MR. DI SALVO: Yes?

DR. OKRENT: So you were able to begin such work.

Suppose there were a user request for in-plant accident monitoring; could you get anywhere? Would it no longer be considered research to improve reactor safety?

MR. DI SALVO: No, it would not.

I think some of these requests have been bumping against what we now call improved reactor safety for some time.

DR. OKRENT: Well, I still need clarification?

MR. DI SALVO: Well, some of the requests for research under shutdown heat removal, some of the tasks that -- some of these early tasks that were conducted, would have been the same whether you called them confirmatory research or whether you called them improved reactor safety.

For example, one of the early tasks -- and I am talking about this a little later -- is a survey of existing designs to determine what's out in the field right now. Now, that could be called "confirmatory" or it could be called first-step.

DR. SIESS: Is that part of the task action plan on shutdown safety systems only, or --

MR. DI SALVO: I believe it's part of task action. It was in response to a research request which wanted us to assess the values and risk reduction potential of bunkered shutdown heat removal systems.

DR. OKRENT: Well, let's see, out of Three Mile Island there's an interest in certain improvements, let's say, perhaps --

DR. SIESS: Dave, I think you're getting a little ahead, we're in '79 now.

DR. OKRENT: I know, but I am trying to understand the logic here, of when something can be included in the research program, and not called "research to improve reactor safety," and when it can't.

MR. DI SALVO: I don't think there are any clear-cut lines.

I think the term "improve reactor safety" is more administrative, because of the origin of the program.

I think it would be incorrect to say that we haven't been working toward improvement in safety before there ever was a program, an improved safety program. And this is by virtue of the legislation that popped up, and separate funding packages; this improvement program has become known "reactor safety," but in reality, I think, there have been moves in this direction for some time.

DR. SIESS: But you do include it as a decision unit in your budget, right?

MR. DI SALVO: Yes.

MR. MURLEY: I think to answer Dr. Okrent's question correctly, if we were to receive a user request probably from NRR on in-plant accident response, we would then feel freer through our internal rules to start such a research program out of the reactor safety research budget, and not have to limit it to the "improved safety budget", even though it could still be directed by, say, Ray, or some of the probabilistic people.

DR. OKRENT: Well, let's see, just a couple more examples to help me understand -- would you put that vugraph back on?

MR. DI SALVO: Yes.

(Slide.)

DR. OKRENT: Now, it shows that value-impact methods pending, but I've recently seen a report from Sandia in which they did some work on value-impact methodology. It was done for the NRC, was it not? I assumed you had it. It was a Sandia report in which they looked at various possible programs and looked at which might more effective to work on.

MR. DI SALVO: Confirmatory research program.

DR. OKRENT: Is it confirmatory?

MR. DI SALVO: Yes.

That work was started quite a while ago --

DR. OKRENT: Like, they're doing value-impact methodology -- it's still value-impact methodology?

MR. DI SALVO: Yes, it is.

On that, -- well, they were charged with trying to come up with some way to evaluate the confirmatory research program.

That was started before there was ever any improved safety program.

DR. OKRENT: I am still curious why it's in this program if it's in the other program.

And improved ECCS is in the program to improve reactor safety, but I think there have been experiments scheduled in LOFT for sometime, I think there are statements by the Commission, the Commission's ECCS hearings, that work should be done to improve ECCS, and so forth.

I am trying to understand now who decides that something falls in the program which is called research to improve reactor safety, and what cannot be done until we have approval from the Congress for reprogramming or whatever it is, who decides that we can do this work?

I am interested in the logic, because I think almost anything on the list I could cite as having some previous request as to having been identified -- I could go back to the task force report which came out in early '68, and it talked about vented containment. One could say this was an identified suggestion in an initial AEC document, let alone ten ACRS' letters.

MR. MURLEY: Let me take a cut at it, and then you can amplify:

We were under the impression, because Congress passed a law that said what we should do to improve safety research, that they were going to support us. And so we put some programs in there that were responsive, as Ray said, to what we thought the committee here and the technical community thought we should be doing.

Once we then put them in, we can't, of course, double-account for them -- or double-budget for them. I'll give one specific example:

We had in mind doing some lower plenum injection tests in semiscale, and so we put $2 million in the improved reactor safety budget to cover part of the operating costs of semiscale.

And there were a number of other items. And this was in the fiscal 79 budget, last year.

And the Appropriations Committee cut the money.

So that leaves us, then, with a number of programs that we said we were going to do that are in the improved safety budget that we suddenly have no money for them. And we aren't budgeted for them anywhere else.

And I think that goes a long way towards explaining the kind of situation we are in.

Now, if we have to fund some of these programs that we think are important, we have to take them out of somewhere else; and there is, of course, some flexibility in my budget. And that is why I am able to accommodate things like alternate decay heat removal, which is only $100,0-- $150,000.

DR. SIESS: It seems to me that Dave's question goes back to what we mean by "confirmatory research" and "research to improve safety", which is still very fuzzy in my mind.

From what you've said, it seems to me that when Congress passed a law that said you should do work on improved safety systems, or systems to improve reactor safety, that you could have said: we are already doing that, this -- lower plenum injection -- this -- this -- are already in that category; which probably wouldn't have gotten you any more money.

In addition, Congress said you should have a long-range plan; and that's presumably what you did with the NUREG 0438.

So, you sort of took the attitude that Congress thought this was something new, you would consider it something new; you would come up with a long-range plan; and you expected to get more money for it?

MR. DI SALVO: Yes.

DR. SIESS: In effect, a strategy --

MR. DI SALVO: Yes.

DR. SIESS: And have you got a clear distinction in mind between confirmatory assessment research, or research for confirmatory assessment, and research to improve reactor safety?

MR. DI SALVO: Well, I think in principle there's a clear definition; when you get down to specific projects, though, as Dr. Okrent pointed out, there's a lot of gray area and overlap.

In general the research, the bulk of our research that we're doing, is to confirm the adequacy of regulatory positions and regulatory standards and guides, whatever the agency uses as a basis for licensing plants today.

That is, in my own mind, fairly clear.

With regard to improved safety, it's working on features that may not be in plants at now, but could very well come down to us in the future.

DR. SIESS: Does "confirmatory" research mean to you at any time that you are confirming the findings of an applicant or a vendor which may relate to existing systems, or may relate to new systems?

MR. DI SALVO: Yes.

DR. SIESS: But you make a distinction between confirming the safety of existing designs or plants, versus evaluating new things?

MR. DI SALVO: Yes.

DR. SIESS: But suppose somebody came in with a new idea, and you did research on that idea; is that "confirmatory" or is that "research to improve safety"?

MR. DI SALVO: We were told that confirmatory -- and a prime example is the upper head injection concept for Westinghouse plants -- we are doing some research on that in semiscale --

DR. SIESS: How much work was done on upper head injection before it was actually put into a PSAR?

MR. DI SALVO: Oh, none by us.

DR. SIESS: Well --

MR. DI SALVO: None by us.

DR. SIESS: Again, there was confirmatory research by NRC until it was actually a designed system?

MR. DI SALVO: That's right.

DR. SIESS: Not a proposed system?

MR. DI SALVO: That's right.

DR. OKRENT: One wants to be a little bit careful. I am sure if one went back and looked at the NRC research program one would find things that are there that don't represent something which confirms a regulatory position or which is trying to confirm the stated performance by applicant, or so forth.

I don't think you'd have to look too long to find many examples.

MR. DI SALVO: Probably.

DR. SIESS: Well, now, the term "confirmatory" didn't really exist until the Reorganization Act?

MR. DI SALVO: That's right.

DR. SIESS: So it would be possible that anything that has been started before that under the AEC would not necessarily have been divided into confirmatory versus improved safety; would it?

MR. DI SALVO: I think that's right, Mr. Chairman.

DR. SIESS: But when Congress did propose the "improved safety research" -- you didn't really try to go back and look and see what research you were already doing was in that category?

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You sort of accepted it as a new category, and one that would be accompanied by new money?

MR. DI SALVO: Right Yes.

DR. SIESS: Now, with the NUREG 0438, do you feel that you've defined "improved safety" by the items listed in there, and things have to fit that category; and that that now constitutes your definition?

MR. DI SALVO: I think the groundrules --

DR. SIESS: It would have to come under that line item in your budget? It can't be put under some other item?

MR. MURLEY: Well, two questions there.

I think, you know, that Sol and I presume Ray, have gone back and looked at the work that was done under their NUREG 0438 in light of Three Mile Island, and in light of recurrent procedures that we work under.

And I think Sol has found that it is generally still applicable; most of the items that we rated as high priority still have high priority. And that we should be working on them.

I believe that if there continues to be what I consider a -- not a unanimity of support for improved safety, primarily in the Congress, and in the Administration, that we may see some of this work in the budget under the regular research.

DR. SIESS: That's exactly what I was getting at. And I guess we can get at it a little more directly when we look at the FY 80 supplement.

I won't speak for Dave; he's hear and he can speak for himself --

(Laughter.)

-- but I think the question is not such much what you are doing, because most of the areas that have been outlined and the ones you've started in on are the ones that I think we think are important.

The question is, really: does it all have to be done under this particular category where it seems to be hard to get money?

Or, is the distinction so clear that if Congress doesn't appropriate money specifically for improved safety research or research for improved safety, it can't be done?

MR. DI SALVO: The answer is, it doesn't have to be under this budget category.

And I think I explained that we thought it was going to get support when we put these items in a high visibility, and at the request of the Commission. They requested that we break out "improved safety" as a separate functional line item.

We thought it would get support in the funding.

So we may have to wind up putting some of the work in other budget categories.

DR. SIESS: Has it gotten what you think is adequate support from the Commission? -- the Commissioners?

MR. DI SALVO: Well, I think by and large, yes; they highlighted it as an important area. And they have in turn requested the funds for it.

DR. SIESS: Back in January when the reprogramming of unobligated FY 78 funds was being considered, one of the Commissioners had some reservations in the area of improved reactor safety. Was that subsequently resolved?

MR. DI SALVO: As far as I know, it was.

DR. SIESS: What kind of reservations were they?

MR. DI SALVO: Well, I don't remember.

Do you?

MR. MURLEY: No, I don't.

DR. OKRENT: Are you referring to Commissioner Gilinsky?

DR. SIESS: Right.

MR. DI SALVO: He expressed -- he requested further, written justification from us. I believe at the time he nonconcurred; and he requested some additional written justification as to why we were requesting this reprogramming action.

And some written justification was provided; and I haven't received any more feedback. But I know also the package was sent to Congress and approved.

But I was not present when he expressed this.

DR. OKRENT: Well, if I can offer a personal opinion:

I haven't seen any sign of strong support, and certainly not wild enthusiasm from the Commission.

What I was told is that they did not concur in any reprogramming in FY 78, although it was proposed by Research. And I haven't seen any large amount of money forced down Research's throat by the Commission, as it were, in this area.

DR. SIESS: Dave, you said they didn't concur in the FY 78 carryover reallocation?

DR. OKRENT: No, what I am saying is: in FY 78 when this program plan was proposed to Congress, I was told that Research proposed that some money might be made available in FY 78 to begin planning the program and so forth; and the Commission did not concur.

So I would say that was step-number-one of non-enthusiasm, or nonsupport, or something.

MR. DI SALVO: I will move on.

There was a question specifically to be addressed as to what effects TMI had on our priorities?

And that's shown on the next vugraph.

(Slide.)

You may want to spend some time on this, or we may want to go back to it this morning several times.

What I've shown is the -- excuse me -- are the five technical areas that we judged the highest priorities, and a category for general studies and a category for the improved methodology.

When we last spoke to the Committee on March the 7th, '79, we showed the breakdown as "three" for alternate containment, "two" for shutdown heat removal, and "three" for value-impact.

As a result of opinions expressed at that meeting and as a result of the Three Mile Island accident in the interim, we have decided to change our priorities somewhat, and with limited flexibility, of course, because we are working with small total dollars.

But it was crystal-clear from Three Mile Island that there are improvements that can be made in the area of human interaction. We'll discuss this in a little more detail. Human interaction is a very broad area, and it covers many, many things.

In the original program this was identified as in-plant accident response (indicating); but it's clear that there are many other areas of human interaction that should be covered here.

So this is the way we intend to spend what money we hope to have available in '79. We've already committed in alternate containment, and we've committed $100,000 of this $300,000 here (indicating) for human interaction.

In fiscal year 80, we subm...ted a budget to OMB in which we put in $4.3 or $4.4 million to implement the research plan. This would have been the first budget year in which we could really make our request of what we felt was really enough to implement the program fully.

OMB responded by allowing us $1 million in budget, and their rationale was explained in a letter from McIntyre to Hendrie, and in another letter dated the same day, from Cutler to Hendrie, explaining that they felt that this amount was sufficient for NRC to evaluate concepts rather broadly and then provide guidance to DOE on how the experiments should be run, giving them guidance as to detailed designs.

We did not not concur with that position, but, nonetheless, it was submitted in the President's Budget for 1980.

And the way we broke that down is shown.

Now, as a result of Three Mile --

DR. SIESS: Can you appeal OMB?

MR. DI SALVO: We did appeal the OMB.

As a matter of fact, they cut something out or -- well, I believe the first time it came back marked zero. And then on app⁄al they provided $1 million. I am not certain about that. But this was the bottom line.

DR. SIESS: Again, I was a little interested in the Commission's support for funds, as to whether the Commission supported an appeal?

MR. DI SALVO: I believe they did. But we are talking about areas that I am not thoroughly familiar with.

There was an appeal made.

DR. SIESS: Now, what did Congress do in the FY 80 program?

MR. DI SALVO: Fine. I'll discuss that with you.

The Senate authorization markup also apparently .lt that $1 million was not a sufficient amount of dollars, especially in light of Three Mile Island; and they authorized as follows, or they proposed authorization as follows:

This bill designates $4,400,000 to continue the program of research into improved safety systems for nuclear power plants. This amount may not be reduced through reprogramming. The amount designated, $3.4 million above the budget request -- as shown here -- to cover this program, $3.4 million is to be reallocated within the research program.

A little further down --

DR. SIESS: So your total research budget wasn't changed, but they proposed that you reallocate into this category?

MR. DI SALVO: In the authorization, I don't know; I'm not sure.

DR. SIESS: I thought that's what you just said?

MR. DI SALVO: Well, the authorization and the appropriation don't always match up. I am not sure what the authorization came up with for a total research budget.

DR. SIESS: I thought you just said this was a Senate authorization?

MR. DI SALVO: This is a Senate authorization markup. It said that we should pull $4.4 million out of the research budget.

But your question was, did it change the research budget?

DR. SIESS: No, the answer is no; I know that.

MR. DI SALVO: A little further down in the discussion it indicates that, "Events at Three Mile Island have indicates areas where additional research is needed. NRC is now in the process of reviewing its three-year plan and reordering priorities within the five areas chosen. NRC believes this can be done without disrupting the overall plan, for example, improved in-plant accident response has been moved from fourth to second in priorities and behind alternate containment concepts."

DR. SIESS: So as of now the Senate authorization markup puts you back where you requested, $4.4 million?

MR. DI SALVO: That's right.

DR. SIESS: The $4.4 million requested before Three Mile Island?

MR. DI SALVO: Originally, yes.

DR. SIESS: And they gave it back to $3.4, presumably partly based on Three Mile?

MR. DI SALVO: Right.

DR. SIESS: Now, this figure doesn't show your proposed FY supplemental? Right? Or is that what "requested" means?

MR. DI SALVO: This includes the supplemental --

DR. SIESS: That means that under your supplemental you won't ask for any more from the Senate than you did before -- which was your original $4.4 million?

MR. DI SALVO: That's correct.

Now, the appropriations bill, as I recall, did not appropriate any additional money for safety research; I believe they left the number of $1 million; and also indicated that some reprogramming action should take place.

MR. MURLEY: Yes. I'll have to clarify that.

They did not specifically speak to the improved safety budget. They cut certain items and left others, certain items, alone; but in general, they cut $6.4 million from the research budget, the House Appropriations Committee.

They also added that we should spend $3.7 million for advanced reactor safety research program, which will have to come out of our budget somewhere.

The net effect is, aside from the gas program, we'll have to take a cut of about $10 million.

They did not specifically reduce the improved safety program. It's a matter of our priorities within research as to where we take a lot of these cuts.

DR. SIESS: Let's see, the authorization bill comes out of the Senate Committee?

MR. MURLEY: Well, the House and the Senate Authorization Committee has altered different bills, so -- I don't think either one of them has passed the formal House -- Senate; but once they are passed, they'll have to go to conference.

That should take place, I would guess, sometime during July.

DR. SIESS: There's already been a markup on the appropriations bill, even though the authorization bill hasn't been through conference?

MR. MURLEY: That's right.

Now, I must add, that the Commission has appealed the cut to the Senate Appropriations Committee. That was signed out by the Chairman on the 14th of June.

And we -- I guess I don't know what to expect from that.

Traditionally, though, we have had many of the cuts restored.

MR. DI SALVO: Specifically, the effect of the Three Mile Island on the program shows a higher priority as indicated for work on human errors; previously we had shown quite a bit more funds, roughly the equivalent funds for human interaction work to be invested; and early in the program on alternate ECCS.

And this (indicating) reflects the change in our priorities.

It also asks for restoration of programs which were not directly linked to Three Mile Island. One example is the advanced seismic design work, which we think -- always have though -- was important work. And I think the five-plant shutdown emphasized the need for that.

In fiscal year 81 -- excuse me?

DR. OKRENT: I really don't see a connection between the five-plant shutdown and what I understand would be done in advanced seismic design.

MR. DI SALVO: Well, the connection I think is just one of topics; in other words, it's an area that's received a lot of interest lately. It's an area that we already had indicated as one of those high-risk areas.

DR. SIESS: I agree with Dave.

There's a connection between the five-plant shutdown and the seismic safety margins research program --

MR. DI SALVO: Yes.

DR. SIESS: -- but I don't see any connection between that an isolation of --

MR. DI SALVO: Well, I wouldn't even connect it there.

DR. OKRENT: This relates to the degree to which these aspects of reactor design have been given proper quality assurance in the past, either by the vendor or by the NRC Staff; and I think one wants to be a little bit careful about justifying one thing in terms of a seemingly related subject.

DR. SIESS: I disagree with Dave.

And I do see a connection. Because I think if we had an understanding of what the margins are and where they come from -- that we hope to get from the seismic margins research program -- a wiser decision could have been made on the algabraic summation than in the absence of that knowledge. So I think if we had that knowledge, we might have done something different; I am not sure.

MR. DI SALVO: Let me discuss and try to clarify for you, if I can explain it properly, the two different columns under fiscal year 81:

The two columns represent two different figures, depending on what happens in fiscal year 80. In other words, this requested column, totalling 4.7 million is what we are proposing to spend, assuming we get $1 million in fiscal year 80.

And the amended column totals what we would request should we get the augmented budget of $4.4 million.

The difference is primarily in maturity of the program. Okay?

DR. OKRENT: We'll come back to this later? Is that the idea?

MR. DI SALVO: Yes.

DR. SIESS: Before you take that off --

MR. DI SALVO: Yes?

DR. SIESS: These are listed as the effects of TMI-2 on programming.

MR. DI SALVO: That may be a little too broad.

DR. SIESS: It seems to me that the first four items could be fitted in that category; I am not sure you can tie seismic design into TIMI-2 very easily.

MR. DI SALVO: Correct.

DR. SIESS: I believe three kinds of research come out of TMI-2:

One is research that might be needed to help a safe recovery from the accident.

Another would be research that might be needed to improve our understanding of the things that went on during

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the accident.

And the third would be related to improved safety. We can look at the TMI-2 and say: this demonstrates that reactors are not safe enough; therefore, we need to do research to improve safety. What can we learn from Three Mile Island that can do that?

Right?

MR. DI SALVO: Well, most -- you are right. This is a broader title than really is warranted. But I just wanted to show you pre-and-post dollars.

You have in your handout some additional detail in the area of human interaction. I don't know whether to go through that now or save that for later.

But I think that was a big budget item --

DR. SIESS: Let's save the details for later.

MR. DI SALVO: Fine.

DR. OKRENT: At some point, and I don't particularly know the right time, I would be interested in understanding how the Division of Research decides that $6 million in FY 81 or $4-1/2 million in 81 -- whichever figure you wish -- is, on a comparative basis, the right amount, when one considers what research is asking in the area of structural engineering, mechanical engineering, large LOCA's -- you name it?

I would like to hear why Research thinks this is the right amount for these topics.

All other considerations aside -- in other words, don't tell me -- I don't know how much the Congress will give, or what the Commissioners will give -- how much do you think you should spend here compared to these other areas? -- if you were given a free hand; and I assume you are, initially, to propose, at least, to somebody?

MR. DI SALVO: Are you asking rhetorically?

DR. OKRENT: No, no.

This is a question whic would like to have seriously answered, because, in fact, it is a question that the committee is supposed to address at its July meeting. And whenever is the right time -- but sometime today I would like to hear that.

MR. MURLEY: Well, why don't we do it now?

Ray, I would ask that you kind of address how you come up with the 4.7 and the 6.6, and get it jumbled in the internal process, and then what we did about it, and how this relates to the overall research budget.

MR. DI SALVO: The numbers in the vicinity of "four" were arrived at in the course of melding the original research plans. And there were quite large fluctuations, on the order of two or three times of what we felt the numbers should be.

I believe originally, the original Staff estimate, for the money that would be requested in this budget category was quite a bit lower than is shown. And then we priced the research that we thought was going to be done with the industry people, and they said, that's not nearly enough; and it went way up; and then it came back down again. It fluctuated quite a bit until there was some collegial opinion on what we thought a reasonable cost estimate was.

DR. SIESS: Well, why isn't it ten percent of the total budget? -- $15, $16, $17 million?

MR. DI SALVO: Why is it not? I don't know. I don't have a good answer for why it's not.

DR. SIESS: How did you decide it should be in the neighborhood of "five or six"?

On the basis of need? On the basis of what you could accomplish?

MR. DI SALVO: I think originally it was decided on both bases.

We looked at what research was underway already, we identified where the results of that research went, where we could build on what we already had available; and then identified some areas where that could be augmented to cover the improved safety area.

And that was the number that we arrived at.

I don't know if there was ever any consideration that said, this work should be a certain percentage of

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the existing work.

DR. SIESS: Well, what you said seems to say everything is building on the past, and there's no new initiatives.

But the improved safety research was intended to be a new initiative. At least that's what the Congress' intent was when they spelled it out. And you certainly attacked it as a new initiative when you made your original budget request you explored a few minutes ago.

Does Research at any time sit down and -- at high levels -- and just say, we've got so much money, we really ought to allocate so much to improved safety, and then go on?

You got a laundry list. Obviously your original ideas from the long-range program was a lot higher -- you are not even approaching that level of $13-to-$14 million over three or four years, which is $4-or-$5-million a year.

MR. MURLEY: Yuh.

Okay, I think we have to be careful in comparing dollars.

It is not correct to assume that dollars reflect importance necessarily in the budget. We have -- I sat down with Sol and Frank Armstrong and we've gone over the budget and the improved safety budget has ranked number-one in Research.

Our fiscal 81 supplemental, that is at the top of the list. I don't believe these numbers have ever been reduced by anyone.

I think they've been added to, as a matter of fact. Some of my staff come up with ideas, for example, in the operational safety area; and it touches on improved safety; and frequently we will decide that that ought to go into the improved safety budget.

All this is by way of saying that in the Office of Research, improved safety has extremely high -- the highest priority.

Now, we are under somewhat of a limitation in the amount of money we can spend, because we are not allowed to spend it on hardware. That was an explicit -- covered explicitly in OMB's letter to the Chairman.

That's why my budget in safety research is so large is because we are spending an awful lot of hardware, operating crews, computers, time, that kind of thing. Ray's program is primarily studies; and so, $6,-$7 million can pay for an awful lot of manpower. That's probably 100 professionals, full-time.

I think in a nutshell, that is the answer: that it is high priority; but you can't compare it with the hardware program.

DR. OKRENT: Well, I would like to disagree with you a little bit.

I in the last day or so have been looking at what's being proposed in -- in what I think's called general engineering, seismic, structural and mechanical, engineering safety questions -- it's proposed in what I've read, if I take the level-4, and just go from about $12 million -- either $10-or-$12-million in FY 80 to $18-to-$20-million in FY 81; and that in general is not equipment-related --

MR. DI SALVO: It is.

That envisions, Dr. Okrent, a bam amount of equipment.

DR. OKRENT: Not very much from what I read.

MR. DI SALVO: Well, that may be true in the narratives, but a large part of that increase is in fact testing of structures and components.

DR. OKRENT: Let me agree that a few million may be for experiments. Suppose that's the case, if you told me that improved safety is number one, and yet this is one of several, I think, that I could look at where in fact there are sizeable increases -- in fact, in this case, the increase is substantially larger than what you proposed for reactor safety.

I repeat: I think the dollars going into studies -- there's a lot of different studies talked about, many, many different studies that are either only analytical or analytical and experimental.

If I look elsewhere in your budget, going from for example, code development in FY 79, 9.4; in FY 80, 9 or 12 depending on what you get is going to be there. Now, that's not hardware, I assume..

MR. DI SALVO: Computer time.

DR. OKRENT: It's money.

So when you tell me that improved reactor safety is being given priority, I have to be skeptical; and when I look at what you propose to do over the years, you are going to make a beginning in some areas; other things on the list you'll do maybe a little more on them.

I think the actions don't match the words.

MR. MURLEY: I think I'm going to have to put you on the spot.

I said I think it's high priority. I believe it is.

The committee, at least some of the members, are suggesting that we're being a little timid, and why didn't we ask for $10-or-$12-or-$15 million?

I guess I'll have to let you tackle that.

MR. DI SALVO: Well, I think this was our best estimate of what we could do in our charter.

Now, we will be hearing from DOE this afternoon.

And they also have a charter towards improving safety. And I think some of their plans are quite a bit more ambitious, at least in terms of dollars spent.

OMB requested us to look at this area as a total, and not necessarily do it as one part of the NRC budget. And it may very well be that we should sit back and reask this question after we've had an opportunity to hear what DOE says.

DR. SIESS: When you requested $4.4 million for FY 80, that was before OMB had said, don't spend it on hardware. Did that envisage any money on tests or hardware?

MR. DI SALVO: Yes, it did.

Well, it envisioned money to be spent on experiments. And let me explain what I mean by "hardware".

We knew we were not going to be developing new systems.

DR. SIESS: How about experiments?

MR. DI SALVO: We did envision experimental work in the areas that I think we felt were most in need of experimental work.

One was the alternate ECCS testing where we had the facility already available, and therefore we could do our experimental jobs fairly early.

Another was in the seismic design area where we might want to do some shaker-table tests.

There was potential for experimentation on vented containment such as examining the efficiencies of various filter materials.

I am sure that we could find many areas where big dollars could be spent on experiments. Now, how well-spent that money would be, still has to be decided.

DR. SIESS: Put that last slide back on?

MR. DI SALVO: Sure.

(Slide.)

DR. SIESS: Do you recall how you had your original $4.4 million allocated among those items?

MR. DI SALVO: It was basically the same -- this area (indicating) was -- the way we originally proposed it in the fiscal year 80 budget -- if you want to pencil these in, I'll just run down the list:

It was 0.4, alternate containment; 0.3 for decay heat removal; 2.5 for ECCS; 0.3 for human interaction; zero for seismic design; 0.3 for scoping studies; and 0.5 for improved methodology.

Now, the reason that the ECCS number was so high was we thought we could do experiments rather quickly in semiscale.

In the out-years in that original package, it indicated experimental work in seismic design, and -- I'd have to go back and check -- possibly alternate containment.

But there were experiments proposed, and this was one of the things that OMB took issue with.

This was to be in the realm of the DOE program that -- DOE, the money would stay with DOE, and we would guide their program.

DR. SIESS: What do you propose next?

MR. DI SALVO: For the agenda?

DR. SIESS: Getting into details of the obligated funds?

MR. DI SALVO: Well, I wanted to answer a couple of specific questions that were raised, and then I think it would be a good point to break for Mr. Kearney.

DR. SIESS: Go ahead.

MR. DI SALVO: Okay.

In your handout you have a page and a half of this format (indicating), you requested information on the status of the work scopes.

The format is broken down into the several topical areas, where we have work scopes finished, they've either been forwarded to you, or I have a packet of additional draft that you may want to review.

If you have any comments on these, they would be most appreciated. But I won't go into detail; the information is all there for you.

DR. OKRENT: By the way, I haven't seen those. If you have a copy of the work scopes -- did you say?

MR. DI SALVO: Yes.

They were forwarded to the staff. They were forwarded quite a while ago. We have an additional one that I have today for you.

DR. SIESS: That was handed out at the March 9 meeting.

MR. DI SALVO: There have been new ones since then.

DR. OKRENT: I should amend my statment: they may be sitting on the floo: of my office in an unopened box.

(Laughter.)

MR. DI SALVO: I think it's important to point out that not all the dust has settled as a result of Three Mile Island. And I think we are still going to possibly revise our plans in future in this area.

There may be additional recommendations, we've got the Lessons Learned Task Force; one of their jobs is to come up with some longer-term recommendations. And these various other groups (indicating) are, I believe, going to affect what we do. And they've just confirmed that what we decided to do was correct.

But I think there are a lot of official studies yet to be heard from. And we are going to have to accommodate these in our reorganization of what funds we have available, or make additional requests -- or, I doubt if they would cut back.

Now, just to summarize on the administrative status, we've committed $400,000 in '79, and we have $400,000 pending, which we'd like to spend as soon as we get it.

And in fiscal 80 we've budgeted $1 million, a 4.4 floor in the proposed authorization, $1 million in the proposed appropriation, but there's provisions for reprogramming; and work scopes are in various stages as we've indicated earlier.

In 81 we've made a request for $4.7 million, the floor is $6.6 million, depending on what happens in fiscal year 80.

DR. SIESS: Now, in 81, the $4.7 million assumes that you get only $1 million appropriated, even though Congress says, spend $4.4 by reallocation?

MR. DI SALVO: Correct.

DR. SIESS: You would spend 4.4 in FY 80, and 4.7 in FY 81.

MR. DI SALVO: No.

DR. SIESS: Well, right now you've been told in FY 80 to spend $4.4 million on improved safety, although they didn't give it all to you. They said reallocate.

MR. DI SALVO: It turns out the appropriations bill supersedes the authorization bill, so that even though the authorization bill may set a floor of $4.4 million, if the appropriations bill does not appropriate the money, then it's only going to be $1 million.

DR. SIESS: They don't appropriate down this far, do they?

MR. DI SALVO: Yes, they do.

DR. SIESS: Their line items go down this far?

MR. DI SALVO: Correct.

DR. SIESS: So, then, what you are assuming is that you -- if you spend $1 million in '80, you can spend $4.7 million in '81; if you spent $4.4 million in '80, you could build that up to $6.6 million in '81?

MR. DI SALVO: Yes.

DR. SIESS: Okay.

When would you know what the final appropriation is for FY 80 -- hopefully before October 1st?

MR. DI SALVO: It would probably be -- I don't know what the Congress' schedule is this year -- but it will probably be September before we know.

Now, I might point out that I believe there's small chance that we will get more than $1 million in the original appropriations bill. If we go forward with a supplemental request, then the intention is -- if the

Commission approves it, that we then go to lb, and they have to approve it, of course; and the intention is that it would go to Congress in I believe it's September, October in time for the Congress to act on it before the year-end recess.

If they were to act favorably on it, then we would get the fiscal AB supplemental by Christmas.

DR. SIESS: That would be 4.4?

MR. DI SALVO: That would be 4.4.

DR. SIESS: Or in addition to the $1 you already had?

MR. DI SALVO: No.

MR. MURLEY: I think it's clear a lot of our problems are in the mismatch between the appropriation and authorization bills. It would be a lot easier if such mismatches did not occur.

DR. SIESS: I am sure there are lots of agencies in government that would share that feeling.

(Laughter.)

Does that get you up to a good stopping point?

MR. DI SALVO: Well, yes it does. I was going to start talking a little bit, say a few words about the NRC-DOE coordination; but you may want to hold that until after Mr. Kearney has spoken? I am not sure. It's up to you.

DR. SIESS: I think we'll -- is Mr. Kearney here?

(No response.)

DR. SIESS: I think we'll take a ten-minute break and call Mr. Kearney and see when he'll be in; and we'll go with him then or if he's not here well we'll let you start.

(Recess.)

DR. SIESS: We will resume.

Is Mr. Kearney here yet?

(No response.)

Okay. Mr. Di Salvo, I'd like for you to just go ahead, if you don't mind, with the understanding we'll interrupt you.

MR. DI SALVO: The committee expressed some interest in the status of the coordination between NRC and DOE.

As you recall, the letters that were sent from OMB to Chairman Hendrie back in January indicated some guidelines for how NRC and DOE might work together in this area. Those letters were in response to the fiscal year 80 budget submittal.

And it indicated several things, first of all, it cut NRC's request level; it said that the level that OMB felt was appropriate, thought was appropriate just to do some general evaluating of concepts, they were quite concerned with the either real of apparent conflict of interest in NRC's getting involved in the development of designs which at some time they might be required to license, or be requested to license.

And it also indicated that what money was made available to NRC was not to be used for physical experimentation, that DOE had funds in their budget which could be used for physical experimentation; and that the job of NRC would be to guide the DOE programs for what we felt would be the most effective service to safety.

Now, I won't say anything more to the DOE program other than this:

I observed the DOE program. The improvement of safety in light-water reactors is one of several objectives that they have in their LWR technology program, along with things like improving the availability of plants, and increasing the cost-effectiveness of the plants; and it's not the sole objective of the DOE program, as I understand it.

Now, given that two government agencies have to cooperate, we have been asked to show how we are coordinating our work. And primarily the mechanisms of coordination are those shown on this slide --

(Slide.)

-- I think the prir ipal mechanism has been informal staff contacts. I talk very frequently with Mark Norin and Frank Gavigan before, who manage this program, as well as with the program manager from Sandia, the technology management center, Mr. Dahlgren.

And in general we are well-informed of what each other's priorities are and each other's plans are; in addition to speaking with each other, we do exchange documents, work plans, progress reports regularly.

Physical evidence was requested; I have a packet of that material if you are interested. The point is, we do exchange information.

But in the course of developing our original program plan, NUREG 0438, there were representatives from the Department of Energy on the group; they provided their input through that mechanism.

Just prior to Three Mile Island there had been a meeting scheduled to discuss the DOE program; but Three Mile Island came along and it was -- that meeting was cancelled until further notice.

But I would assume at some point when DOE is ready to present their plan, there will be representatives from NRC to provide their input, and, hopefully, introduce our perspective into that plan.

Finally there was also some recommendation made for the development of a coordinating committee; the objective of this committee, as stated to us, was to review expenditures. I think it really must do much more than that.

I think the objective of such a committee is really to reach some agreement on the direction and scope of NRC-DOE programs.

DR. SIESS: You said there was a recommendation to develop a coordinating committee? A recommendation from whom?

MR. DI SALVO: We were requested by -- let's see, in a memo from Chilk; that generally means a request from the Commission -- to provide a recommendation on the formulation of a coordinating committee. So it's our recommendation in response to a request.

And the objectives were as I indicated, to try to reach some collegial agreement on the scope and direction of the program.

I think if such agreements are to be made, this has to be rather high-level management personnel on this committee. I think that's already been agreed upon.

DR. SIESS: Reading from the January 31, 1979 letter from OMB, there is some very specific guidance in there.

It says that the NRC is to give guidance to -- it says, this approach also provides sufficient funds to enable NRC to give guidance to the DOE program based on these assessments.

MR. DI SALVO: Which OMB letter are you reading from?

DR. SIESS: January 31, 1979, McIntyre to Hendrie.

It says this approach also provides sufficient funds to enable NRC to assess concepts for improving reactor safety, and to give guidance to the DOE program based on these assessments in NRC's recognized expertise in the reactor safety area.

It goes on to say, it is intended that the NRC participate in DOE's development of a program plan for DOE's safety research program. This will influence the direction of DOE's experimental efforts to focus on the most important new safety concepts.

Now, that seems to be fairly specific as to the role of NRC in relation to DOE's program.

Now, was there some kind of a letter written to DOE telling them that they were supposed to cooperate with NRC in this fashion?

This certainly implies a level of coordination higher than you've indicated.

MR. DI SALVO: I'll have to ask Gerry Griffith that. I don't know what they received in the way of guidance.

MR. NORIN: I'm Mark Norin. I am new to the program. I don't know of such a letter.

MR. CARLSON: Carlson, DOE. We got copies of the OMB letter, but the coordination -- the draft plan was produced by Sandia, and NRC views were going to be taken in

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during review of the plan.

MR. NORIN: Well, the answer is we did not receive separate letters.

MR. GRIFFITH: Gerry Griffith, DOE.

The ball is in NRC's courts for setting these up. There has been managemental action below the OMB level where people agreed that this is NRC's motion to coordinate the committee between EPRI, DOE and themselves.

DR. SIESS: What's the status of the coordinating committee?

MR. DI SALVO: It hasn't been established yet.

DR. SIESS: Has Research submitted a proposal to the Secretary for it? You said it was requested by Chilk, he recommended something?

MR. DI SALVO: It was being worked on this week, and a letter was being prepared for Mr. Levine's signature.

DR. SIESS: Is it expected there will be a memorandum of understanding relating to this?

MR. DI SALVO: I don't know.

DR. SIESS: Okay, I understand Mr. Kearney is here. Is that correct?

(Indications of assent.)

I think we will change directions and let him speak at this time.

MR. KEARNEY: Generally I prefer a more formal operation, but I appreciate the opportunity to come here in a somewhat formal sense and talk with you about the Administration's positions and views on improved reactor safety; to also solicit your comments; and assure you that your views on the subject -- since there are a lot of decisions yet to be made on it, the organization of the safety effort -- solicit your views into our process, the budgetary process; and assure you that they will be taken into account.

What I want to do today is just kind of run through generally how we developed our particular view of improved reactor safety and the disparate Federal agency roles.

I think we all view this as a total Federal effort to assure the innovation of improved safety concepts; and I think it is from that perspective that I would like to talk.

I should introduce myself: I am Branch Chief for Energy Technology in OMB. And I have responsibilities for all the energy development activities conducted by the Federal Government.

I mention that because I think that this will have relevance later on in some of my comments on how we see this kind of activity and how it compares with the other energy resources and programs and activities being conducted by the Federal Government.

There is really no easy way to approach any difficult subject such as the question of our involvement institutionally in nuclear safety. We all know what the goal is for the future safety of reactors; the difficult question is the route to get there.

And my work is not doing the work, but the organizational considerations.

I want to contribute today whatever I can to your discussions. As I mentioned, I do wish to encourage you to give us your views either now or as time goes on.

Let me go back to some of the development of the Carter Administration's views:

As you know, the President, during his campaign and thereafter, recognized the importance of reactor safety. This is reflected in his national energy plan, where he describes something that he wishes be done and particularly implemented.

As a consequence of that the Federal budget in reactor safety improvement area -- I am not talking about the base confirmatory research of the NRC -- improvement in the reactor safety area, the budget which didn't exist, there was no activity, was increased in fiscal 80 to $8 million, between both the Nuclear Regulatory Commission and the

Department of Energy.

A great deal has happened over the past year, and all this demands a rededication to reactor safety. And this, I am sure, is going to precipitate additional concerns on the part of the Administration, reflected in its actions, in the budget, and subsequent to any of the ongoing investigations of Three Mile Island.

It is with respect to assuring reactor safety that I wish to focus many of my comments, that is, on doing the research effectively, not only on getting research out into the field, but in making sure they get the job done; making sure we achieve the objectives; that something moves all the way through from the laboratory into the reactor where it gets used.

We've had particular difficulty in this area in a lot of our energy technology developments.

I have said and I have not yet been contradicted I think, that I don't know of an energy technology that the Federal Government has developed for energy purposes alone that has gotten out into the private sector that's being used. We in the Federal Government have a major problem in moving something out into utilization.

And there's some of that consideration that reflects in our views in the institutional arrangements for improved reactor safety.

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As you know some of these considerations that affect how things move into the private sector have to do with the complex regulatory environment in the nuclear area, the affordable development of nuclear power, that is, as a totally Federal responsibility; which make it much more complex than the garden-variety of technology. It makes it more of a concern to us to assure that things get done and get done well.

There is one area which draws a lot of our consideration, too -- you are all aware of this, and I needn't go into too much detail; and that is the conflict of interest in the case of NRC.

I know we are all cognizant of the regulator, the NRC, in this case, also being the developer and innovator of nuclear designs. We have to be continually conscious of that, that role, and the problems that that presents.

I think NRC has the lead responsibility, obviously, for safety research in the confirmatory area; and they must play the role of the Federal regulator.

If NRC also has the lead responsibility for conducting research leading to innovation, they readily can get into a conflict of interest situation. And I want to get into that in a little more detail later on.

Let me address the character of nuclear safety: improving nuclear safety as we see it is a complex research and implementation endeavor. It spans basic research, development of concepts, through to the engineering of them, to the application and integration of these into the industrial complex.

Today's agenda emphasizes the focus on the technology side. And as I mentioned, I want to focus on some of the institutional questions.

I think the organizational structure both of the nuclear industry and the Federal Government needs to be looked at as we address the question of which agencies will conduct which kind of research.

The regulatory environment that the nuclear industry and the utility industry in general exist in, also plays a role. Not only do you have technical regulation by NRC, but you also have economic regulation by public utility commissions. This affects what we see and how we act in budgetary areas.

The fact that industry has relied on the Federal Government for the development of nuclear power also results in an anomaly which doesn't exist in a lot of other energy technologies; the anomaly being that the sole responsibility for reactor safety rests with the Federal Government.

There is no other technology development and no other Federal activity that I am aware of where that sole responsibility does rest with Federal regulation.

Even though we call it confirmatory research, I think that the amount of research being done in industry is minimal at best. We have to recognize that.

But I think that there isn't any disagreement on the need to be careful about the role NRC plays in improving research. I think you are well aware of that; I think NRC is well aware of that.

The problem arises in drawing the line of what kinds of activities NRC can and should be doing, and what kinds of things ought to be done by other agencies -- the Department of Energy, in this situation.

In viewing this, I want to reemphasize consideration of the following items which really lead the Administration to its present proposals for the distribution of improved safety research responsibilities:

First, NRC's need to maintain a disinterested regulatory role. This must be preserved, even if -- and this is tough on you -- even if inefficiencies result.

Second, in order for more effective use of Federal taxpayer expenditures, we must be assured that the research will result in implementation of innovative concepts.

We have difficulty seeing that occur within NRC -- a totally-NRC oriented effort. NRC cannot work too closely with industry. If innovation is to occur, industry must also carry the burden in bringing these things into existence.

Finally, we are most sensitive -- and I think NRC and other agencies share this -- to the need to assure that taxpayers do not needlessly bear the full cost for the development of improved concepts. As is the case in all other energy technology developments, the nuclear industry should share the cost to develop new safety concepts. This is not being done today in NRC; I don't think it's appropriate that it be done in NRC. NRC is in a very difficult situation if they begin to work and develop too closely with industry.

I think also in the development of -- from what we see in other areas of things that are most likely to be accepted, be taken up by the industry, are those things in which the industry is involved in at the very outset. This argues for early industry participation, actively, in the research being conducted by the Federal Government. If that's to occur a lot of the responsibilities for conducting nuclear safety research must be born by industry.

These principles lead us in general to distribute the improved safety research activities to the Department of Energy and the Nuclear Regulatory Commission as follows:

First-idea-generation is preliminary effective evaluations, which are supposed to be the responsibility of the Nuclear Regulatory Commission. The NRC has the expertise; they are the sole holder of the expertise; they are the sole holder of the large bulk of experience -- costly experience -- that the Federal Government and the Nation has.

This investment treasure can only be used by those people most familiar with it, and that's the Nuclear Regulatory Commission.

Secondly, laboratory research to prove out a concept and the engineering and design, central designs through large-scale, if necessary, research demonstrations, should be the responsibility of the Department of Energy, because DOE has no conflicts with respect to working with industry as a regulator would. They should have this responsibility.

Furthermore, as I mentioned, the Department of Energy can share its costs with industry; and this provides us with an opportunity to both lower the taxpayer burden for improving safety as well as using the willingness to cost-share as a measure of those things that are likely to be successfully used.

Finally, the regulatory review of these concepts obviously has to rest with the Nuclear Regulatory Commission. The usual confirmatory research required as a compliment to that regulatory review, is the Nuclear Regulatory Commission's responsibility.

And as I see some of these things developing, that will become a larger conglomerate part of NRC's existing confirmatory research somewhat down the line.

NRC's review, comment and recommendation role throughout this process ought not be dismissed, either, or minimized. The expertise has got to be used in all the Federal decisions on research activity.

And I was just discussing the planning role that NRC has -- we will address that in one minute but NRC has the responsibility to make sure Department of Energy and its own activities in safety are coordinated, that they are appropriate, that they reflect their best assessments of the realities of safety and of those things that will improve safety.

Let me then just quickly list the kinds of activities that we have in mind to distribute the improved safety activities; the general guidelines, the general concepts that I mentioned before, lead to the following detailed descriptions:

NRC's responsibilities should be the following:

One, to study acceptable levels of risks; to study the improvement in those risks that might be accomplished by modifications to designs, and modifications to safety approaches.

Two, to produce examinations and evaluations of the numbers of safety concepts you have in mind, or, basically, doing the paperwork that is to be used to decide whether anything has a possibility of proceeding.

To propose the scope of experimental inquiries. This places a bound on the uncertainties to be reduced, the problems to be identified, if these are to be used by the Department of Energy in its formulation of the more detailed research activities.

NRC also should review and certify elements of safety and integrating some of these safety concepts into the overall reactor systems. These would be done on an ongoing basis for the research conducted by the Department of Energy.

I think another role that the NRC has is to assure that its regulatory activities and procedures are oriented to accommodate the concepts that may be proposed by industry or Department of Energy as a result of their investigations. And this is not a point to be minimized, either, I think it could be a weak spot in the whole chain.

The Department of Energy should propose potential improved safety concepts; it should work with the Nuclear Regulatory Commission and develop a plan for investigating those concepts.

The Department of Energy is to conduct analyses and evaluations of candidate concepts. They should conduct laboratory research, and add information to those analyses; and they should conduct detailed engineering and concept design as required to ultimately bring these into the private sector.

These should be done in close work with industry; these should be cost-shared with industry; and the evaluations should have associated with them some concept of what is the possibility of economically incorporating these into reactors, and assessments of how -- or the possibility of having these approved by the NRC.

I think that's all I have to add.

Let me just mention one thing about the planning activities and the allowance letters which were referred to here:

The NRC's letter of January 31st that you referred to asks for the NRC to set out a number of things, a number of things for the NRC to do in the reactor safety area; one was to coordinate activities with Department of Energy.

In the letter of February 1st, 1979, the allowance letter from Jim McIntyre to the Secretary, Department of Energy, the outline of how we would conduct this business was provided to them.

And let me quote:

Some $7 million budget authority are provided for research on improved safety. In conducting this program

NRC and DOE will work together in developing the DOE improved reactor safety program strategy.

Okay, can I answer any questions?

DR. SIESS: Just for the record, you indicated that we're getting, I think in your very last statement, $7 million to DOE, for improved safety programs.

In our meeting of March of this year, DOE said that actually only $4 millionof that was what they call their improved safety program, which would relate to the types of things we've been talking about here; and that the other $3 million had to do with in-plant dose reduction, which I guess relates somewhat to safety of the people employed by the utility, but not really to the safety of what we consider to be the public.

MR. KEARNEY: Well, I think in our reviews we generally did not get down to that close a scrutiny of each of the individual projects, and that's why we've really tried to set up a process by which the proper research activities will be conducted.

It turns out that when we talk about improved safety, some of the things that the agency wishes to do don't fall in that category; and I think that it's something that we can look into.

I think we see your views and impressions of that.

DR. SIESS: Well, our view I think as expressed at that time was that the impact dose reduction, although certainly desirable as an R&D effort, was not what we had in mind in terms of improved reactor safety; and we did not think it was what the Congress had in mind in terms of improved reactor safety. And I'm not sure what DOE thought.

This differentiation of the $4 million and $3 million is not simply projects; as I recall -- I can't find it in my notes -- I believe those were in two separate divisions of DOE.

MR. NORIN: They're in one division, but two separate programs.

DR. SIESS: So you do make the distinction between the two? Thank you.

DR. OKRENT: I'll be giving personal opinion, now. I have a feeling like I'm being taken back five, ten years to the point where the regulatory part of the AEC was unable to get what it thought was the desired kind of safety research done by the development part of the AEC.

And if you recall when the AEC still existed, the light-water safety research program was split away into a separate group which was to be responsive to the regulatory program of the AEC.

And I think what you are doing is setting up a system which will not be responsive unless some very, very drastic measures are taken.

And let me give you one example:

In our previous discussions with DOE on improved reactor safety, they indicated things that they were doing and they also indicated things that they felt they should not do.

One was improved containment designs intended to deal with accidents that go beyond what is normally considered the design basis. And among the reasons that they gave, as I recall, was that these were not a requirement in the regulatory process; they didn't feel it was appropriate for them to be proposing or initiating such research -- or however you want to rephrase that statement.

It of course is one of the lead items identified in the program to improve reactor safety in the NRC. It's one of the first ones they funded.

It represents a difference in philosophy which is not new. I can go back at least a dozen years and show you where the development part of the AEC has resisted doing work in this area.

I think in fact that what OMB has done is delay work in what is called improved reactor safety as discussed in NUREG 0438.

Now, in principle -- I am not saying you wished to produce a delay -- but I say you have, and I really look upon that as a higher priority than the questions you've raised about possible conflicts of interest, which is not, certainly, to be neglected; and other kinds of things of this sort.

I would be interested in knowing whether you have a practical mechanism, not a theoretical one, to get really appropriate priority in this area, if it's thought that this is a high-priority area to OMB?

MR. KEARNEY: Okay.

I will make a number of comments: First, you are absolutely right in that any bifurcation of this responsibility is a very difficult judgment call; it weighs any potential conflict in ability to get the job done against the possibility of the development agency running off and doing what they wish and not what is the wish of the regulator.

In setting up the program in the Department of Energy, the way to do this was more as a contractor -- independent, of course -- but contractor to NRC; contractor in the sense of ideas generated in NRC, NRC-derived research, rather than ideas generated in DOE, or DOE-derived research.

We have the situation in the environmental area with the EPA and DOE in their fossil research. There, too, we have a problem with the regulator driving controlled technology development; previously a lot of the research on the actual development of new control technologies for the demonstration sides, was conducted by the EPA. It was for a lot of reasons that I won't go into, very efficient to do that, to have them conduct those activities through to that level. And as a result the Department of Energy is now initiating programs with large demonstrations in mind for the development of control technology.

The reason why I mention it is that we do have problems in working out the relationships between those two agencies; and NRC and DOE in this case.

The way we had set up this situation here-- NRC-DOE -- was to allow them to do their coordination, to jointly-coordinate.

In the situation with EPA and DOE -- and I don't think there is any difference in the desire on our part or the Administration's part to get the right kind of work done -- it involves a regulatory problem -- in this case, improved safety, in that case, improved clean air.

We have had to play a much closer role -- OMB -- in monitoring that activity, in making sure that the coordination occurs.

If this does not seem to be the case here in the reactor safety area, then we clearly would be willing to play the same kind of enforcing role.

To reiterate, we did not view the activity in the DOE as a development activity, per se, that they were getting into the light-water reactor research area as they would in any other energy area; it's strictly to be an activity for safety with the ideas of the NRC.

I think that we need to reevaluate in the NUREG context where we are. There's no disincentive on our part to look at that again. We will.

And if whatyou are saying NRC is not providing that kind of driving force, we will remedy that.

From the standpoint of delay, this is something that we certainly saw as a possibility, but we want to minimize it. I don't know that much can be done; I hope they are moving along now.

DR. OKRENT: I wouldn't be so hopeful from my perspective, the pace of this program is much, much less than it should have been. That was a statement I made at the ACRS I think before Three Mile Island; so it's not predicated on that event.

I think when you look at the five items of priority, three of them in fact are quite related to the kinds of things that occurred at TMI -- not that they would have been involved, all of them, in that event -- but all three: namely, improved containment, that wasn't called on, but it could have been. Certainly improved operator response to incidents and accidents, and also improved shutdown decay heat removal, which was a part of the problem, although not th e only problem.

So it's -- none of these are moving.

MR. KEARNEY: Let me throw another perspective on the table:

You, I am sure, know better than we, but from our limited perspective the research that is conducted by NRC, confirmatory research, in the past we have found, even though the research was done, we have found few examples of where that research has really impacted in the last couple of years, has impacted the regulatory process.

And as a result, we went into this with a technical bias on the other side, meaning, if we are going to get something at the end of the road, then we might need to have somebody that's going to force whatever this research has done, force the rest of the process.

DR. OKPENT: DOE is not in a position to force it through the process, if I understand their position. If somebody's going to force it through the process, in my opinion, it's the NRC.

In my perspective of how things work and the regulatory process, not only in NRC but in others that I have had a chance to see, it's frequently regulators will see things that they would like to see improved. But until they see a feasible or practical way of doing so, they are unable to move.

Now, if they can't study the problem at least to the point of knowing what is a practicable approach, and industry or some other agency of government does not study the problem, then it sits.

You see it, you would like to do something, you may be pretty confident something can be done; and you are unable to recommend something that is practical.

And it leaves one in a very awkward situation.

MR. NORIN: Perhaps I could make a comment here:

Historically DOE does not feel that certain types of research should be initiated by DOE; if on the other hand NRC performed some preliminary work to ascertain improved containment or improved decay heat removal would have some benefit, then DOE would indeed consider performing the engineering design on it, testing to take it to completion.

MR. KEARNEY: And I think what Dr. Okrent is saying is that this doesn't seem to work.

Is that correct?

I think that this is something that obviously deserves your attention -- which you are giving it -- and ours on your views of it. I make a promise this is something we will look into.

DR. SIESS: In the looks we have had at these programs in NRC and DOE, it has been very difficult for us to feel that there was anything like $8 million worth of effort or even $5 million worth of effort on improved safety systems going on. And that subject came up originally -- what? -- three years ago now? Well, it was the FY 78 budget -- we just can't see the progress being made.

NRC has not had funding. DOE got back into the safety program, what, in FY 78?

(Chorus of "'79".)

DR. SIESS: '79. And the directions they are going only partially relate to the directions NRC is going in what was called its long-range plan; and we do not see the mechanism to get these two programs coordinated.

Now, in some ways it may be too early to see the coordination; but things are getting started awfully, awfully slow. We just do not see the progress.

We don't see a coordinating committee. We don't see a memorandum of understanding. We don't see a mechanism by which NRC tells DOE -- except DOE may have some incentive to spend the money in order to get more money -- and we don't see NRC's participation in DOE's development of a program -- which are the words right out of the letter to Mr. Hendrie.

MR. KEARNEY: I would suggest in your report on this session that you make those points: I will guarantee you OMB will take action on that immediately.

DR. SIESS: Thank you.

Our first report will really be in a letter to the Commissioners sometime in the middle of July related to the FY 81 budget; but we may try to get something out earlier.

MR. KEARNEY: That would be fine.

DR. SIESS: That may be the earliest we can act. It will either be in that letter or something else.

MR. KEARNEY: I don't need a formal letter to do something, and we shall start working on that immediately.

DR. SIESS: Any other questions for Mr. Kearney?

(No response.)

Thank you very much.

We appreciate very much your coming. If you would like to stay for the remaining discussions or have someone on your staff stay, you are certainly welcome.

MR. KEARNEY: I wil certainly have someone from my staff stay. Thank you.

DR. SIESS: Mr. Di Salvo? We will be glad to have you continue where you left off.

MR. DI SALVO: Okay.

(Slide.)

To recap where we are, I gave a rundown on the administrative status. I think I indicated to you where we are in terms of funding, and NRC-DOE coordination.

I would like to move on to the technical status. I have broken the areas down into those programs which we have already, those programs which we have pending, and contingent upon receiving FY 80 funding or FY 79 funding; and finally, programs planned beyond 80, and those programs which we would initiate as soon as we got additional funds.

I finally will address the special topic which was requested on core catchers.

Let me reiterate what I feel is NRC's charter on improved safety:

I think it is very clear that we are primarily safety-motivated, not economically-motivated; and that we are to develop and evaluate concepts. There's no question that we don't intend to get involved in any detailed design development. But we do need to evaluate things.

We have to evaluate feasibility and we are talking about things like technical feasibility. And the kind of feasibility that might not come immediately to mind is the feasibility of backfit, for example.

I think that's quite within the scope of our responsibility.

I think we are responsible for evaluating the net effect on risk of introducing a new system, what effect does that have on the overall plant system? -- because I think if you look very carefully, some things could have the potential for adverse effects on risk, as well as beneficial effects.

More generally, I think we have to assess the values of impacts of any new concepts.

It is also within our responsibility, I think, to propose new or revised requirements, that is, the Office of Research would propose such requirements and provide recommendations to the Office of Nuclear Reactor Regulation on standards regarding what these requirements should consist of, and what we feel the values and impacts of these requirements might be.

The requirements might be characterized functionally as performance in safety design -- and I can go into detail. There is a rather fine distinction between some of them, but basically functional is: what should a system be capable of doing? Performance requirements are generally under what conditions must those functions be fulfilled.

And safety design requirements refer more to requirements such as methods of activation of a particular system, or redundancy.

I think all of these are fairly within the charter of NRC.

I might also make a personal point:

I think in order to accomplish some of these tasks, in order to make some rational recommendations, I think it is necessary for us to be involved to some extent in physical experimentation. I cannot see a clear reason for precluding any physical experimentation in the NRC task.

So that is a point I will make personally, and the committee may take that into consideration if it wishes.

(Slide.)

Now, --

DR. SIESS: You say must be involved in physical experimentation? Would it be possible to say that physical experimentation must be involved in doing these things?

MR. DI SALVO: That's certainly true.

DR. SIESS: And NRC is not going to be doing physical experimentation itself; it will be contracting with somebody for doing it.

Now, it was my understanding from the OMB letter that basically, not the contractor, but the agency that would do the physical experimentation as necessary to reach these, would be DOE. I got that impression from DOE, that they didn't want NRC to be spending money for physical experimentation; they wanted DOE to be doing it, and they would give DOE the money.

MR. DI SALVO: As I understood the letter, and I may have misinterpreted it, we were not to spend any of NRC's resources --

DR. SIESS: Right.

MR. DI SALVO: -- even on contracting for physical research; although we have our own contractors under the DOE list.

DR. SIESS: But if, for example, there were directives from somebody that DOE was given money, and they were to do with that money what you told them to do with it in relation to these project s --

MR. DI SALVO: Yes?

DR. SIESS: -- then there would be no need for NRC itself to contract, to spend its money, throw its resources to that.

But you would have somebody doing it, and essentially doing what you think ought to be done, or working it out with them.

MR. DI SALVO: Yes.

I think that's true. There are probably other benefits beyond just getting the work done. There are other benefits to having NRC sponsor the work and actively involved in sponsorship of the work, other than just getting the work done.

I mean, I think it can help the Staff considerably if they have responsibility for monitoring the status of the work, rather than having to do it through some intermediary. I agree.

DR. SIESS: But assuming that NRC is going to play or should play a major role in deciding what physical experimentation is done, how it's done, monitoring it, et cetera, I don't see how a conflict of interest is reduced simply by having somebody else's money spent to do it, rather than NRC's money spent.

If NRC's going to decide what has to be done, then the conflict must be there.

I am not saying that what you proposed, the physical experimentation to determine the feasibility, the backfit feasibility, the physical feasibility -- I think that is necessary.

I don't think we can go out with some good idea and start requiring it unless we know that it will work, and have a reasonable assurance that it can be engineered. We approve concepts on the basis that we think they can be engineered. Someone's looked at them far enough along.

So if NRC's going to do that, I can't see where it makes any difference whether it's your money, or DOE's money; it's all our money, it just gets up here somehow and gets passed out.

And I don't think the conflict disappears by ju whose money is being spent.

And I don't see that the organizational arrangement that keeps NRC out of that contract and let's DOE do the work. I don't care whether you contract it out, or whet you tell DOE to contract it out, if you don't have control of it, there's a certain amount of conflict; and if you don't have control if it, I don't think it's going to work.

MR. DI SALVO: I had planned to cover very briefly three programs which we do have in place, and in the agenda you wanted contract objectives, funding -- and I spoke to schedule.

One program that we'll put into effect quickly as soon as we receive the authorization to do so, is the work on vented containments. Our contractor is Sandia Laboratories.

And they are specifically looking at containment designs for venting and filtering, and the end product would be a spectrum of the design requirements, also accompanied by, hopefully, some qualitative indication of what is the risk reduction value and possibly the cost impact --

DR. SIESS: Excuse me, Ray?

MR. DI SALVO: Yes?

DR. SIESS: You are going into contracts now?

MR. DI SALVO: Yes.

DR. SIESS: You have a slide that listed the status of approved reactor safety research. I think you put it on once earlier in the day.

MR. DI SALVO: Yes.

DR. SIESS: Why don't you start with that just to give us a quick overview?

MR. DI SALVO: All right.

(Slide.)

DR. SIESS: I think it would help.

MR. DI SALVO: It's on two separate pieces of paper.

These are the program areas (indicating). Containments, we have a contract underway at Sandia.

For shutdown heat removal we have a contract underway at Sandia.

For human interaction work, I'll be discussing in a little more detail -- we do have one program committed on sensitivity analyses; and we have several others in the planning stages.

On seismic design, we have at least one proposal under evaluation; it will start in '80 -- or maybe sooner, I don't know -- if we get lucky.

And we'd like to get some work underway with improved methodology.

Those are the programs. The ones I plan to discuss right now, between now and 11:30, would be the vented containment, decay heat removal, and human error sensitivity analyses.

Okay, as I mentioned, the work at Sandia is looking at potential design requirements for vent-filter containment systems. We committed $300,000 in'79. We expect commit an additional $300,000 if it's available in '80.

What that will buy us is this scope of work (indicating).

The program plans, the draft of the program plan for this has already been developed. I have a copy which I forwarded to the Staff. I don't know if the committee desires to review it or not. I'll make it available to the committee.

It's not the nice, clean thing that you're used to reviewing, but if you would like to review it, we would certainly welcome it and appreciate your comments.

DR. SIESS: I think if you pass it out you probably will get some comments on it.

We have had a work statement on the current FY 79 project in hand for some time.

MR. DI SALVO: Yes, sir.

DR. SIESS: And I might ask the subcommittee members if they have any comments to make on that at this time?

DR. OKRENT: Well I unfortunately can't recall what was in it, and I don't know whether the program plan differs -- with regard to developed design concepts by 2-80, is that for several types of containments?

MR. DI SALVO: Yes, it is.

DR. OKRENT: So that would include ice condenser, Mark I, II --

MR. DI SALVO: Yes, we've identified exactly which ones we'd like to have. We do know that we want to look at several different kinds of containment because of the different properties of the containment designs.

So we might want to fit a concept of several of those designs.

DR. OKRENT: Well, it may not be the same concept or at least the same size or whatever that fits each of these?

MR. DI SALVO: That's right. Infact, that's one of the things we want to look at a little more closely.

The work plan that you have now or that I've just distributed, has some literature surveys, it reviews a lot of the work that's already been done in this area. And there has been quite a bit of work.

And also it proposes some technical approach. It has not been reviewed yet by the NRC Staff, so don't assume that whatever's in there is what automatically is going to go. There are probably some comments that NRC Staff would also like to make. In fact we are going to be reviewing this program next Thursday.

DR. OKRENT: Could I ask -- if I look at this schedule, and assume that you follow it that way, would you have to wait to 6-81 before you could propose to DOE what you thought they might do in this area?

Or would you be ready at some earlier point? And if so, at which point?

MR. DI SALVO: Well, we made a provision one year from now to provide a report on this material, because I think DOE is going to be faced with some decision points in their program. And we recognize that.

And, in fact, I think in the work that goes on between the rest of this fiscal year and next fiscal year, I think that will provide some documents. And that's why we've indicated an interim report in this area.

So, does that answer your question?

DR. OKRENT: And what is it you envisage that DOE might do?

I realize it's speculative, but what are some things in this area do you think --

MR. DI SALVO: Well, I think we are getting into that area of conceptual design versus detailed. We might, after having looked at the application of these containments or a particular kind of containment design, say, we've taken it as far as we can go. We've evluated that as much as we can. And without a more detailed analysis of how this could actually be fitted, what kinds of interactions might it have with other systems, what might the cost of this system be?

Those are things probably DOE is more interested in than us.

And I think the nature of our request might be: take what we have done, and try to bring it to the point where it could be implemented in practice. What kinds of advances are required to bring it into hardware?

That's the kind of activity I would envision under the direction of DOE.

DR. OKRENT: And quickly, one or two other questions:

If one assumed that this had a potential for continuing interest after the interim report, since there is some body of literature and in fact some experience with some of the kinds of systems that could be involved in an overall system of this sort, is it too early for DOE to begin their own preliminary effort so that if they were going to take something into a more detailed design stage than you would do here, is it too early for them to begin now to assess the nature of the engineering problems, et cetera?

MR. DI SALVO: I'm not sure of the answer to that.

I would think that certainly they would want to be aware of what we're doing. They may want to start some work on their own to get a tentative viewpoint.

I would rather somebody from DOE had an opinion on that.

But certainly I think it would be difficult right now to go out and provide a detailed design that's going to fit all the considerations that I think we ought to come up with.

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But I would rather have someone from DOE answer it.

DR. OKRENT: Okay.

DR. SIESS: I've seen a couple of papers recently where people have writen about something that looks like this and have carried it forward enough to have estimates of costs.

MR. DI SALVO: California Energy Commission, their study was one good example of that. But I wouldn't consider that a detailed design.

DR. OKFENT: One other question:

You mentioned that it's appropriate for NRC to do some estimating of the risk reduction potentials from these various potentials for safety improvements. And in fact you have on the list here, value impact assessment, as a particular system.

How are you going to factor into such a value impact assessment the uncertainties that exist now -- and I have to assume will continue to exist -- with regard to accidents for which this concept will not do much?

And one can envisage accidents where the containment is penetrated, have a steam explosion as in WASH-1400, where you violate containment. This is not one for which at least the vented containment designs I've seen -- it is not one that this concept can deal with. And there are others. Pressure vessels differ, for example.

Is there some additional effort that you have underway that will reduce the existing uncertainties in other kinds of accidents?

Or just how do you plan to cope with that aspect of the evaluation?

MR. DI SALVO: Well, that's two questions.

First of all, are there programs underway to reduce the uncertainties in other aspects of containment failure? I think the answer to that is yes.

And, secondly, how would you factor such phenomena into the risk reduction, into evaluating risk reduction of your concept. And I think that's one of the tasks that we'd like to get underway in the value impact work, is to come up with some systematic way of identifying what contributors to risk are. And then identifying how the system -- what change the system would see, what physical change would make in the system. And then alalyze what the delta is as a result of that system change.

We'd probably do this through fault trees and event trees. And simplistically you'd just eliminate those trees that you feel have potential for elimination.

DR. OKRENT: Now, the Commission says Staff can't use WASH-1400 for absolute evaluations of risks?

MR. DI SALVO: This can be done in a relative way as well.

DR. OKRENT: I think it's the absolute numbers that are relevant.

MR. DI SALVO: I'll just treat that as a rhetorical question.

(Laughter.)

Someone mentioned to me by the way a potential bumper sticker for probabilistic analyses Staff that says: "PAS does it with uncertainty".

(Laughter.)

We have a second program underway on alternate shutdown heat removal. The contractor is Sandia Laboratories. We felt that they were particularly qualified to conduct this work for us by virtue of their work on risk assessment in reactor design, and also their work on sabotage. We feel it is an appropriate interface.

Again, there's the objective and the general objective, the development of design requirements which in this case is to enhance the reliability on the availability of decay heat removal systems. And again we would like to assess the values and impacts of implementing these requirements.

The dollars you see there are estimates of what this will cost.

We would also like to augment these monies in a program pending category, where we show 100K additional; we'd like to augment these studies to take into account the European experience more explicitly.

We have an opportunity to do that and if we get enough funds we'd like to factor that in.

What the current Sandia program looks like is as follows:

The identification of current designs and criteria -- I mentioned earlier that this really is a task that probably we would also do if we were just looking at this from a confirmatory standpoint. We'd want to know what's out in the field.

And also identify events requiring or threatening a shutdown heat removal operation, and develop models.

These two or three tasks, by the way, have benefitted considerably by recent action by the Staff as a result of Three Mile Island.

There was quite a thorough examination of the auxiliary feedwater systems for all Westinghouse and Combustion Engineering plants. There were logic models developed in terms of block diagrams to try to identify the dominant vulnerabilities of the system.

And in fact out of that report, which I believe will be available in a month or so, there will be some specific recommendations for design changes in those systems. And I would assume, also, some longer-term recommendations on design of shutdown heat removal systems.

Now that was done for the Westinghouse and

Combustion plants.

The scope of the Sandia work also includes BWR's, as to which Staff has not conducted a similar activity; but it's quite possible that is shown here, which was drawn up several months ago, could be accelerated.

DR. SIESS: At what point in time, then, do you think you might be in a position to make some specific recommendations to DOE regarding the experimentation they might find necessary?

MR. DI SALVO: I'm not sure physical experimentation is really required in this particular concept. I think this is one where it's primarily a matter of heat balances, and design changes to improve availability of that capability.

Now, it's possible in the vented containment area we might come up with some ideas for experiments.

But in decay heat removal I don't think that we would l kely make a request for experiments. Conceivably we could make the request for a detailed design.

DR. OKRENT: Which European study did you mean?

MR. DI SALVO: We've had -- we received a proposal recently from the group which designed the bunkered system for the Liebstadt reactor, I believe, in Switzerland.

And that's an underground system which works off of ground wells; and not only is it underground and separate from the normal cable system, but it also has double-redundancy within itself, two independent trains: and water is provided from ground wells and can be injected either into the core or into the pressure suppression pool, or remove heat from the pressure suppression pool.

It's a BWR, it's a GWE MARK -- I'm not sure which -- GE.

And they've also designed a system for a reactor under construction in South Africa.

So we thought we might be able to take advantage of this organization's capabilities. But that's still in a -- we're just considering it pending the availability of funds.

We think there's good potential there.

DR. OKRENT: And if I can ask another question:

Assuming at some stage in your studies you thought there was merit in looking at detailed designs, I guess I am led to wonder whether this is something an architect-engineering company would ordinarily be a logical group to do such studies, or what kind of technical background would you think is appropriate?

And where would you see DOE fitting in to handling the development of such information?

Would they be the group that tries to find the right architect-engineer? Or do you think that they would break it up into pieces? Or what?

MR. DI SALVO: Well, I'm not sure how they would operate.

I think we would make a request, or we would make some recommendations that we feel this is an area of high risk reduction potential; we've looked at it conceptually; we feel we can't go any further in assessing the merits of the design until we have more detailed information.

And then I think it would be DOE's role to seek out an appropriate contracting firm. I think an architect-engineer would be very appropriate in this case, to develop a detailed design, with the information that we provide plus whatever extra DOE has in-house, and with their technology management center, they would provide that the financial support and the technical guidance for that.

Again, I haven't really spoken to the gentlemen from DOE on what approach they would take.

DR. OKRENT: Is your contractor, Sandia, looking at this both from a backfit and from a front- point of view, or only a front-fit?

MR. DI SALVO: [illegible]h.

I think in the exercise that was done on the operating reactors, that was looking at backfits. I would hope that we would look at both aspects.

Of course, when we talk about backfit versus front-fit, we get into the question: what effect do they have on risk reduction potential?

Because if we look at the entire community of reactors, of course, reactor risk is dominated by those reactors that we have in place today, plus the others that are coming on line in the next ten years; and if we are talking about near-term risk reduction, then we are talking about backfit.

But I don't think we should be so short-sighted that we s. ıldn't look at plants which haven't been designed yet. The same for containment.

Okay, we started a program on human error reduction. Actually I should rephrase that: we started a program looking at the contributions to risk of human error.

I think -- now, this is an effort to get some quantitative guidance on where human errors might most effectively be reduced.

This is a rather small effort right now, but I think it's a rather important one. The contractor is Brookhaven National Laboratory. And this is basically what they are doing:

They are using WASH-1400 as their source, and they are categorizing all of the human errors identified in WASH-1400.

And in your handout you have a couple of -- you have a cover page of a draft report, and you also have a sample page which indicates what I mean by categorizing of errors. They've tried to categorize human errors in terms of cause being either an act of omission or an act of commission.

And in terms of timing, did it occur before the accident started,.or was it a post-accident type of an act? Where the accident occurred, -- I'll skip over the Y column because I'm not sure what that means -- whether or not there was any way to detect the occurrence of the error; in what system the error occurred; and subsequently -- categorize what the error is and what is its contribution to the unavailability of the system?

Now, this is strictly a bookkeeping task, but I think we are going to go much further than that.

DR. SIESS: These are all operator errors we are talking about here?

MR. DI SALVO: Not all operator errors, there are many test and maintenance errors.

DR. SIESS: But I mean people in the plant?

MR. DI SALVO: Yes.

DR. SIESS: Excluding at this stage design errors, construction errors, which are human errors, too.

MR. DI SALVO: No, those come under hardware failures. We don'thave that kind of error; that's right. These are errors by the operating staff.

DR. SIESS: It's distinguished on the next slide, it says operator contribution to risk.

MR. DI SALVO: Yes.

But these are actually by the operating staff; and in fact we will go back to WASH-1400 and determine as quantitatively as we can, with the uncertainty bounds which we'd like to put on these, what the errors are which tend to dominate risk.

There might be specific errors in specific accident scenarios, such as an operator forgetting to go from an injection mode to a recirculation mode after an accident. Or they might be more generic errors in that test and maintenance procedures generated results in a valve being shut off.

But at any rate we are well aware and along on that work.

DR. SIESS: What if a procedure requires something, is that a human error?

MR. DI SALVO: It's an error in writing the procedure, certainly.

DR. SIESS: You call that a human error?

MR. DI SALVO: Yes, but it's not reflected in here. It's in the same way as a design error.

And I think what we want to get out of this is a quantitative indication of where errors might most effectively be reduced. I think this is consistent with the philosophy that OMB expressed as to the kind of study we would do, something that would give guidance as to where we should direct our energies.

So that work is well underway, and we are very optimistic that that's going to give us some very useful results in the near-term.

DR. OKRENT: Suppose somebody in NRC or DOE or wherever thought that there could be possible merit in developing abetter simulator. I don't know if there is or noc. But let me speculate that somebody may come up with that idea.

Would that be considered hardware or, you know, getting back to this question of who can do what?

Have you got any idea where that would fall?

MR. DI SALVO: We are trying to think about that. I think it's very clear that we would be within our turf or jurisdiction to identify what a better simulator should do, what kind of capabilities it should have.

Let me talk a little bit about program pending, and in particular ways to reduce the operator's contribution to risk.

Let's talk philosophically for a moment: this addresses at least partially some of the discussion earlier about operator contribution.

I think there are several questions that we want to ask ourselves in terms of how the contribution, once identified, you might want to know: what is the status of the plant? What instrumentation is available? How reliable is that instrumentation? Does it tell us anything about the availability of engineered safety features? In some cases it does, in some cases, not.

Secondly, how is that status displayed to the operator? I think you all know how it's displayed now; it's displayed on a big board which stretches 180 degrees, if not more, and it's generally in terms of individual signals, whether it be dials or gage or strip chart.

But I think, as I'll indicate later, it's obvious we can make improvements in the way that information is displayed.

Then what does that display mean to the operator? And this is a function of his basic knowledge, the training that he's had, including training on a simulator, the previous experience he's had in this particular situation, whether in real-life on this plant or on the simulator; and also what his physical and mental state is at the time.

We've all had occasions where information was presented to us where it didn't sink in immediately.

And finally, what should the operator do once he understands that something has to be done, what should he do?

I think the procedure today is to rely upon written procedures which may or may not be applicable to the situation; but I think it's possible that we might make improvements both in the procedures themselves, in the way an operator can act on them; and also provide better diagnostic aids which integrate the information available to him.

And in the long-term I think we might also want to consider the computerization of corrective actions as a way of recommending to the operator what he should do.

I recently was fortunate enough to visit Halden, Norway, where they have a system called the disturbance analysis system which assists operator actions in the event of normal plant operation.

The objective there originally was to include plant availability by providing the operator with some advance warnings of situations which would lead to reactor trip. And the system was devised so that it would present him with very graphic information on the status of the plant, and it would also give him some guidance on corrective action that he might want to take.

A copy of that trip report was sent to the ACRS for their information.

What was very obvious from that is that there are ways that we can improve the display of information to the operator -- I'll pass this little pamphlet around. It's very instructive. It indicates the obvious improvements that can be made in obtaining information through the use of cathode ray tubes; a condensation of the information that's available.

I think we can really look at this in two parts:

We can look at improvements in presenting the information, monitoring the plant, presenting the information; which I think is rather clear-cut, and can be implemented without a lot of new research.

And then we can look at a longer-term effort which considers diagnostic aids to the operator which is a little more complex of an undertaking and involves a lot of analysis of systems and hardware, which might be a little longer-term.

But nonetheless, there are improvements which can be made.

DR. OKRENT: If I could make one more observation?

The NRC I think has been a member of whatthey call the Halden Group for some tim e--

MR. DI SALVO: Yes?

DR. OKRENT: And it's my impression that up to now there have been two programs, one is in fuel behavior and one is in reactor operations.

The NRC has been only to the fuels part.

MR. DI SALVO: You are correct. 448 104

DR. OKRENT: And this other program has been going on without NRC participation where the Germans and so forth have been working on this disturbance analysis; there's some papers been given there, but there's been no one from NRC really participating or getting that information.

MR. DI SALVO: Recently it did receive a lot of attention.

By the way there's a similar effort in the United States which you may not be aware of, funded by EPRI for some time now, jointly between CE and ________ Control, Palo Alto, which has similar objectives.

And it is I would say at a comparable level to Halden.

The interesting aspect of the Halden program is that there's a commitment from a German utility and a German vendor to install the system in their plant; and, in fact, such system will be installed in a PWR in '80 in time for startup, 80, 81.

Now, the particular system that they have in mind only models the feedwater system; but nonetheless, it's a prototype, and demonstrates feasibility for use in a commercial PWR.

Another very interesting feature is that they will have two separate control rooms, one, the conventional control room; and the second control room strictly devoted to

CRT displays. It will be a control room as pictured in that diagram (indicating).

And it will be used not just to perform standby control of the plant, but also to perform experiments on the benefit of the new system to the operator.

Experiments like this have been conducted for some time at Halden, and they've come up with some qualitative guidelines on effective ways to present information on the sceen; and some qualitative indications that it is in fact helpful in reducing operator error.

DR. OKRENT: I think my impression of the EPRI program and the German program is that they started with a different emphasis, that the EPRI program in fact was aimed at improving plant availability; and this leads, then, to a certain orientation of your model development and so forth where the German program was aimed toward safety improvement, availability perhaps, also; but I think I would not myself label them as either in the same stage of development or similar in approach.

Now, the EPRI program may be -- could be modified to become safety-oriented, and that could lead to a rather considerable change in the thinking that has gone into how you approach the subject, what you would expect of the system; it is a much harder task than they had originally set.

MR. DI SALVO: Yes.

Well, I think, too, maybe the balance between availability of systems and the work at Halden is probably a little closer.

But in order to get the cooperation of the utility I believe the European program had to show benefits for them.

DR. LAWROSKI: Do you know whether or not color-blindness precludes being licensed?

MR. DI SALVO: I asked that exact question while I was there, and the answer that I got was no, it did not preclude an operator becoming licensed, because you use symbols as well as color, and variations in brightness as well as colors and symbols to differentiate.

I don't know what the percentage of color-blind males is.

DR. LAWROSKI: But there's a variation, too, in degree of color blindness, as well.

MR. DI SALVO: Well, we might have to make sure that's a requirement for operator's licensing.

But they've considered that, they are very thorough in their work in this area.

Okay, so we expect to start our initial work in that area before the year is out.

I do want to make a comment on one additional program --

DR. SIESS: Do you expect to start something on this particular item in FY '79?

MR. DI SALVO: Yes.

DR. SIESS: What money?

MR. DI SALVO: Okay.

We have --

DR. SIESS: If you get the additional 400?

MR. DI SALVO: Yes.

We have been talking with Oak Ridge to evaluate the feasibility of additional requirements for improved systems operator action. And their emphasis is on computerized diagnostics. I would say it is at least 50 percent on computerized diagnostics. And the rest a survey of human error contributions, such as procedures, and potential improvements in simulators -- just to sort of get a baseline.

We have a tentative schedule for the early work which would review the information currently available to operators, review what systems we might want to consider monitoring more closely with potential for looking for violations of tech specs or additional warnings or possibly providing interlocks such as the reactor could not go to power; and also the work on computerized monitoring diagnostics.

This is in plus-months because we haven't started to program yet.

And I would hope even out of this very early information we could do some guidance to DOE; DOE anticipates a rather large program in this area.

And I would think before we go too far down the road we would be giving them at least our first-cut information. And they can make some decisions on where they would like to go.

This is an area that we are most likely to get implementation out of, and we're excited, and it seems to be the one where we have momentum; and we should move quickly so as not to lose that momentum.

Okay, the last item in the program is pending, and you can make a decision on whether you want to go into '81 after I've finished this.

I discussed this program several times in the past. We have a contractor pending -- I don't know if he's still willing to work on this, we put him off for so long. It is developing improved methods for assessing value impacts.

I'd like to make a point about this program:

I think the last time we spoke there were some comments made about the value of this, and the ability of this program to -- the value impacts in general -- to develop any useful information.

DR. SIESS: Ray, I think you're wrong.

I think at the last meeting there was a fair amount of discussion about whether the value impact methodology should be coming under the improved safety systems spectrum. I don't think any of us have question the need for the value impact study, cost-benefit analysis, or whatever you want to call it.

But we thought that it applied to across the board selection of a research program, to how you were going tospend your research money; and in view of the small amount of money that was available under the budget item for improved safety, that we didn't like several hundred thousand being taken out of this.

And we were trying to convince Sol that this is overhead somewhere.

MR. DI SALVO: Okay, I understand your point; but I think -- well, let me make the statement in support of this program:

Specifically, I think that this particular program is even more important as a result of TMI than originally thought.

Previously we had indicated that it would going to help us prioritize our research -- and you are right: it should go across exploratory and confirmatory research.

And we also indicated that we needed this to give us some guidance as to implementations of some of these concepts that we've come up with.

I don't think you need a value impact system necessarily to make judgments; we make judgments all the time without that.

I think, assuming we can get this work underway, it is going to assist in the defense of our decision, and also assist the rationale, developing the rationale on which we make decisions.

As a result of TMI there are all kinds of requirements being imposed, some if not all of which will be laid upon the industry; yet I don't believe there is any quantitative answers on the effect of these requirements.

Secondly, NRC is working on a lot of different areas on improved safety. And conceivably there will be requirements proposed, developed and/or proposed, in all of these areas.

And it's not obviously to me that we should try to impose all of these requirements or implement all of these requirements; I think the risk reduction potential, once you apply a certain requirement, changes for subsequent requirement.

So it is very obvious to me that we are going to need some methods for at least relative techniques to help indicate where the real risk reductions might lie, both for any given concept and also for combinations of concepts, and even for timing of concepts.

So I want to again express my support for this particular work; I don't think that you are arguing with me on this. But I just wanted to emphasize for the record that I think it's an important program that is going to assist us not just in improved safety.

DR. OKRENT: I am arguing with you on it.

MR. DI SALVO: Oh!

(Laughter.)

DR. OKRENT: You still have what looks like a relatively limited budget, and given the previous discussions we asked the safety research staff how it was that they were applying their risk assessemtn methodology to tell the licensing people which generic issues they should study, but they weren't looking at their own program to see what they should be doing research on.

It seems to me, rather than spending 400K from your limited funds in research to improve reactor safety, you -- on methodology -- you should spend whatever is the appropriate amount of money to look at your own programs and see if they are across the board, you are expending your money most expeditiously.

And it's not I think a question of generating methodology. I am skeptical that by work on methodology you will be able to get very much beyond where you now are with regard to your ability to make judgments.

Either you'll assume that the numbers in WASH-1400 are right, and arrive at some judgment; or you'll say there is some uncertainty in the numbers -- which, indeed, there are -- and you'll have to then arrive at modified judgments and so forth.

And I am skeptical about the import of the methodology developing, frankly.

I'll leave it at that.

MR. DI SALVO: Yes.

DR. SIESS: Dave, you are skeptical about the development of methodology for any purpose?

DR. OKRENT: To be able to apply some kind of methdology in these generic issues, they didn't have to go out and do some kind of $400,000 research study on methodology before they gave advice on generic issues; and they are giving advice here to put your money with regard to Inspection and Enforcement and so forth.

Well, how is it they need it, methodology development, in order to assess their own research? -- is what I'm asking?

DR. SIESS: You've got no objection to using the availabile methodology. You don't see any point in going out and spending money to develop more refined ones?

DR. OKRENT: Wel', I need to be convinced there's a need --

DR. SIESS: More refined, but not necessarily better?

DR. OKRENT: Yes, that's a way of putting it; and especially out of a small budget.

MR. DI SALVO: I think you may be overstating the degree of sophistication in the methods that we use to assess the generic issues.

DR. OKRENT: It's not that I am overstating those, I just want to know what you will have after you've spent 400K on methodology?

DR. SIESS: How much of that 400K is on developed and how much is on applied?

MR. DI SALVO: I think we envision about --

(Slide.)

-- if words are any indication of amounts of dollars, I would say about two-thirds developed and one third applied.

But the idea would be that this, the development phase would be just that, with a few applications. The individual programs involved, the program on vented containment, the program on shutdown heat removal, and all these others, would take the guidelines and methods developed in this program and apply them to concepts, such that the application really would be within the individual program areas, to develop some consistency amongst all of these different assessments.

So, you know, it's an iterative thing. You can't do development without some application and vice-versa; but I think maybe two-thirds o.. development.

DR. OKRENT: Let me give you an example of why I am skeptical.

You have a very fine methodology, very detailed, a big checkoff list of whatever, and one could have looked at WASH-1400 with its assessment of seismic risk, and have gone through the whole checklist, and then looked at the bottom line of WASH-1400 and said, seismic risk is not a contributor, so there's no value, as it were, from reducing it; and arrived at a conclusion which is different from the current emphasis of the safety research program, which is arrived at without this value-impact methodology, by going back and seeing whether WASH-1400 was correct or whether there were uncertainties with regard to evaluation of seismic risk.

MR. DI SALVO: Well, that assumes you believe WASH-1400, I think we recognize that there are some shortcomings in that.

I'm not sure it's worth pursuing any more; I understand your point.

DR. SIESS: Let me ask: I guess if you could come up with a value-impact methodology that was easily enough understood and formally enough carried out, that you could come in to the ACRS and they will be convinced immediately that you have made a right decision -- without their judgment -- and you would have something?

(Laughter.)

MR. DI SALVO: I doubt that.

(Laughter.)

DR. SIESS: The chances of your doing this are less than average.

(Laughter.)

MR. DI SALVO: I would agree but at least it would give us a framework on which to base our arguments. I think that is one of the major values of this.

DR. SIESS: The danger I think some of us figure it will be used in place of judgment.

MR. DI SALVO: I doubt that -- well, that's certainly not my intent; and I would hope that that wouldn't occur. I think we always view this as an aid to judgment, not the decision-maker itself.

Okay, I have talked about what we anticipate doing until the end of '79, carried on in some detail about programs planned in 80 -- and I could end it right here.

You have the package with the planned achievements in the program areas, and you have additional information in your handout; so it's really up to you how much you want to cover this in detail.

I would just as soon conclude now, unless there questions.

DR. SIESS: Well, what is Mr. Silverberg's presentation on?

MR. DI SALVO: Core catchers.

DR. SIESS: Let's keep in mind the ACRS has to provide to the Commission some advice on the FY 81 budget; and I think you better get us up through '81.

MR. DI SALVO: Would you like to do that before or after lunch. I can get you quite a way through by 12:30.

DR. SIESS: I suggest we go right on -- let's see, the coordination between NRC and DOE, you've already covered that?

MR. DI SALVO: Yes.

DR. SIESS: So it's the two items scheduled here for 11 o'clock; right? Proposed changes to the program because of TMI?

MR. DI SALVO: I covered that briefly in the overview.

DR. SIESS: Yes, you did.

So it's really going on through '80 supplement and FY 81?

MR. DI SALVO: That's right.

DR. SIESS: Well, we would like to hear FY 80 supplement proposal, and FY 81.

MR. DI SALVO: Right.

DR. SIESS: Let's take a short break, and we won't necessarily break at 12:30. We'll try to finish those two items.

(Recess.)

DR. SIESS: Okay, proceed.

MR. DI SALVO: Okay, the topic is FY 80 supplemental and I'll refer you to an earlier slide in your handout which was labeled Effects of TMI-2 on Programming -- somewhat erroneously. And what I'll be discussing is the delta between the 1.0 and 4.4.

I have a detailed slide on each of those, and I don't think they are really necessary. I think I'll touch enough of those that you'll get the gist okay.

Okay, the first one identified was alternate containment concepts. As you know, the work that we have underway right now is strictly limited to assessment of the vented filter containment; but in reality there are many, many more containment concepts which have been proposed or may be proposed other than vented filtered.

The kind of concepts we are talking about and the kind of risk reduction we are talking about are generally those concepts which in some way would help to mitigate the consequences of a meltdown accident.

We feel that that's where the greatest potential for risk-reduction lies.

What we envision with the delta for 80 in alternate containment is a survey study which would assess the values and impacts of the alternate containment concepts. It would review the previous analyses, systematize the information available on the acceptable designs, and long-range for us the experimental information.

And then make some assessment for the technical feasibility, and some relative assessments of values and impacts -- these may not be very quantitative.

But I think the idea is to get some systematic look at the great variety of containment concepts which have been considered.

The following slide is a list of some of those concepts.

(Slide.)

I'm not sure yet whether we want to look at some of those individually, or whether we want to look at them all at once.

I gave to your staff earlier today a work scope which was characteristic of the survey study.

In addition we might want to break some of these out in more detailed studies.

DR. SIESS: Let me back up a minute:

This FY supplemental budget request, FY 80 supplemental budget request for improved safety systems is 3.4 million?

MR. DI SALVO: Correct.

DR. SIESS: And you are talking about the increment now?

You had 300K for alternate containment originally?

MR. DI SALVO: Right. Strictly for vented filtered containments.

DR. SIESS: Okay, and this is other than vented filter?

MR. DI SALVO: Right.

Of course the information on vent-filter containment we would hope to get in our major program; the passive containment system is one that I understand we'll be hearing a little bit more about today; core retention devices, which we previously identified as a separate area, and remains so; but I think it belongs in the context of alternate containment concepts.

And also changes that you might make within the containment itself, not necessarily the structure or design of the containment building, but the whole concept of containment itself, whether benefits might be achieved by recombiners or what's the feasibility of recombiners that could cope with a lot more hydrogen in a design basis accident.

So we perceive some additional work. We've done some work on this in the past, which has been published in reports. We'd like to expand upon that.

I don't have a slide for the delta on alternate decay heat removal; but basically it's this:

The work that we have now at Sandia is limited initially to that equipment necessary to bring the plant to hot standby.

We also would like to look at extension of that work to cold shutdown conditions.

And we'd also like to look at some of the concepts which have been proposed other than add-on bunkered systems, such as ground wells, and see how much they might improve the availability of system.

We talked in the past about alternate ECCS. We still think this work is necessary.

DR. SIESS: You don't have a slide on decay heat removal?

MR. DI SALVO: No, I don't.

We have talked in the past about alternate ECCS. We still feel that this work is necessary for various reasons.

The delta is 300K, and again this would be a systematic identification of concepts, collect the information and review the experimental information which has already been generated; and possibly evaluate the feasibility of some of these concepts using the existing thermal hydraulic codes.

We might even go so far as to identify additional experiments.

I think what we are talking about in 80 is oh, I would say, I think we would start analyzing performance of alternate ECCS; I think we could get that far, at least for things like alternate injection point. Currently we can handle things like alternate injections quite easily. And we might want to examine those.

So we see additional work on alternate ECCS.

DR. SIESS: Now, originally in your 1980 request you had $2-1/2 million in alternate ECCS?

MR. DI SALVO: Correct.

DR. SIESS: What was that for?

MR. DI SALVO: We envisioned beginning work in semiscale test of alternate ECCS concepts.

DR. SIESS: And how did TMI-2 change that?

MR. DI SALVO: We decided to shift our emphasis to doing interaction work; also it turns out that as a result of TMI there's a lot of additional work that's been identified for semiscale; and semiscale might not be available to do the kinds of tests that we are talking about.

DR. SIESS: Basically within the same budget framework you shifted?

MR. DI SALVO: Correct.

We delayed the start of experiments on alternate ECCS in emphasis and replaced that emphasis with work on human interaction.

Now, in the area of human interaction we've asked for a sizeable delta, and back in your handout there is an indication of how that delta would be spent.

The delta we are talking about is the change from 0.4 which was what we had originally budgeted in the 80 budget on human interaction, up to 2.1, which is a rather hefty increase.

And the areas that we are talking about are those shown.

The work on human error sensitivity I've already described to you.

And these two (indicating) we expect to start at Oak Ridge; and these would be continued in 80. We might or might not continue this work in 79.

Bu we would pick up some work on safety system interlocks, trying to identify what information is presented to the operator as to emergency or engineered safety features.

But let's talk about differences here:

We see a potential for much greater activity in the area of accident monitoring diagnostics, along the lines of what I showed you in the CRT displays, what should be the requirements for such systems? I think we would like to look at this. This is somewhat related to that (indicating). I think as a minimum we want to go back to areas in WASH-1400 and try to identify what information should the operator have in each of those sequences, or at least in representative sequences? -- to tell him what the status of the plant was, what did he have available? And what improvements might help him in understanding the status of the plant.

I think this would help us determine what requirements we might want to make on new instrumentation.

The monitoring and diagnostics would enable us to get a better feel for what kind of improvements we want to make on display again.

It's very difficult for me right now to make some specific suggestions for requirements, but I think as was made clear by the handout earlier, there is potential for improvement in terms of this information.

What we call human interaction review is sort of a broad study, a continuing effort to allow us to reassess the contributions of human errors, and make some quantitative recommendations as to where we should invest our resources.

Class-9 simulator capabilities, we talked about earlier -- there's really two ways you can go about it:

Basically we are talking about what -- how would we improve the capabilities of the simulator, such as to be a more effective tool to assist in operator training.

There are a couple of ways you can look at this, you can look at this from a narrow perspective, a near-term perspective, and that is just take some representative sequences from WASH-1400 and put it into computers and study the capability of that.

Or a second, longer-term approach might be that you want to examine the potential for simulating the entire spectrum of accident conditions which would be based on best-estimate thermal hydraulics and system response -- much more difficult.

But at least we want to look at what would go into improving capabilities of those simulators.

I think it's also interesting to note that we might want to look at the link between simulator capabilities and accident monitoring and diagnostics in that I would think there would be a potential for incorporating in newer plants at least, if not older ones, computerized systems which might suit both purposes to some extent.

You might have a system which modifies the status of th nuclear reactor in which it installed, and while it's not being called upon for use, such as during refueling or other periods, use that same system as a simulator for training operators. You would have a plant-specific simulator which might be an idea that is worth pursuing a little further.

Safety system interlocks, it's really too-restrictive a term. What I really mean there is better ways to identify the availability of engineered safety features, and other systems; and this would be helpful.

One would be a list of the safety significance of particular systems, safety and nonsafety related as determined by their involvement in WASH-1400 and other risk assessments which have been done since then.

And a second list which would take a look at these systems and identify when their status is made known to the operator, and whether or not those status indicators might be improved somewhat.

And sort of do a cross-comparison to identify improvements that might be made to systems which provide a significant contribution to risk, should they not be available.

And then propose a spectrum of ways to implement those improvements. One is just to put another alarm in the control room that that system is unavailable.

Another might be that you actually engineer some interlocks in the systems such as to make operation impossible. The thing that comes to mind is the old seat belt idea where you can't start your ignition unless your seat belt is locked.

But that would be on the other end of the spectrum. I think we would want to look at what the possibilities are and evaluate the pros and cons.

And finally, an item called information flow during reactor accidents -- I really don't have this well-defined in my mind, we are talking about this in the Staff, internally. This would be more of a systems model of information flow, not just within the control room or even within the plant site, but information flow internal and external to the plant amongst the regulating agencies, those people responsible for generating evacuation plans, and also, of course, within the control room.

The idea would be to try to identify areas where improvements might be made in terms of information flow, what kind of information is generated, what kind of information is needed, where the decisions are made. Something along this line may be done now I think. The Commissionis thinking about what its role is, and I think some of these investigating commissions are, also.

DR. SIESS: Suppose they come up with something you haven't thought of? Have you got any flexibility in here in the FY 80 or 81 to take care of that?

MR. DI SALVO: I think if there was -- well, yes.

DR. SIESS: By reallocation or dropping something?

MR. DI SALVO: Well, I think we provided sufficient funds and sufficient generality in our specifications that we have certain flexibility. Unless it's something that's really major.

I would think that these areas broadly enough interpreted cover it all; although I am not certain of it.

DR. SIESS: What about simulators for anomalous transients? You've got Class-9. But TMI wasn't a Class-9.

MR. DI SALVO: Oh, I think it was; it depends on how you define the term. It wasn't a meltdown, but it was Class-9 in terms of more than Class-8.

(Laughter.)

DR. SIESS: I classify it as an anomalous transient, which had characteristics that people weren't trained to handle.

MR. DI SALVO: You are talking multiple failures as opposed to total meltdown.

DR. SIESS: I am talking about how you might get there, rather than where you end up, -- where you don't want to wind up.

MR. DI SALVO: We want to look at simulator capabilities that have -- well the capability to simulate more than just the classical DBA.

I think that's been the case up until now.

So that explains the delta in human interaction.

We indicated a delta for seismic design, and we in our original 80 budget we didn't have any money at all for seismic design. We simply were waiting for the results of the margins program.

But I think we've seen some things we can do before then that might be appropriate. The scope as originally proposed was to review candidate concepts in terms of capabilities, and either strengthen the current designs, or you could increase the energy adsorption capability, or you could isolate things.

We've also recently considered another alternative, that is subsurface modification around the plant. I'm not well enough informed to discuss this in detail, but I've been told there are ways you can provide trenches and things in which would reflect the seismic forces; and that has in fact a potential for backfit.

I don't know how feasible that is, but it's a concept which has been proposed.

We also received some interesting proposals onenergy adsorption capability, and we'd like to pursue that. We haven't made any commitments on that.

In your handout after this slide you'll see some pages from a report from Engineering Decision Analysis Company that was for Sandia Labs several years ago, before there was ever an improved safety program. And it evaluated some 25 different concepts for seismic effects. And these are examples of the kinds of results they generated, and and I think we would want to look at this kind of stuff in detail.

This is an area where there is probably some experimental work warranted, whether it be on the properties of the energy absorbing material or some shaker table tests with mock-ups; but I think it's an area where clearly we would want to have the capability of doing something.

DR. SIESS: Do you want to go back through how you got this into the FY 80 supplement based on TMI 2?

MR. DI SALVO: It's not strictly based on TMI 2; we figured while we have a chance we might as well go for it, request a full reinstatement of the program. It's not directly related to TMI 2.

DR. SIESS: Well, it's not a reinstatement, because you didn't have anything in your original FY 80 forit.

MR. DI SALVO: Right, but we saw some things that we can do in the near-term, and thought this was the appropriate vehicle for getting that work started.

DR. OKRENT: Let me suggest an area of interaction between seismic safety and improved operator response.

I am not sure if you tried to think about how many signals the operator might get if there were a large earthquake; and what fraction of them might be spurious, and how he would decide.

I suggest you flag that as one of the items under one or the other of those that at least you start thinking about.

MR. DI SALVO: I think we have that question in mind, Dr. Okrent. I've heard you ask that question before, and we have that in mind in terms of instrumentation available to the operator.

Of course the scope I described in seismic design does not address the question.

DR. OKRENT: I'll go one step further:

You might also link this to the shutdown decay heat removal question, given a severe earthquake, is there some advantage to having certain parts of the plant, whether the specific controls respond and are particularly available to decay heat removal, or are particularly subject to confirmation as to their status, or whatever.

So if you are trying to look at an area of improved seismic safety, you might try to mix those different items as they relate.

MR. DI SALVO: Okay.

Finally, we requested a reinstatement of funds available to do some scoping studies on these other concepts. If we look at this, these were the things that were regarded as having less risk reduction potential -- I shouldn't even say that.

They may or may not have had less risk reduction potential than some of the other areas of higher priority, but they didn't make it into our top five for various reasons.

But looking at some of these in light of TMI it's very instructive. We had identified offsite emergency response as a topic that was worthy of further study, and I think that's proving to be the point right now.

It's not so obvious to me at least what type of research this falls, for this category; we are coming up with a lot of research on a lot of fixes that are going on. But it's less obvious what actual research should be conducted. But this is one that's received much more attention since TMI.

Protection against sabotage, we feel it's very adequately covered by the ongoing work on sabotage. The committee has received a published program from Sandia on their program for protection against sabotage; and their bottom line for this is the development of design options for protection against sabotage.

On-line monitoring, that's very valuable for some systems since TMI; referring to this under the human interaction group earlier.

Improvements in plant control might have been warranted in light of TMI, expecially as relates to the secondary side.

So those are the things that we might want to reexamine in terms of elevating those particular items to higher priority. But right now in those areas in which work should be underway -- there should be an asterisk there (indicating) -- I feel they are receiving appropriate attention (indicating).

DR. SIESS: So what does that mean? You wouldn't be looking at the ones with asterisks?

MR. DI SALVO: Well, no it means that we are looking at them any way. We might look at where we would want to augment various areas, but we don't see any big, new initiatives in these areas.

DR. LAWROSKI: You referred to a specific Sandia report?

MR. DI SALVO: I have a copy of that if you'd like it.

DR. LAWROSKI: I would like it.

MR. DI SALVO: So that covers the delta for 80. Now, I think we can cover 81 very quickly, because it follows along the same lines.

I think we see a termination of the work on alternate containment, at least as far as what's been proposed so far.

We are holding ourselves open for the possibility of experimental work on the vented containment and possibly other containments.

As I mentioned earlier, things like efficiency of containment filter material -- and I'm not sure what. I think the specific topics will be generated in the course of the work.

I'll talk about the amendment column:

This assumes that we get the $4.4 million and do the work that we hope to do.

Under alternate ECCS we would like to get actively involved in modification of semiscale and testing of alternate ECCS concepts in semiscale or some other experimental facility.

The human interaction work we expect to continue for a high level effort for some years; and it's difficult for me to specify exactly what the products are going to be. In your package you have some indications.

In seismic, this number reflects the possibility for experimental work (indicating).

The scoping studies that have been presented at (indicating) this level.

DR. SIESS: What did you say about seismic design?

MR. DI SALVO: I said in the amended level, this presumes a potential for experiments that might be identified in our earlier efforts.

DR. SIESS: As of right now you are not authorized to spend any money for experiments. All you can do is get DOE to spend it.

MR. DI SALVO: Well, that's what we are going to ask for in our 81 budget, ask for a reconsideration of that position.

DR. SIESS: Now, NUREG 9438 has five items. It had a list of others that you were going to scope and to add into the program as time permitted.

The FY 81 budget essentially assumes that none of those will have been scoped far enough to add them to the list?

MR. DI SALVO: That's right.

If you'll recall, originally we had a lot higher number here, but we got called to task for trying -- for being underly-specific. We put in a large dollar amount here which indicated additional research as identified; that doesn't seem to fly too well in the administrative circles.

(Laughter.)

It doesn't provide for contingency, if you will.

DR. SIESS: ECCS also includes some experiments, does it not?

MR. DI SALVO: Yes.

Experimental work potential, alternate containment, alternate ECCS, seismic design, possibly interactions -- I am not too sure.

There's a separate item in the 80 supplement, by the way and maybe the 81 budget that proposes the possibility of installing computerized monitoring and diagnostic equipment on LOFT. That would be a very good test vehicle. I think without getting into problems of who should do what and pay for it, I think that's a very good idea.

I think we have a reactor there that while it's not a PWR in the strictest sense of commercial operation, it nonetheless provides a very good opportunity to investigate accident conditions, and also an opportunity to understand what kind of information is available for operators in those circumstances.

DR. SIESS: Going back to the OMB ban on physical experiments, at least theoretically the work on alternate containment, seismic, might be done under DOE auspices.

But anything you wanted to do in semiscale, that's not under your office; is it?

MR. DI SALVO: Yes, it is.

DR. SIESS: You couldn't pass that off to DOE.

MR. DI SALVO: Well, the facility itself is owned by DOE.

DR. SIESS: Okay.

MR. DI SALVO: The same is true of LOFT.

DR. SIESS: Who's going to pay for the

decommissioning?

(Laughter.)

MR. DI SALVO: Okay, so I'll summarize.

Summary of technical status, it's that we feel we have appropriately revised our priorities in 80 and 81 to reflect the concerns related to TMI.

I am happy to report that we have actually initiated work on our highest priority topics -- and that I have been unable to report in a year and a half.

And finally that we are still under quite a bit of uncerta:nty here as to our rate of progress in the future, both the rate and the depth and the breadth of our progress still has to be determined based upon relative allocation of funds and other agency dealings.

So that's more than I intended to say, but it is all that I do intend to say.

Silverberg has a presentation on core catchers.

DR. SIESS: How long is that presentation? Without questions?

MR. SILVERBERG: About 20 minutes.

DR. SIESS: Dr. Lawroski just voted for doing that after lunch.

(Laughter.)

Recessed one hour for lunch.

(Whereupon, at 1:45 p.m., the hearing was recessed to reconvene at 2:45 p.m.)

AFTERNOON SESSION

(2:45 p.m.)

DR. SIESS: The next order of business will be a presentation by Roger Mattson from the Office of Nuclear Reactor Regulation.

MR. MATTSON: This presentation might emphasize the formality of what I have to say; but I do have a couple of points to make, and then perhaps we can discuss them. The Research people have been kind enough to let me intervene in their schedule.

As I understand it, the subcommittee is considering the improved safety research program pursuant to its annual review of that program for reporting to Congress -- is that the bottom line?

DR. SIESS: Right.

We are interested in the FY 81 budget, and also in the FY 80 supplement that's TMI-2-related; as well as any comments that the representative of Regulation might want to make about previous or current programs, shall I say.

MR. MATTSON: Let me back up and say how we came to a collegial Staff view last year in the formulation of this NUREG 0438, which contains the five general program areas currently in the improved safety research program.

NRR participated in the group that wrote that report. The NRR representative was Les Rubenstein. Les went to his work with the group to prepare the report armed with NRR Staff concurrence, that is, we performed an administrative function within the Office of Nuclear Reactor Regulation to obtain input from various divisions, to keep informed of the development of the program, and just where their inputs were factored in, and tell them why; and over a period of several months there was a consensus Staff view within NRR on the program that was proposed last year.

Finally, the program was written down and on its way to the Commission, NRR formally concurred in the program at the Office Director level.

Then of course it went through Commission review, the ACRS inputs were factored in; and it became what it became and was approved and published and what-have-you.

You have to recognize, I think, that there are two kinds of NRR interaction with Research on this sort of thing:

The first is a technical interaction, and although technical discussions are complicated, and technical principles are sophisticated, and they take some time to work out, there is no particular record of technical disagreement between NRR and Research on what the program ought to contain, or the methods for going about solving some of these questions, or addressing these questions.

The technical interaction is, as you would expect, complicated, but it is accomplished.

The resource interaction is more difficult. There are finite resources for any agency in government today, and the NRR and Research are in competition for funds that become available.

That isn't to say there's a goal, that we get our share and they get their share; it's more that if there are going to be program increases to address safety questions, said program increases are for the agency and some finite character determines the budget process. And if they go for one thing, it is more difficult to go for another.

We said in the course of last year's budget preparation that while we supported the technical content and importance of the improved safety research program, that if it were to be funded by taking money away from more instant safety questions, like unresolved safety issues, or a confirmatory research of some long-standing character, then we would have to oppose that.

So it becomes a question of balancing priorities at a Commission total-program level; and it may be that because of those resource priorities and balancing judgments that go on in developing this kind of budget, there's an impression that NRR is behind the improved safety research program.

I think that's an over-simplified impression.

And I hope it doesn't imply that there's not technical agreement on how this kind of thing should go.

I am sure that as we go forward in the budget process in 81 there will be similar considerations over the next few months; but the activity going on now to obtain technical consensus and technical thought on where to go can be kind of separated from those research priorities and resource priorities -- those considerations will come later.

Okay, let me turn to the technical questions:

I'll first say that the traditional or recent organization within NRR for developing the kind of technical thought that I'll attempt to represent here today doesn't really exist in our current organization in NRR today.

We have two division directors out of four assigned to other activities; we just lost Vic Stello to the Office of Inspection and Enforcement; and we've just lost Roger Boyd to a job outside the agency.

We have three major task force efforts disrupting our normal course of work, and so the time available in the management system to form collegial views on technical matters of the sort being discussed here today, is not as good today as it was a year ago.

Nevertheless, the Lessons Learned Task Force, which I am directing, does have an eye for where are we going in the future, and what we change relative to what we did in the past.

And I think that that perspective is probably more to the considerations of what sort of improved safety research ought to be done.

I'll try to boil that down in a few words:

Improved safety research, I used to think of in terms of more prospective change than retrospective change; that is, improved safety research seemed in my mind, and I think in others, to be: what can you improve in machines that you might be building in the future, or in machines already under construction? -- more than backfit, the retrospective application of improved safety.

That's not to say that there might not have been some retrospective implications; but I think prospective was more the word that meant improved safety research.

Well, I think Three Mile Island taught us that we need a retrospective look, we needed a thorough look, and very quickly.

That's led you to you, as a committee and this subcommittee to look at exploratory research. And I guess the thought I want to offer to start with is:

What is the exploratory research in relation to what you thought of previously as improved safety research?

One of the difficulties, for example, of choosing the five big things to look at for improved safety research last year, was the difficulty in understanding what needed to be improved.

And there were people who suggested that the way to choose these five things was the risk assessment; there were others who suggested that the way to understand what five or six things ought to be chosen was by exploring consequences of failures of some existing things that then might be thought to be in need of improvement.

I think somewhere in all those words is an association between what you've been talking to Sol Levine about, in terms of exploratory research, and what I have been talking about in terms of exploratory research, and what we've been talking about for the last couple of years in terms of improved safety research.

Maybe it helps make the point if I say that I think the improved safety research program might ought to have a retrospective aspect to it this year that it didn't have last year.

So, for example, if you are looking at alternate containment concepts, -- that's the thing that was important last year -- then the difference between alternate containment concepts program and an improved containment program -- both of which are now in the Office of Research -- which of those ought to be in the category of improved safety research, that is, the special program flowing through special legislation the last couple of years, and which ought to be in the confirmatory research program?

What does that mean about their priorities, and so on?

I think it's more important that we have an improved containment research program with short-term payoff in the licensing process and in change in existing reactors, both those now operating and under construction -- that is, it's more important today than it was a year ago.

And it is certainly more important to me today than it is to worry about improved designs for a new generation of reactors that I don't get any clear indication will ever exist.

Said another way: over these two or three years I would think that the licensing view, the research view, the ACRS view, is -- because of Three Mile Island -- a retrospective view.

I don't see that many new construction permit applications in the next two-to-three years.

If exploratory research and improved safety research should come to mean approximately the same thing, and maybe they ought to, then let me offer three areas that we see, and the Lessons Learned activity I think generally are shared in the NRR -- as places we ought to consider spending that kind of money.

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The first is the area of degraded-core-cooling. The Lessons Learned Task Force said to the Commission yesterday, that there are a few things of a degraded-core-cooling nature, that need to be addressed in the short-term; some others need to be considered in the long-term.

But the real, fundamental question is, are you going to decide to do a better job of preventing degraded-core-cooling --

DR. SIESS: Excuse me, where does the hyphen go in there? Is this really a degraded-core or degraded-cooling of a core?

MR. MATTSON: It's the question of whether you decide to prevent -- do a better job of preventing -- a core from becoming degraded; that is, producing large amounts of hydrogen and shattering because of metal-water reaction, or melting.

Or do you decide that prevention alone is not enough and that you have to mitigate degraded cores, mitigate the consequences of degraded cores through design.

So you have the question, for example, of whether to improve emergency core cooling systems or improve operator training, or improve plant control room diagnostics, so that you increase the probability of interceding in events leading to degraded-core conditions; or whether you decide that you must do more to mitigate degraded-core consequences.

And mitigation of degraded core consequences could go from a simple decision to increase the hydrogen or to design to cope with it inside a containment, to increasing the capability of emergency core cooling systems to deal with debris from core for example of the sort that was believed to exist at Three Mile Island -- the core catchers.

It could be any, some, none, of those kinds of approaches.

That kind of decision isn't going to be made by the Lessons Learned Task Force in the two months its got left. It probably isn't going to be made by a research program over the next six months, either; because you have difficulty in contracting in six months.

And in this time of trying to review where improved safety research ought to be going in the future, which you get an opportunity to do once a year, I am not sure what to say about degraded-core-cooling.

Except I am fairly confident you don't say ignore it.

The Commission, and the Office of Reactor Regulation have to make decisions in the course of the next year sometime I would think about what more is required to be done.

But decisions I think can be made now, separate from that, as to what more ought to be understood, what ought to be understood about alternative ways of dealing with large amounts of hydrogen, what more ought to be understood about the course and consequences of cooling the core -- those kinds of things would appear to me to be really more important today than they were a year ago; as long as we understand -- and I think we must -- that a decision to study them, to explore them, to consider alternative ways to deal with those situations, do not necessarily imply decisions that they have to be designed for.

Okay, that's about all I wanted to say on degraded-core.

The second area is the -- I think we called it last time -- abnormal events or abnormal transients and accidents --

DR. SIESS: Anomalous.

MR. MATTSON: Anomalous -- there we go! -- that is the word.

I've come to use a different one, I call it "off-design".

There is an area of analysis, experimentation, and simulation of transients and accidents, both those within the design envelopes of current regulations and the current standard review plan, those that fall in between events as currently analyzed for the design, and those that exceed the event currently analyzed in the design.

And there is a fair consensus of opinion already informed in my mind, or in my judgment, among the representatives of the industry, vendors, utilities, the NRC Staff and I think within this committee, to begin programs now which will grow over the years to increase the capability of operations organizations to handle permutations and combinations of events different than those used in the design process, to be able to interpret, understand, take action, or multiple failure events, things that happen in the real world that are not conceived in the prescriptive stablized design requirements used in the licensing process.

These include control room monitors and switches all the way to the digital analytical capacities or capabilities of codes like TRACK, RELAP, and their industry counterparts.

And then a use of those simulators in several capacities, one being the training of operating crews, their training, retraining, continual upgrading; the associated development of procedures, drills, what-have-you, enhancing operational capability.

And a second role for those simulators is a sort of evaluation through gaining role the understanding and feedback of reactor operator experience.

The best way I know to illustrate that is to say if there were such machines, a hybrid analog control room with a digital track, for example, and were there a proce· by which reactor operating experience was fed back into an evaluation group, either in industry or government, or both -- for the Davis Besse transient, to enter this hybrid analog digital machine -- a group of savvy, experienced, systems-type engineers and analysts who were responsible for evaluating operating experience using this tool, this simulator -- I think we probably would understand Davis Besse tomorrow better than we did a year and a half ago.

So two roles for better research, improved safety research, in the training, analysis, simulator.

The third general area I speak to has two factors, and I know this is in the research proposals for modification of the improved safety research program -- things like instrumentation improvements, both instrumentation to detect and control off-normal things happening in the reactor, degraded-core cooling, for example -- there the hyphen is between "degraded" and "cooling".

And also instrumentation to follow the course of an accident.

DR. OKRENT: Excuse me.

I don't know how you got the hyphen between "degraded" and "cooling" with a word in between.

Perhaps you can help me?

MR. MATTSON: Degraded cooling of a core.

DR. LAWROSKI: The core was degraded but it was cooling.

MR. MATTSON: Improvements in the monitoring way and diagnosis area in the control room -- for example, one of the things we're considering in Lessons Learned is Regulatory Guide 1.47, Status Monitoring.

As I understand it, and my information may be superficial, but probably the first Reg Guide 1.47 plant is Sequoyah. It's going to an operating license. It's near the end of its review now.

Regulatory Guide 1.47 is a fair advancement in the state of the art, but -- for status monitoring -- should it be backfitted or plants currently operating and capable of backfitting under Reg Guide 1.47, or portions of it?

If not, what kind of research need we do to understand what's practicable in terms of status monitoring?

The same kind of questions as to control room displays.

I had occasion recently to go to the Singer Company and see the black box, a control room simulator; it's got 12 or 15 cathode ray displays of system status, and multiple software options where you can call on the various permutations, and combinations of systems; and because of status monitoring in the plant the computer in the control room display, those things will show you what's happening in all of these systems, where the flow is, where the flow isn't, where the leaks are, where the leaks aren't, what valves are open, what valves are closed, what pumps at running at speed, which ones aren't.

Those are pretty sophisticated control rooms. They are not anything like some of the older ones in operation.

What's possible to backfit into existing control rooms?

We are also looking at diagnostic equipment, EPRI and Oak Ridge and others have been working with these for several years, aimed at improving plant capability.

Now, subsequent to TMI people are looking in terms of taking a wide spectrum of information out of that available in a control room and doing computer diagnostics to aid the reactor operator.

We are told that the people in Halden and possibly elsewhere in Europe may be a step ahead of the Americans in this field.

The people I talked to who are expert in this area on the Staff, and some outside the agency, tell me there's promise here.

What ought to be the retrospective view of those sorts of devices?

I think that's an area that clearly fits into the improved safety research program.

Again, not so much with, how do you go about improving what's there for the most recent CP applications, like Black Fox -- how do you advance that state of the art? -- because that's pretty advanced compared to Three Mile Island or Dresden 1.

But, rather, how do you find that kind of current technology retrospectively?

Well, those I guess are the technical matters I wanted to hone in on. I don't think they are much different than what we see coming in research thinking.

DR. OKRENT: Would you help me again, the first one was --

MR. MATTSON: Degraded-cooling.

DR. OKRENT: Degraded-cooling, and measures to prevent it, measures to mitigate it.

MR. MATTSON: Yes.

DR. OKRENT: And the second one I have is studies of off-design or anomalous transients --

MR. MATTSON: Right.

DR. OKRENT: To help improve one's capabilities to keep from getting out of hand?

MR. MATTSON: Yup.

DR. OKRENT: What was the title on the third one?

MR. MATTSON: Well, I called it human factors, but I started with instrumentation. That may have been the confusion.

DR. SIESS: Now, Roger, at the very beginning you said that sometimes there might be disagreement between NRR and Research over priorities; and you mentioned such things as unresolved safety issues.

Do you feel that what you said after that suggests that your priorities have changed somewhat as a result of Three Mile Island? Some of the unresolved safety issues are maybe trying to learn more about more and more, and don't look as important as they did before Three Mile Island?

MR. MATTSON: They are still a problem.

DR. SIESS: Realizing that the unresolved safety issues are not just a technical problem, although they have other implications with the Congress and so forth, but as a technical problem?

MR. MATTSON: Yes, I think it's fair to say that our priorities on some unresolved safety issues changed on Three Mile Island.

That is to say, that you [illegible] to swap half a dozen of the below-20 list for half a dozen of the above-20 list; but things like loss of AC power, I think it's more important in my mind and several other people's minds since Three Mile Island.

DR. SIESS: It's almost under your anomalous transient, an unanalyzed case not in the standard review plan.

MR. MATTSON: I see steps being taken both in the task force and Lessons Learned which would go directly to that problem.

For example, Lessons Learned recommended yesterday that all pressurized water reactors would be required to provide emergency power for the number of pressurized heaters required to go on natural circulation, and to provide emergency power to pressurized level indicators, PORVs.

I also know that the Bulletin's Task Force in its review of Westinghouse and Combustion Engineering plants is going to require diverse power supplies for all those auxiliary feedwater systems whose valves are operable or whose lub oil systems are operable only on AC power. And that those changes will occur within a very short time.

So that when you come finally to a solution of loss of all AC-generic-issue-question, you will come to it from a different starting point than if Three Mile Island hadn't happened.

DR. SIESS: You've got a lot more things hung on that system than you had before.

MR. MATTSON: It's going to be a better system than it was before.

DR. SIESS: You are just hanging more things on it.

MR. MATTSON: No, I mean for example, the capability to use a steam turbine off feedwater system for a loss of all

AC power, that right now it doesn't have any.

DR. SIESS: You run the valves off the steam system.

MR. MATTSON: I'm going to open the valves off the DC power supply in addition to the AC power supply; today in some cases they are only on the AC power supply. Or I'm going to run the lube oil --

DR. SIESS: You make a distinction between DC and AC?

MR. MATTSON: I am going to run the lube oil system off of either the DC power supply or off of a connection to the turbine, which they have in some plants; whereas in some plants today they are run off the AC.

DR. OKRENT: You know, I'm surprised at least in one sense to hear that, because in this room in connection with several different individual cases, we asked the then applicant, did he need AC at all to continue for some period of time?

And in each case the answer was no, we could run for one or two or six hours.

MR. MATTSON: I don't mean to imply that there are large numbers of plants in this case, but there are a few.

DR. OKRENT: Well, I'm surprised that you did go back and pick that up. I'll just say that in passing.

There is something you said that -- about exploratory improved research that I think warrants a comment:

You tended to equate the two, and I by no means want to say that exploratory research does not lead to research in improved reactor safety, but I think the sense of it as the committee used it, was somewhat different.

To some extent during the past year or two more and more of what the Office of Research can do is it has to have a user. And in fact you just indicated that NRR has exerted some influence to have short-term activities accen uated in research, and not do longer-term things that might have a payoff, if any, at some future time.

That's one way in which there's an influence. But another way in which the need for a user is, somebody has an idea -- it may not be in the Office of Research; it may be somebody at some nonprofit organization, a national lab, or some university, whatever, of some things to look at.

He can hardly have a chance at having it supported until it gets to the Office of Research and then have NRR agree that there is a use; and there could well be difficulty.

Now, I can think back, let's say a dozen years, when the discovery that the zircaloy would embrittle, if heated up to, oh, 2200, 2500 degrees Fahrenheit, and then fell back in temperature, it might shatter.

That wasn't in some task action plan to be studied. It was observed from an exploratory point of view. You know experimenters were doing studies and this was not the mission; in fact, it had a very early impact on licensing, because when they immediately changed from no-clad-melt to below 2200 F.

The question of exploratory research is in my mind a freedom for some research, whether the idea originates in NRR or RES or some other place, to go forward and see what additional areas to look at.

And I think a problem has been that you had the standard review plan for things important to the immediate licensing process, and I think it was in fact hard for NRR to look too far beyond this in looking at what research should be done.

And even now you've indicated a very strong interest in doing something that's good for the operating reactors, and you are less interested in reactors being constructed -- if there will be many in the next five or ten years.

I can understand your point of view. But I think there needs to be some balancing factor because otherwise you are going to get to a point where these reactors, let's say, come in and they are new types and you've not prepared yourself for them; there are improvements you could have made that you just didn't because you didn't study them.

And a little earlier today, before you were here, I took a rather strong point of view in a discussion concerning the relationship between NRC and DOE, for example, on research to improve reactor safety: NRC should have a strong input into DOE.

But I would object if there were no flexibility in DOE to initiate things that they feltwere important.

I don't think all of the fountainhead of wisdom is going to be within NRC, either. It's just I think there needs to be that.

But again it seems to me we want to have flexibility to do whatever is exploratory -- they may not choose to call it that.

MR. MATTSON: I think not only do I agree with what you said, I'll go a step further:

In my mind the Office of Research, that is, the research function of the NRC, was not created by the Congress as solely a service organization to the licensing function.

The Congress understood, I think, and I certainly support, a concept of regulation that has a licensing function which needs research in order to be accomplished.

And a research function in and of itself simply to provide increased understanding and increased insights guarding against things that aren't thought of in the licensing process, thinking foward, thinking broadly, thinking independently -- and we've kind of lost the flavor of that for a couple of years.

We have users need letters before bucks can move in the Office of Research. And that's contradictory to this other motivation for research; and I guess I have to say I am speaking as an individual, rather than as an Office, because I am not certain the Office supports that concept.

DR. LAWROSKI: Why do you think the Congress used the term "confirmatory assessment"?

MR. MATTSON: Well, they used it, but they had a hard time defining it.

DR. SIESS: Did they ever define it?

MR. MATTSON: Not to anybody's satisfaction that I know of.

And several years later Congress came along and agreed with the concept, in fact, I think it originated in Congress rather than in the agency -- of improved safety research; so expanding and adding to that concept.

I think it's there. I think we need to do more of it. And I am afraid I haven't the authority to change the requirements on users' need letters. I am willing to support it and speak to it.

DR. SIESS: And yet, you spoke as a user, you know, when you said that in any arguments between NRR and Research you ask for --

MR. MATTSON: I am in the Office of Nuclear Reactor Regulation, it's my job to represent my office.

I ought to say one other thing:

Mr. Levine was down here for the full committee meeting, I believe, when Mr. Budnitz presented the 80 supplemental.

Since that time NRR has given Mr. Levine our concurrence in a slight revision of the program he was speaking to you of, something of the order of $30 million for FY 80, which I am sure the people presenting their program to you have talked about in relationship between the supplemental FY 80 and the 81 budget, because if you get one, you need the other; and if you don't get one, you need more of the other.

And there are things in improved safety research in this FY 80 supplemental as a result of Three Mile Island.

DR. OKRENT: You said there is a general concurrence in NRR.

Could I ask a different question. The last point you dealt with in human factors was sort of focused at the end on the question of, should there be a backfit of various currently-available technology.

It certainly is an important question and one that NRR is going to have to address at some point.

Do you feel that this is something that should be studied, that is, the background information developed so that NRR can arrive at its recommendation?

Should this be studied as part of the program of the Office of Research, as part of the program for research to improve reactor safety? Or should it be studied perhaps by some inter-staff group, the probabilistic assessment group and licensing people, as some kind of high priority or some kind of priority issue that needs a regulatory decision?

MR. MATTSON: I think Lessons Learned is going to say by the first of September that it ought to be done, and I think we are going to say that it ought to be done by the Office of Research.

I don't think we'll say it ought to be done with probabilistic assessment staff, because I think the recommendation we'll make is that there appears to be an existing state of technology to backfit, and the Office of Research ought to go to describe practically the backfit from that existing technology.

The resources aren't there in the Office of Nuclear Reactor Regulation to do it with on-board staff, plus the pending 30 OL's, so a lot of the studies in near-term recommendations for developments that can be applied over the next couple of years are going to have to go to the Office of Research.

That's why I said earlier, it's difficult to sit here and talk about 81, because there's going to have to be a lot of activity in 80, starting in October -- maybe semantics is the problem -- but an improved safety research nature.

And I think one of the things that you are going to have to do in the course of this annual review is come to a better understanding of three terms we now have:

Confirmatory, exploratory, and improved.

DR. OKRENT: I'd say there's a fourth one, because I would think the last category -- and say the Office of Research is really providing technical assistance to the Regulatory Staff, the Licensing Staff -- which I don't object to, you know, workloads being what they are; but it's almost more in that category than in research.

DR. SIESS: You said there's going to have to be an awful lot done in FY 80 in the area of improved safety research.

I don't think so. There might have to be a lot done in FY 80 on improved safety and decisions about improved safety; but I am not sure that research --

MR. MATTSON: That's why I said it may be semantics; "improved safety" is to be done in Research and it's a change relative to the way we used to do it; and it's retroactive instead of prospective.

DR. SIESS: I have a feeling it should be done in Research, except Dave says it's this technical assistance basis, then it's probabilistic analysis staff or other people; because it's really not research if you are going to get it fast enough to start making decisions six months from now.

MR. MATTSON: Well, maybe what we need is better advice or better ideas on how to manage all this; because you see, the Licensing Staff of the NRC would be the place to take something from the forefront of technology and understand it and study it and scrub it and describe something that could properly be applied. Licensing Staff uses analyses and designs and decides whether they need some regulations, some regulatory guides and stuff like that.

DR. SIESS: Now you are talking about research staff as being a resource --

MR. MATTSON: And not just to the licensing function.

DR. SIESS: If the research staff spends all of their time managing contracts, managing projects, they are not going to be a resource to anybody. Office of Research may be a resource to you; but I think this committee has said in previous reports we though the research staff should not only manage contracts and respond to user needs and so forth, they should maintain cognizance of what's going on in the rest of the world.

They should be on top of all this recent stuff, and should serve as a resource for the rest of the staff. They are not going to be much of a resource if you tell them what the problem is, and the only thing they do is put out an RFP, which means it's six months before the work starts; two years after that, another report.

You would like to use their knowledge and background in R&D in what they've learned from some of the things they've done in the past, not just as contractors that are going to go out and get the work done.

MR. MATTSON: That says that you want to double or triple the size of the research staff and have this expertise from the front of technology residing in Washington. I am not sure that that's necessary.

I don't know why it isn't equally as effective tohave that expertise residing in Tennessee or New Mexico or Illinois or wherever the national laboratory is.

DR. SIESS: Much of it does, and you use it in your technical assistance contracts; don't you?

MR. MATTSON: Generally they are different people. In each of these laboratories there's a small cell of people that give technical assistance, and then there's another group of people working on the research program. But generally not the same people.

So when you tap the Office of Research to provide something for NRR, you really are going to a different kind of people.

You need that information and your people in the laboratories under technical assistance were the same people that you could go to and get the information? -- it generally does n't work that way.

DR. SIESS: Well, how would you test those reservoirs in the national lab?

Just because there are people out there doing research it doesn't mean you can't get them to work on your problem; does it? -- by going through Research?

MR. MATTSON: Yes, but there are problems to be solved that have more of a research character, and we try to use our technical assistance dollars to extensions of the licensing capability, to a specific design or a group of designs that have a particularly unique problem.

DR. SIESS: If an answer doesn't exist to a question, and you think that by doing certain things experimentally or whatever, spending a certain amount of money, a certain amount of manyears, you could come up with an answer. There's one definition of research.

There are many times when the answer exists, you just don't know it; and maybe there's no single person knows it. But you get four or five of them together and they come up with a pretty good approximation of an answer.

Now, that's not research; but it's solving your problem.

Now, some of that you do with technical assistance contracts; don't you?

But you are sayi ig you can't get to the same people Research can, or -- ?

MR. MATTSON: No, I'm not tr ing to raise that as a problem. Clearly, if I need to get to the people, I don't have a difficulty there.

DR. SIESS: I think that giving an increased amount of money might -- to increase the size of the staff -- it might improve their response more than the same amount put into program support.

MR. MATTSON: Well, it wouldn't have to be trippled to get more time with the problems.

I think tech assistance is more on the lines of a direct extension either in breadth or depth of the licensing staff; and research is more in the nature of: here's a problem, now, what do we do about it for the future? Or, it isn't a matter of the regulations that need implementation today, and we want to consider adding it; or if it's of a comfirmatory nature this is the way we've been doing business and making engineering judgments on the basis of incomplete information, go out and fill in the gaps of knowledge to confirm the judgements were valid.

Those are words more descriptive. Those are different categories.

DR. SIESS: One is time, and the other is confirming some existing type of thing, or whether you should consider something else?

MR. MATTSON: I don't think that time should necessarily be the difference between tech assistance and research.

I think if research takes as a premise that the only things they do are things that are more than X-months delivery or X-years delivery, then we fail to take advantage of some things that research could give to us.

DR. SIESS: The basic difference is that research is usually answering a question where it requires some new knowledge, new information, new data, in order to get an answer.

Basically, for technical assistance you go out to the state of the art; don't you?

MR. MATTSON: In tech assistance we don't try to advance the state of the art.

If it's advancing the state of the art, I think it should be research. If it involves equipment, it should be research, because we have no ability to manage equipment in a technical assistance program.

But if you limit research to advancement of the state of the art, and equipment, I think they are too narrowly limited. I think research can provide a function in the state of the art, in putting things together, in deriving a consensus.

For example, the control room diagnostics: it would be one thing to go to research and say, oh, develop something, and come back to Regulation and tell us what we can now require.

But another thing is to go to the Office of Research and say, through your contractors across the nation, develop a synthesis of the current state of the art of control room diagnostics, consider practicality, consider dollars, consider time, consider space, and whatever's important. Develop a report and come back to us in six months.

DR. SIESS: Has Research ever done anything like that for you?

MR. MATTSON: Yes. There have been such requests made of the Office of Research.

DR. SIESS: Did you have any problems?

MR. MATTSON: I haven't made many of them from the Office of Nuclear Reactor Regulation. I have made them from another office.

MR. SILVERBERG: Mr. Chairman, in the course of our interactions with advanced reactors people in NRR in the case of FFTF, we have had done more at the request of NRR, on short-term notice things like what is the state of the art of interactions of this with that; we need it for our review; we would like to know exactly where things are because we'd like to come up with a position on it.

So we have done it in advanced reactors.

MR. MATTSON: You know, you have to look at it on both sides, I guess:

There are also programs in the Office of Research that tend to go on and on and on --

DR. OKRENT: Could you name one?

(Laughter.)

MR. MATTSON: I think advanced code development is one.

(Laughter.)

They ought to start to come to some conclusions pretty soon. We ought to be able to freeze the codes in a couple of the simulators and start using the darned things, instead of studying them forever and ever.

DR. SIESS: Small breaks?

MR. MATTSON: On small breaks, large breaks, transients.

I guess saying that in different words would be although I support the broad outlook and the exploratory nature and improvement nature and advancement of the art nature of the Office of Research, I think that the two offices, NRR and Research, need to work together more closely by saying what are the productivity aspects of research? When are they needed, and in what form can they be used -- that sort of thing.

DR. SIESS: Well, I think part of the problem there is in the questions you ask that they are trying to answer. And it seems to me as a representative of NRR that told us that the reason for the LOCA-ECCS research was truth in LOCA.

If that's what you asked for, you are going to be a long time in getting it.

MR. MATTSON: Well, I go back to the finite research problem.

I have for two consecutive years in the Office of NRR been director and asked to double or triple my resources for research coordination. I have been denied those resources in both budget processes.

It takes people. It takes time. And if you are 100-percent occupied with unresolved safety issues and pending licensing cases, you won't get a perspective on what Research is doing; you don't have opportunity to communicate to people what kind of product you want and on what time scale and giving them feedback on whether they are doing a good job or not.

There's clearly a deficiency in the resources put into research management by this agency.

DR. SIESS: How many manyears in Systems Safety are devoted to research?

MR. MATTSON: Gee, I'm not sure I know the number off the top of my head. It's on the order of one-to-five on the order of 170 manyears.

DR. SIESS: What about Office of Standards Development?

MR. MATTSON: I think they have the same problem of having asked for better resources to coordinate with Research, and have been denied them.

DR. SIESS: What would be the manyears that the Office of Research expends on research coordination with other offices, not with contractors?

You don't have to answer, but I'd like to get the figure eventually.

MR. MATTSON: You are asking the management resources? A million dollars or something like that.

DR. SIESS: I would like to know how many men or manyears Research has assigned to research coordination, and how much the user offices have?

I think it's something we might well address in our report to Congress; because I have a feeling ever since I got into this thing that it was not the kind of coordination that anybody was happy with.

MR. MATTSON: And it leads to problems. You get problems that are off-track or out of kilter with what their original intent was; you get frustration in the research managers, because nobody will listen to their problems and help them give program direction. Or they get products and NRR jumps all over them -- that isn't what we wanted; and what-have-you.

So they form users groups and they don't get well-attended because the man that's supposed to be on the users group or the research review group has got case deadlines staring him in the face. Clearly he knows which takes precedence in his performance appraisal.

DR. SIESS: I think that's a veryimportant point you brought up.

Any other questions for Roger?

(No response.)

Thank you.

Mr. Silverberg?

MR. SILVERBERG: My name is Mel Silverberg, I am Chief of the Experimental FAST Reactor Safety Branch in RSR in RES Division.

What I would like to do today is very briefly address the topic that was on the agenda for today, having to do with the status of LWR care catcher research, or, as we refer to it core retention research.

And let me start out by briefly recalling the recognition in 1978 of the ACRS regarding the review and evaluation of the RES program in this particular area, namely, the ACRS recommended that emphasis be placed on scoping studies on topics related to prevention or mitigation of consequences resulting from core melt accidents, that pathway.

Now, Ray DiSalvo noted this morning that the work that we have going on in RES, which is of a generic nature, in effect is addressing the intent of the scoping studies which are called out here.

What I will do today is to indicate just briefly where that program lies within the kinds of research we are doing within the general subject of core melt, how we get involved in core retention research; and just look a little bit to the future of things that might be coming down the road that will probably help us focus even further in this area as we see it.

Now, by way of background and history, we have to look at how NRC got involved in core melt research in the first place. It comes in two parts:

One, relative to the LWR in the Water Reactor Safety Research Office, under Dr. Murley, in 1975, they proceeded to do some phenomenonological work in model development related to improving models that are used for risk assessment and in the WASH-1400 study.

And the scope of that work that evolved over a number of years was experiments in melt-concrete interactions, a variety of concretes, different melts; most of these experiments are phenomenonological in scale, small field scale experiments; development of an interaction model called Inter and Corcon; and cooperative studies, cooperative arrangements between the RSR -- LWR, RSR -- and the Federal Republic of Germany, to participate in large-scale experiments that they are planning now in the way of trying to verify some of the models that have been developed in this country as well as in Germany.

Now, as of the moment, the LWR WRSR is looking into the work in FRG as a new program that's currently planning to somewhat deemphasize the FRG experimental work, starting in 80. However, in view of current interest in this area, so forth, some measure of reevaluation, you know, will have to go on there.

But nevertheless in RSR we have always maintained rather close coordination between Water Reactor Safety Research and the LMFBR. In fact our program sort of evolved from this; it was at Sandia Lab, started there --

DR. OKRENT: Excuse me.

Before you go on, could you be more specific about this reevaluation that you said you think may be underway with regard to previously planned -- namely, a reduction in the planned LWR program.

I couldn't see anything specific that looked like a turn-around of that in the material that was submitted to us.

MR. SILBERBERG: Well, I would say it isn't a turn-around, but I think there's been some thinking along those lines.

And I wouldn't say it was in a state of turn-around at this point.

Now, some of the information we are going to present here on core melt research and how -- what component of that is core retention research, certainly has been presented to the various research subcommittees over the last few years.

It wasn't until fiscal 78 and 79 we started with some experimental work, analytical work, that we launched into it seriously. But in core melt research the motivation was for generic development and verification of containment systems codes used in analyizing LMFBR accidents, core melt accidents.

A component of this work has always been to explore the possibilities or alternatives to concrete. Certainly one has to develop the data base for concrete and then follow up on that with core retention data base.

Now, much of our program, roughly back in 1976 was driven and motivated by specific needs, which also incl:ded generic needs identified by NRR, CRBR in 1976 and more recently in 1978.

But the scope of our program here has been to again look at core melt interaction phenomenology both respect to small-scale pehnomena to understand those as well as scoping studies of large-scale, that allows us to identify further what additional experiments one needs to perform to understand the phenonema that are used in the interaction models for the containment code.

The same holds true of melt retention materials which I'll go into next.

But along with that, in order to get into quantification for code development and verification and to make more precise assessments of comparisons between concrete and alternatives, one has to get into additional advanced instrumentation which was not available when the project started and development of a large field scale facility to allow one to get into the experimental regime in terms of scale and initial conditions that make for meaningful experiments.

Now, let's just examine the core retention part of the program.

We had as the objective there in similar ways as we did with melt-concrete, scoping studies to identify important phenomena for retention materials. Some are different, in fact quite different in many respects from concrete, the behavior of concrete.

A quantitative data base for evaluating the candidate materials, and to establish a framework using an existing framework if possible, an interaction model that would be of interest to core retention situations.

The scope of this work, which as I say got underway in 1979, was initial scoping tests on molten stainless steel, where the temperatures only apply to 1760, up to the scale shown, and a variety of separate effects tests and full scale tests of trying to get parameters that one could survey more quickly, and looking at such things like chemical attacks, which is of interest in the case of retention material.

Let's take a look at some of the retention materials that are of interest. This --

(Slide.)

-- is by no means an exclusive list. There are some I have left off.

They all enter three categories. The asterisk denotes where we have used the material in initial scoping studies.

We have what we call cruciblematerials, we are working with a refractory and in fact it will stay and for the most part keep its basic shape and form with a minimum of penetration over some period of time, the one that was specified.

Sacrificial materials such as borax or lead or iron oxide, where the sacrificial material serves as diluent to not only reduce th.. at load but actually reduce the heat source from the core melt, by not only just volumetric means, but also by means of chemical solution of, let's say, the melt material and the other material, in terms of low melting eutechtics.

Miscellaneous materials we see things like firebrick because right now the FFTF has used in its core cavity, the liner, an array of firebricks; so this was of interest to us, and of interest to the NRR people.

DR. SIESS: Is this what they filled the room with down there?

MR. SILBERBERG: Yes.

They have different grades of firebrick but basically it's firebrick.

And another material of interest to us has been the high alumina cement because it tends to be more refractory than concrete, also in terms of working with it as a working material it has advantages over things, let's say, like bricks and things like that.

Now, just a few shots from our program to give you an idea of what we have found:

Here's an example of steel melt on concrete, and characteristic with large flames from hydrogen burning and large amounts of aerosols.

By comparison one of the more recent experiements that we've run in the past year, one happens to be with high alumina cement; but you can see quite a difference in reduction --

DR. SIESS: We could if you would move.

(Laughter.)

MR. SILBERBERG: -- in terms of the amount of aerosols coming off as well as gas generation. And certainly one of the parameters is the amount of gas generation.

DR. SIESS: By high alumina cement, you mean concrete with high alumina cement?

MR. SILBERBERG: That's correct.

DR. SIESS: With what for an aggregate? Crushed firebrick?

MR. SILBERBERG: It could be. It's certainly alumina type materials.

DR. SIESS: Do you know what they used there?

MR. SILBERBERG: I'm not sure.

DR. SIESS: So this really wouldn't be any more resistance than firebrick itself, would it? Probably with the crushed firebrick aggregate you'd have 80 percent of the volume made up of the aggregate.

b180

VOICE FROM SANDIA: Alumina aggregate.

DR. SIESS: I never heard of an alumina aggregate. I am surprised to hear you say that concrete would be more resistant than firebrick. I don't think it is, because that's an old material, one I've been familiar with. It seems to me it starts to go little over 1,000 degrees F. I know the firebrick goes better than that.

MR. SILBERBERG: I do nothave a comparable photo for the case of an MGO, but this is a set-up for the MGO test that has been ~~.

We have some movie film of that, and there you can see it's much reduced, you know in terms of smoke coming off. Certainly it would follow this to be better than firebrick or high alumina cement.

DR. SIESS: What is that?

MR. SILBERBERG: That's MGO. An array of MGO brick packed with an MGO mortar.

MR. ETHERINGTON: Was the ladle heated before you poured the melt into it?

MR. SILBERBERG: In this particular case it was not.

Let me just very quickly list the -- a number of the key questions that one would want to address in the program, and a number of which are being looked at now.

There's the mechanism and rate of melt attack, in the case of concrete we're looking at more of a thermal relation-type mechanism, where in the case of the retention material, like an oxide like MGO, we are looking more at a chemical interaction, the solution and perhaps the mass transit control situation as opposed to just the heat transfer control. These are some of the things we are just starting to get to look at.

We'll take a real quick look, moving from here to the future, we see a continuation of the types of testing we are talking about, trying to get a quantitative data base; and coming off in the future will be a large-scale sustained melt test.

One thing is getting a large-scale facility, the second thing is the technique for sustained heating, some of which has already been demonstrated at Sandia, but there's still a lot of additional work to be done there. It is not necessarily an easy task.

Then what one could get into in observing the larger test is engineering features that are of interest to a core-retention system design, such as in the case of putting bricks together in joints, things like this, that type of thing. Again it's a question of looking at interactions on a larger scale.

We see some measure of support coming for the NRR review of the floating nuclear plant, which I won't go into much today, but just throw a slide or two up, so you may know what's coming up there.

We do have a user request into RES from NRR on this, and whereas our generic program will have some capability to provide answers, it by no means can provide the full bread h of answer on a time-scale that one -- that has been requested.

So in order for us to do any measurable support that program will have to be augmented in that direction. And right now that's under review.

And, again, looking at the core retention research the bottom line is to assess risk reduction potential in the case of core melt.

Here is an artist's drawing of the facility that's now being assembled at the large melt facility at Sandia with a 500 kilogram capability; and this is now under construction. This is a facility we feel is an important part of the program, not necessarily for core-retention research but even core melt interactions.

DR. LAWROSKI: What's the temperature limit on that?

MR. SILBERBERG: I believe that the induction furnace will have a capability of about 2800 degrees C., which is the kind of thing one would want to get into.

This is just a history of user requests, and in effect I've addressed it.

Let's take a quick look at some more recent ones, that we are now developing a response for, and the NRR request indicates that they would like to confirm the feasibility of refractory material retention device -- such as MGO -- on a three-year timeframe, that is to manufacture and license.

Nevertheless they do indicate the generic interest in the subject beyond SNP, and these are some of the highlights of some of the things they've asked for:

Particularly they note the importance of sustained heating (indicating).

The NRC Staff made a requirement in the FES for FFT which extends from these four requirements which are not in themselves very profound but certainly that's where the design responsiveness is.

To give you a quick idea of -- there's more on this subject tomorrow -- this is what applicant has proposed for the floating nuclear plant, a tongue and groove network on a number of courses of bricks, something like 8 feet, 10 feet deep.

MR. ETHERINGTON: What is the purpose of the concrete?

MR. SILBERBERG: Underneath it all? I am not really sure.

MR. ETHERINGTON: Underneath and around it.

DR. SIESS: You are welcome to come to the meeting tomorrow, Harold.

MR. ETHERINGTON: Oh, yes, I see.

DR. SIESS: And you'll probably learn a lot more about it than you are interested in.

(Laughter.)

MR. SILBERBERG: Those are my remarks, basically.

DR. SIESS: Could you give us some idea of the scope of the current project and any past or current projects on light water reactor core melt -- core catchers? In terms of dollars, years?

MR. SILBERBERG: Well, let me refer -- I'll do it for core melt, if you'd like that, as the overall topic and then -- unless you just want the core retention.

DR. SIESS: I think the subject --

MR. SILBERBERG: Core catchers? Okay. Fine.

Okay, in fiscal 78 there was just some planning studies, certainly under $100,000, that related to getting ready for fiscal 79 and setting up the program.

Fiscal 79, the number would be something approaching $200,000.

In fiscal 80, and depending on that this would be run with the new facility, a linea system with MGO -- so that would be the first test on that facility; so those tests are not cheap. I would say $250,000 to $300,000 for the fiscal 80.

And for 81, the number again is dependent on the number of tests, but probably like $350,000.

Now, that's exclusive of real support for the floating nuclear plant. I don't want to go much into that, but I would say to meet the NRR needs and the time scale it will be another $1 million a year.

DR. SIESS: 80 and 81?

MR. SILBERBERG: Well, certainly for 81 and 82.

DR. SIESS: That's for FNP related?

MR. SILBERBERG: Yes, over and above the other, the generic program.

DR. SIESS: Now you don't have that in the FY 80 budget; do you have it in the FY 81 budget?

MR. SILBERBERG: My understanding is there's some of that, but it's not clear that it's all that much.

MR. SILBERBERG: How do you propose to spend $1 million in FY 80 with nothing in the budget?

MR. SILBERBERG: I'm certainly not sure. That's a question I believe my management is certainly going to take up; but that would be the possibility.

DR. OKRENT: Where is this work done?

MR. SILBERBERG: The work I have described, the large melt facility and the core retention work is under the Advanced Reactor Research programs.

DR. OKRENT: What's the connection between that program and the work that has been ongoing under Dr. Johnston?

MR. SILBERBERG: Well, my vugraph addressed that. That work started as an improvement in core melt interaction to prove the calculational bases of core melt accidents. And in effect that was all it needed, making an improvement but not all the way over to a systems code verification task. It was risk assessment oriented.

Our work has always been containment margins.

DR. OKRENT: And the work you do, is there some point where what happens when and if you all were to drop onto this MGO system, what happens at that point, and what would happen if there's water there and so forth?

MR. SILBERBERG: That is one of the items that was requested by NRR, to look at that situation, a situation of water flooding.

Now, I might add that as we proceed down the road on FNP we'll be in close coordination with Dr. Johnson's office and my office in terms of developing how we can take the best from each of the programs and come up with that information for NRR.

But water-flooding is one of the issues in the FNP.

DR. SIESS: Are those figures you just gave only for the Advanced Reactor?

MR. SILBERBERG: That is correct.

DR. SIESS: The work you and Dr. Okrent were just discussing was done when?

MR. SILBERBERG: 1975 and 76, 77, 78.

DR. OKRENT: Is it fair to say that there has been some effort intended to improve risk assessment -- I don't know quite how -- but those are the words I've heard, and we've had this program in Advanced Reactor Safety; but there hasn't been any program to look at a conceptual system which would examine the possibility of maintaining containment integrity for LWR, at least with regard to downward penetration? From a systems point of view?

MR. SILBERBERG: Certainly not from a systems point of view.

But I think the floating nuclear plant probably represents the first focus on a systems thing; however, I will say that in the case of the FNP while we are considering our response, it is our preliminary thinking that Research would probably like to do more than just address a core catcher in an FNP.

We think that a broader integrated systems approach to core catchers versus vented containment, that type of a trade-off, merits coupling those two types of considerations, and not just focus on what's down below, so to speak.

DR. OKRENT: I don't know if it's a trade-off, but

I do think we certainly have to look at multiple aspects of the problem.

But again there has not been such a program.

MR. SILBERBERG: Correct.

DR. OKRENT: Nor is there one in the budget?

MR. SILBERBERG: Correct.

DR. SIESS: Ray?

MR. DI SALVO: I think under the program I described this morning on alternate containment concepts, we do want to take a sort of a broader look at core retention devices, and look at them from a systems standpoint.

We've done some work like this in-house already, to try to help us determine what the risk reduction potential of such devices might be.

And when we do those analyses we do look at it from a systems standpoint because we try to identify the various failure modes that might occur in containment, and identify what a core catcher or core retention device might do relative to the other failure modes, as well as the downward penetration.

We've done some looking at it. It may not meet everyone's satisfaction. But we are cognizant of the fact we have to look at it from a systems standpoint.

Another point I wanted to address was your comment you weren't sure how this LWR work on concrete was used in improving the risk assessment.

The reason that work was generated was because in WASH-1400 there is a very simplistic model assumed for penetration of the core through the concrete, and it was based on a minimum of experimental information.

And this effort was designed to provide a more mechanistic phenomenonological model, which it has done very successfully; and, in fact, was used in evaluation subsequent to TMI during the early hours of TMI's accident.

And, finally, two points that I didn't want to be lost, and that is first of all just because of work in particular program areas does not show up in the improved safety budget, specifically I am talking about work on core retention devices, does not mean that that work is not being done.

Again, this points up the problem of improved safety more as an administrative label than it is a technical label.

So even though this doesn't show up as a line item it is work being done in Research.

The second point I wanted to make is that we feel that the work that is being done both in water reactor safety and advanced reactor safety and in-house on probabilistic analysis, we feel is responsive to the recommendations that the

ACRS has made to do scoping studies in this area.

And if it isn't, I would most appreciate your identifying for us where we can improve the program.

DR. OKRENT: I'd like to respond to that, because I don't think it's been what I would call responsive; and I'll tell you why:

Based on what you've done and what I see is being proposed to be done in FY 80, I don't think I'll have the information which tells me what the feasibility is when a reactor is being constructed of retaining a molten core in the containment, what other containment features would you need to include with this in order to be seriously interested in it.

Is it a filtered vent containment, or what?

If you were to do this, what reduction in risk occurs with what uncertainties? This relates to how well do you know the liquid pathways, and how is this site-dependent?

I am sorry, but I don't see that, I think through the whole research program, not only in what we've heard today. There's nothing inhydraulogy that relates to this, and so is someone who is doing this trying to respond to the point quoted at the beginning of Mr. Silberberg's presentation -- I would like to know about it.

Nor do I get it out of your laundry list of things done on containment. That could emphasize any one of eight things. I can't accept that as being responsive.

MR. DI SALVO: There is a study underway in probability analysis of liquid pathways at Sandia on risk of liquid pathway in a land-based plant. And it's my understanding that the results of that study will provide some additional information upon which to make some further judgments in terms of the risk.

DR. OKRENT: I think that's good to know it's well underway and it may in fact give that piece of information; but I don't see the rest that could be useful with regard to hydrological, seismic, if you want to put it that way; not only with regard to the site characteristics, but are there design features in the plant that should be considered.

MR. NORIN: As those plans develop, we will share them with you.

DR. OKRENT: Are there draft reports giving partial results of the Sandia study.

MR. DAHLGREN: I think some of the thoughts are down on paper, but I will ask the project manager and see what is the status.

DR. SIESS: Suppose there's a difficulty of a semantic nature that we get into in trying to decide what's research to improve safety and what is research. I keep going back to

NUREG 0438 which is the long-range plan that the Congress asked for.

I noted on page 44 and elsewhere that item 10 out of your original list, core retention measur :; and then at the bottom of this list of left-over items -- it's the items for the scoping study -- it says six of the research topics listed above are covered by current NRC programs.

And that was one of them.

MR. DI SALVO: Well, light-water reactors at the time --

DR. SIESS: Well, then I look back where it was described in more detail, and it defines function of core retention measures would be to cool and thus to retain within containment the molten core materials that could result in accident sequences in which the reactor core would melt. Successful retention of molten core materials reduce the potential for interrupting the concrete and penetrating the containment floor.

Well, with that definition, I guess the core-concrete interaction studies don't have any relation to core retention; certainly theFNP studies don't; the object of the FNP core ladle is not to retain the core, but to delay it. And the essence of this was to cool it.

And unless you are going to get a bubble spread out far enough to dissipate the energy within the containment without overpressurizing it, you aren't cooling it.

So I guess leaving it out of that list made sense.

MR. DI SALVO: I only addressed the passive concepts.

DR. SIESS: The research has only addressed the passive.

MR. DI SALVO: I think the work on core-concrete interaction is relevant here, even though it doesn't correctly address retention devices, it certainly is helpful in terms of generating a baseline.

I am not thoroughly convinced -- I am not even mildly convinced -- that in a majority of cases you will in fact ever penetrate the containment face mat. And using that as an assumption, then I still question the need for a core retention device.

Now that's not necessarily to say that it wouldn't be helpful in some ways. But I really think we have to look at the entire retention capabilities of even the LWRs before we consider core retention.

DR. SIESS: What good does it do you if you don't penetrate the base mat, but it goes out the top?

MR. DI SALVO: Well, the same is true if you had a core catcher there, if it went out the top, the core catcher didn't do you much good.

DR. SIESS: If the core catcher kept you away from the material that generated all the water and steam --

MR. DI SALVO: Then it might help.

DR. SIESS: It might help.

MR. DI SALVO: But not necessarily. You know in many accident sequences you overpressurize just by virtue of the steam --

DR. SIESS: And if a core catcher kept you away from the water it might prevent steam explosion.

MR. DI SALVO: It might.

DR. SIESS: You know I would justify what you've done more as support for WASH-1400 to find out how long it's going to take to go through, and how long it's going to take that gas to pop the vessel --

MR. DI SALVO: That's what its original intent was.

DR. OKRENT: Ray, it's your conclusion, your individual conclusion, that containment failure in a downward direction is unlikely, is correct, this has a very significant input possibly to the conclusions on WASH-1400.

And it might lead to estimates that the risk is 10 to 50 times larger. So it's a nontrivial question in that sense. That's the first point.

The second point is the reason why I emphasized the systems approach in looking at a core catcher or core retention device is for the reason that I wouldn't want to use something like this to lead to a high probability of uncontrolled releases of radioactivity, and among other things; in addition to that you have to look at other phenomenon as well as the limited ones in this program.

So, again, getting back to the first point, if in fact the results of the studies at Sandia with whatever it is they are using in fact when put into analysis of core melt situation suggests that you will not penetrate the liner and release your pressure buildup in a downward direction, I'd like to know this.

This is a conclusion of the risk assessment group, and I would like to know it soon.

DR. SIESS: Now, since core retention devices were not in the top five priority list, I am not quite sure how we got into that today except it's one of Dr. Okrent's favorite subjects --

DR. OKRENT: You put it on the agenda.

DR. SIESS: Yes!

DR. OKRENT: At least it was on the agenda, however it arrived there.

(Laughter.)

DR. SIESS: You've got five areas spelled out in NUREG 0438 and you ended up I think with 11 left over for scoping; this morning you indicated your future budget has some items you might do some scoping on. L t me find the slide.

And were these all off of that list?

MR. DI SALVO: It should be the same list.

DR. SIESS: And you still got the asterisk you put on the core retention measures, work in these areas is part of NRC's ongoing program.

So what you propose for the next couple of years, I guess the FY 80 and 81 budgets, is to do a little work on scoping all of these areas?

MR. DI SALVO: All of them or some of them.

DR. SIESS: You listed three or four that you thought were TMI-related. Is that intended to suggest you might give those a little priority? The asterisk side would get higher priority or less priority?

MR. DI SALVO: No, the asterisk is to indicate where we thought applicable work was already going on.

DR. SIESS: But no scoping work in the sense you are talking about here?

MR. DI SALVO: Well, I think the work Silberberg described is scoping work, but it's heavily oriented towards experiments.

DR. SIESS: It's something you might do as part of the scoping work, but it was more systematically planned.

Have you considered at all -- seems to me you didn't have very much money in there for scoping.

MR. DI SALVO: No, it was around $300,000 or $400,000.

DR. SIESS: How much does it take to scope one area, without going into experimentation?

MR. DI SALVO: Well, if we just did some, let's say we took some fault trees and event trees and we identified where we might eliminate the contributors to risk, then I think we could make some judgments on all of those areas. It's more a question of the depth than the confidence you have in your analysis.

DR. SIESS: On this particular question of core retention, how far could you get without physical data?

MR. DI SALVO: Well, as I said, we could take the models that we have of containment processes, and we could make some assumptions about whether or not the containment wherever penetrated, see what those consequences might be.

DR. SIESS: Have you got a physical model on steam explosions?

MR. DI SALVO: We have a model in the containment analysis code, but it's not what I would call a mechanistic model. We assume some probabilities for steam explosion occurring and then penetrating the containment; but it's not necessarily mechanistic.

That's an area that there is confirmatory research on.

DR. SIESS: Just looking at the core retention as an example, it seems to me you could get around the prohibition against physical experimentation by doing that under the confirmatory research program.

MR. DI SALVO: That's a keen observation.

DR. LAWROSKI: He'd make a good lawyer.

(Laughter.)

DR. SIESS: We have finished the agenda items relative to the NRC's presentation. We now have scheduled presentations by DOE, and a presentation by NUCLEDYNE.

We are running a little over an hour late, which isn't unreasonable in view of the time we have for quitting, and the fact that everybody is going to be here tomorrow on the subcommittee and staff -- suppose we take about a ten-minute break and get an hour to two hours late.

(Recess.)

DR. SIESS: The meeting will return to order.

We will now hear a presentation from representatives of the Department of Energy on the new developments in their improved safety system programs; and I guess it wouldn't hurt if they'd review very, very briefly where we were in March.

And this will be presented by Mr. Norin.

MR. NORIN: Briefly, I assumed management of the program from Frank Gavigan, and I'm with the Division of Nuclear Power Development, Director of the Division. Any regrets he could not come here at this time.

With me also are Gerry Griffith, who is the deputy director, and Dr. Dahlgren, Sandia Laboratories. Sandia is the technical management center for the DOE LWR improved safety programs, and Dr. Dahlgren is the manager of the center.

Also with me today is Jim Carlson, sitting back there; he's been in on this program pretty much since its conception and has done a lot of work in getting the program to the stage of development it is now.

What I propose to do is give a few brief remarks on the structure of the program, a few brief remarks on where we are now; and then the detailed discussion of the program will be conducted by Dr. Dahlgren.

Let me briefly state a few remarks about the charter of the program. As you heard from Joe Kearney from OMB there are some constraints on us. One type of constraint is to assure ourselves that what we do will be transferrable to industry. We've also had some discussion here earlier today about our responsibility to be responsive to initiatives that are provided to us by NRC.

DR. LAWROSKI: Who determines what's transferrable to industry?

MR. NORIN: I guess that's part of our job. In the current program what has been done so far is to try to contract the work out to those aspects and areas of industry who have a significant interest in that kind of work.

That is not to say we would not be also putting work into the laboratories and consulting companies, also. That's one avenue.

In the long term this is a problem I am particularly interested in, having spent a number of years prior to coming in government in R&D and lots of times R&D goes off in a different direction than it was intended to when it started.

And that's going to be one of the difficult problems in our program and any other R&D program that's intended to be transferrable to the user industry.

One thing we've considered and what we've done in the LWR technology program is cooperative funding, where we get part of the industry interested enough that they'll pay part of it. That at least is a leg up on transferring.

DR. LAWROSKI: So that would be one criteria.

MR. NORIN: Yuh.

I see that as a continuing problem in our program and any other one.

The basic structure of the program, the current plan, the work we've done through 79 and have currently have before the Congress in fiscal 80, is divided into the elements of improved systems, man-machine interaction, risk methods utilization, and safety data.

We are currently since TMI working on an expanded program which is still in development, which would include emphasis on the experience gained from TMI, and the addition of other categories of work, namely, utility training, emergency and recovery procedures, and TMI-2 examination and analysis.

The rest of the prepared remarks will be provided by Dr. Dahlgren. I will be here for questions.

DR. DAHLGREN: We basically had three requests. I wish to address the third one first, the matter of DOE-NRC coordination.

First let me mention that Tom Murley and Tony Buhl both designated Ray Di Salvo as contact for research for the DOE safety program.

Accordingly, most contacts have in fact been through or with him. Accordingly, we have sent to Ray the following types of documents: first, he had most of the work statements, and he has copies of most of the RFP's. I say most since he may not have gotten the last few that went out; but he will.

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In addition he does the same thing for me, and I in fact know most of the programs they have in place.

Secondly he is on a distribution list to get in a routine manner program reports that we turn out.

As far as meetings are concerned, there have been approximately 30 DOE-NRC meetings related to this program during the past year. I have been present at approximately 22; Frank Gavigan, Andy and Carl have been present at the rest. This is an average of approximately one meeting every eight working days, fairly frequent interaction on this type program.

I point out in the review group area DOE has participated in NUREG 0438, in addition, NRC has participated at the formal DOE-Sandia planning meeting that launched into the FY 79 program.

Another factor -- if you look at the program that NRC is doing, and this is Ray's vugraph, you'll find that in our program consideration, all items on this list either are or have been considered.

The one that is currently not involved is the alternate ECCS; the reason it's not involved is to the best of our knowledge the NRC research program is in fact doing the experimental work to support it.

There is going to be some question about the types of projects we may or may not pick up of the list here of NRC.

According to the guidance from OMB, one of the things we must watch out for perhaps somewhat more so than NRC does is the fact that research is useful only in terms of being used. This requires to our understanding either a push to make sure it's used, which means that NRC legislates in some way, or it has to be of some advantage to the industry, either a safety point of view that they perceive they need, or a financial point of view.

We try to screen to some extent according to those criteria.

Let me now repeat a statement that was made earlier today about the Class-9 accident area: DOE does not feel the Class-9 area is an area where safety research should be focused, and it will not research in this area.

On the other hand, if NRC performs the necessary preliminary studies to show the ideas have significant merit, DOE would certainly consider performing engineer design test studies developed by the NRC.

DR. OKRENT: Could I ask a related question:

One of the ways whereby one might get to an accident that goes beyond what we currently calculate for the design basis LOCA and so forth, in other words, an accident of major core damage or possibly core melt, would be from a loss of systems going beyond current regulatory design basis.

For example an extended loss of power, and there are others that one can think of.

And in fact the ACRS has in the past in connection with its recent letters on TMI-2 suggested that a look could possibly be taken at the single failure criterion and it might warrant modification; and one might also see whether there are ways of modifying system design where you could stand a loss of AC power for a longer period. So it goes in different ways, this kind of study.

Now, it's that kind of thing, an examination of how failure beyond the current design basis could lead to trouble if not interdicted; and a question of how design modification might improve this, what do they cost, and what's the gain; and are there some negative aspects, and so forth.

Is that something that fits within the DOE program, where it's already a part of the DOE program?

DR. DAHLGREN: Most of the things you have indicated are already on our list. The answer is yes.

DR. OKRENT: These are things you are thinking about?

DR. DAHLGREN The second item is what activities have been engaged in in the last three months.

The first thing we did in the last three months was to continue implementing the FY 79 program that was in fact presented to you last time.

The individual tasks are listed here --

(Slide.)

-- I went in detail last time.

What in fact has happened is those that weren't funded, most have now been funded and are in active operation.

The second task we were under charter to do was by April 1st was give DOE the program plan for the next ten years or so.

We did accomplish this task, and turned it in to DOE on approximately April 1st.

We have made plans to submit it to NRC, and to get together with the industry and talk it over with all of them. Those plans were obv[illegible]sly put aside beca se of the need to reassess priorities. So we effectively put it aside for a while.

We then started looking at Three Mile Island to try to learn as much as we could about it and figure out how it might affect the safety program. And then we start ed to revise program.

Now the third part of the discussion I wish to have with you is what we conclude should be done. I would like to now run through some of our currentthoughts on the subject of what kind of research we think should be done.

The DOE LWR safety technology program is comprised of six technical components: risk methods utilization, safety technology, man-machine interface, safety data, operator training, emergency and recovery operations. The last two task areas have in fact been added since the last meeting.

I would note that under this layout of the program the TMI-data acquisition, data analysis, was in effect; in other words under safety data breakdown. The exact program DOE is going to carry out has not been defined.

The magnitude of the program also is under acted to date. There are significant uncertainties with respect to funding levels that DOE is interested in having and that Congress will appropriate.

As a result, the best I can offer you is a statement of the type of work that we think needs to be considered and is being considered as the dollars and the Congressional appropriations are being made known to us, as the inputs from the various committees studying TMI become known, the selection of the areas that we make becomes much clearer.

(Slide.)

And this is again Ray Di Salvo's vugraph.

As you know there are a fair number of organizations that are in fact studying Three Mile Island. The input of these organizations will influence our choices as in fact it may influence situations in the NRC safety program.

I would also say that some of these tasks that in fact we put up here may well wind up not being done by DOE, but may end up being done by other organizations. That's a real possibility.

The first area is risk methods. We start that off by thinking about -- let me say the thoughts that are put forward here are not our program thoughts. They are based on a list of the areas that are -- we believe should receive increased emphasis on what we have in planning in the past, and those areas which are new and have been added as a result of TMI information.

The first area systems and components data collection and dissemination -- and it's pretty clear that the data base formation, data analysis, dissemination, is going to receive increased emphasis. It is clear that the LER's are going to be studied much more in detail. It is clear that useable and automated data bases need to be developed, and statistical methods need to be improved.

Secondly -- the fourth one on the vugraph -- we think we have to review accident analyses by general classes of accidents which has not heretofore been considered in the licensing process.

We are also going to have to review and revise application of the accidentclasses in safety. We are going to have to consider replacing a single failure criteria by some kind of balanced liability for risk design goals, as you mentioned just a minute ago, Dr. Okrent.

This requires some kind of technology development and also this requires the determination of some kind of acceptability code, both of which we think are terribly important.

Now, it is clear that you a: [illegible]ing to have to do systems analysis of accident sequences including partial operations of systems operations and nonrecurrent failures. This may require methods development as well as application to a wide variety of accident sequences.

It is clear that the focus is going to be away from the big LOCA accident even more so than in the past.

We are going to look at human error analysis, at human accident initiation by testing or procedural errors; we are going to have to improve the data basis available for human errors. We are going to have to understand human response during accidents.

The next area let me go through briefly: improved safety systems; this is a partial list of the kinds of things that need to be thought about.

We think you probably are going to be interested in supplying plant layouts to reduce sensitivity to common cause accident initiators, such as correct maintenance activities, adverse environmental conditions, and the like.

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We think that we are going to have to study unique containment systems. It is clear that valves need to be looked at. We want to identify the key valves, and their operating environments by perhaps improved specifications, installed status indicators, the desirability of remote powered operation, and perhaps study mixed phase flow operations through valves.

Improved shutdown heat removal systems, that will probably be looked at from both the primary and secondary sides. You may decide to replace auxiliary feedwater systems, you may wish to look carefully at the location of these systems, their applications and performance under emergency conditions, you are going to want to know flow capability, and cooling under containment isolation conditions.

Containment isolation response obviously has to be looked at; hydrogen recombiners should be looked at. Systems interaction. Partial and intermittent operation has to be looked at because this may mean redesign of some of your safety systems which then would require some testing and qualification.

It is clear that systems and components and their qualification for operation in accident environments will be looked at, especially for long-term accidents, radiation environment, humidity and so forth.

I should note that when I say components here I include the instrumentation.

Man-machine interface -- this is an area that we decided very early on should have importance, and have started as a result to try and develop a comprehensive program plan in this area.

I would point out that in the discussion earlier in the day as to EPRI and their program, they have undergone a significant transfer to removing their disturbance analysys system away from just looking at availability, in to the area of safety. And this is going on today and they are trying to come out with a first set of directions in that program. They are making a significant endeavor.

And in the area of cost sharing in that, DOE and EPRI are going to get together and talk seriously about how to jointly work these things. Again, our desire is to help on things that are useful and where there'll be an emphasis or a push to get them out and be used.

There's a list of items here, let me just pick a couple:

Well, a lot of these things Ray Di Salvo mentioned earlier. There's a wide variety of things to look at.

Human error avoidance, emergency operating procedures; you may wish to go to interlocks to stop you from violating tech specs and predict when you are getting hear tech spec limits, give you a little time to avoid it and take some action; remote operation of key components, and possibly the whole reactor during severe accidents may be considered. Improved display and operator communications, the human factors engineering needs to be looked at. And a lot of that seems to have made significant progress.

Again, as was pointed out earlier, this may be more of a question of looking how you implement plans that propose significant research in this particular area.

We'll move on to safety data.

It's clear that Three Mile Island's accident produced an environment that we've really never seen before, and it's sort of a unique opportunity to learn a lot about performance of equipment in an environment, and for failures, the types of equipment that have failed; it gives you an opportunity to look at your environment definition, your regular activity transport studies, your equipment sensor behaviors; also an opportunity to look at core analysis under accident conditions. That is clearly an area that has to be looked at carefully.

The TMI accident will increase emphasis on primary systems behavior including small break LOCA's, transients; we are going to have to look at natural circulation with blockage, how to avoid generation. These things will be done by accident analysis studies, model development and experimentation.

We want to look at hydrogen combustion and a wide variety of physical and chemical interactions that may turn out to be important.

DR. OKRENT: What sort of meteorological models will you use for verification?

DR. DAHLGREN: Well, as I understand it, the capability for specific site analysis; what you have are models more suited for the generic application to a wide variety of things as opposed to specific, individual models.

We may in fact want to get into that area; that's possible. There are some people who believe this area needs more work. You need to try and take the knowledge you have and see what you come back out with.

DR. OKRENT: I guess I am still trying to understand why -- the question of fission product release -- what do you have in mind there?

DR. DAHLGREN: Fission product release?

DR. OKRENT: There's one on the vugraph, fission product release and meteorological model, validity, verification, need to estimate release is not well known.

DR. DAHLGREN: If you don't know the source term for the release very well, you don't know the transport and deposition very well, it is going to give you considerable uncertainties when you have to predict and make decisions about, say, evacuation.

DR. SIESS: Wouldn't you be just better off putting monitors around every plant?

DR. DAHLGREN: Maybe so.

DR. SIESS: Seems to me you've got as good a chance of doing that as you have of getting a fission product release for an accident that hasn't happened?

DR. DAHLGREN: You may well be right. That may in fact be the correct solution.

If that's the correct solution then you can move on; if you don't know, you have to consider it.

DR. SIESS: A lot of the problems we had with Reg Guide 1.97 was the requirement that they monitor fission product release at all release points or possible release points, and nobody could decide what a release point was. Whether this valve was going to be open, or whether it was going out the sump or the auxiliary building or what.

DR. DAHLGREN: To the best of my knowledge there is not a good way of measuring, stating what is in the field today, that tells you what kind of releases you have and gives you the right information that you can feed into deciding whether you want to evacuate.

MR. DI SALVO: Didn't I understand this to be fission products established by Three Mile Island; I thought that's what this item considered.

DR. DAHLGREN: Well, here's the data collection and as Dr. Siess just pointed out that may or may not be the solution. It may be you are going to wind up with such significant uncertainties that other approaches are warranted. The question has to be looked at.

DR. SIESS: Well, what was the release point at Three Mile Island? The auxiliary building stack?

DR. DAHLGREN: It's my understanding there were several.

DR. SIESS: I haven't seen any proof that there was several, including the question of the DC generator which was blowing into the atmosphere when it went out; wasn't it?

DR. LAWROSKI: What spectrum of accidents are these fission product release terms for?

DR. DAHLGREN: What spectrum? For the purposes of this discussion we are taking a wide viewpoint.

DR. LAWROSKI: Including Class 9?

DR. DAHLGREN: You cannot put instrumentation out there -- the impact is modest so you put out something that has wider range; if you are in a situation where you getthe next ten percent of accuracy, the next level, you have an order of magnitude increase in cost.

You know, there's limits for everything.

DR. LAWROSKI: Well, I didn't know where you were proposing to stop.

DR. DAHLGREN: It depends on the individual situation we lo k at. You know, you push things a little bit farther with a little more research and not much more cost, then you might as well do it. If it winds up in significant cost increase for something that's really pretty far beyond what you are concerned with, then it's not clear you want to do it.

DR. LAWROSKI: Well, if you applied that to the last item, up to Three Mile Island you would have people stop when it generated 2200 F temperature.

DR. DAHLGREN: I don't think fuel clad temperature got over 2200, did it?

DR. LAWROSKI: 2200 F.

DR. DAHLGREN: Oh, F.

I am sure it went over 2200 F.

DR. OKRENT: So I guess the same question relates to the hydrogen explosion -- so I guess it's not clear what DOE has in mind; this could be quite wide in scope or it could be quite limited.

DR. DAHLGREN: Until more evidence is in on some of these latter questions, until some of the accident analyses have been looked at carefully, and you can get a range on what problems you ought to look at, and also to some extent on the type of guidance you get from various official bodies studying the problem.

DR. SIESS: What's not clear to us is the first item on that list is clearly a TMI-2 post item; right?

DR. DAHLGREN: Right.

DR. SIESS: Is the second item to establish exactly what happened at TMI?

DR. DAHLGREN: No, not as we envision it. It is a class of accidents which have not received a significant amount of study and needs to be looked at.

DR. SIESS: What does the heading "safety data" mean as opposed to the other categories?

DR. DAHLGREN: There are some where in fact we expect you are building chronological models and obtaining actual physical data, and other categories where you are doing systems studies, accident progression studies, risk studies.

DR. SIESS: You put analyses of accident situations under safety data?

DR. DAHLGREN: No, the division I have in my mind is that things like safety data provide data for models and things like that. Under others you do things like you run systems studies where you use products of the safety data to find out what the impacts are.

DR. SIESS: The last item there, is that again generic or trying to figure out what happened at TMI?

DR. DAHLGREN: If it turns out when you do your analysis of the type accident sequences, then you wind up looking at these classes. It turns out the hydrogen explosion is a generic problem, and you should look at it.

DR. SIESS: In containment or in primary systems?

DR. DAHLGREN: To the best of my knowledge I am not aware of how you can get an explosion in the primary system.

DR. SIESS: We all agree now there was a period of a few days where --

DR. DAHLGREN: The answer to your question is if there is a significant possibility, if you could produce a mechanism for hydrogen explosion in the primary system, you could look at it. But until such a thing exists --

DR. SIESS: There are certainly some intersting questions on Three Mile Island as to hydrogen explosions inside containment, the first being, was there one? I mean, if there was, how did it happen with 1-1/2 percent hydrogen, and how much did it take to get 28 psi, et cetera.

That's an awful good place to start.

DR. DAHLGREN: I'm sure somebody is going to look at that particular question. I think somebody will.

DR. LAWROSKI: Is this elaborated some place else?

DR. DAHLGREN: We are working on a revised program plan which will list all of these things as options.

DR. SIESS: Just now they are your ideas?

DR. DAHLGREN: Yes.

DR. SIESS: You haven't tried to organize them, or pu[illegible] dollars on them, or years on them?

DR. DAHLGREN: We are working towards that, we have not yet got it in that state.

Obviously what we are doing now is going back and looking at these areas and trying to devise a plan.

And we are complicated by lack of understanding of what happens next year.

DR. SIESS: These areas you had on the last vugraphs are the areas that the current program is already organized on?

DR. DAHLGREN: Yes.

DR. SIESS: And these are additions to your current --

DR. DAHLGREN: Or things where we think emphasis out to go, where we already had items involved.

For example, improved components area, we already had valves, things like that. And utility training, again, there's a number of things you can think of, things Ray said earlier on today. We are going to look at accident response, we are going to have to look at the extension of simulator training to cover more accident sequences, we have to look at the effects of stress. I don't know how much further simulators have to be extended; my understanding is they go fairly far down some of these accident paths now.

I'm just convinced some people are going to have to have major programs and will have to increase safety consciousness at all organizational levels, and improve maintenance and test procedures, less human error; even to have the operators more cognizant of what happens when there are partial systems failures, and the use of alternative systems.

Then you have to look at operator certification and training, things like educational requirements, operator capabilities, training methods, content of the training, adequacy of simulator useage; should you have some training on real plant? The certification procedures currently involved, are they correct?

These are the kind of things that we think we are going to think of.

DR. OKRENT: Do you think DOE would initiate research programs in these areas possibly for things like operator training?

DR. DAHLGREN: Someplace in the budget you put something in to work in the operator training area, you can get training programs upgraded and in place.

That would include some of these considerations. You know, the Congress has given emphasis in some of these areas.

The last area, emergency recovery measures. The first thing I might want to mention we want to develop design guidance to facilitate contamination and accident recovery; we might want to consider design guidelines for future plants and modifications of current plant in order to facilitate these things; you obviously want to evaluate how you do fuel handling under accident conditions; waste storage, waste disposal are currently problems at Three Mile Island, as I understand.

A national or planned emergency response organization --

DR. SIESS: What do you mean there's a problem, they are having difficulty storing the waste?

DR. DAHLGREN: Trying to figure out how to get rid of it. They have not yet succeeded.

DR. SIESS: Does that mean they don't know how to get rid of it, or that they can't find anybody that will accept it, their solutions on how to get rid of it?

DR. DAHLGREN: I am not sure they found a place.

MR. GRIFFITH: The problem is that no one will accept the waste.

DR. SIESS: And how do you research that problem?

MR. GRI FITH: I wasn't addressing that question. The research associated with the decontamination is to look at the methods for decontaminating equipment and tools, handling, and the problem that is involved with that is the acceptance of the residuals, the wastes.

DR. SIESS: Decontamination and recovery is a generic item.

DR. DAHLGREN: It is generic or DOE will not be in it. Contracts which are being looked at would involve a case clean up effort with R&D effort to decontaminate, methods.

DR. SIESS: DOE would put money in so they could watch how it was done, and how it was done, and what the problems were, and decide what you might do on future plants or existing plants that would make it easier?

MR. GRIFFITH: Well, we also would be involved in the development of new techniques. In some places we are already working on advanced decontamination.

DR. SIESS: And it could be used at TMI?

MR. GRIFFITH: And elsewhere.

DR. SIESS: At TMI there's a time scale, elsewhere puts a different time scale in?

DR. DAHLGREN: Yes.

MR. GRIFFITH: We would be interestedin the things which would be available in the national stockpile for use in emergencies downstream.

DR. SIESS: One of those might be ten years away. That would be one kind of research. But TMI is probably a year away, which is a different story.

And the question I am trying to get is, you are going to try to do the research and help recovery at TMI, or are you simply going to observe and participate in the recovery at Three Mile to such a level that you could get a basis for research that would help the next one?

DR. DAHLGREN: I think the latter would be closer to at least part of the problem. There is though the techniques which are currently being developed which TMI constitutes a large laboratory to confirm that these techniques work as they have been developed.

DR. SIESS: And what's the possibility that they got no problems at all in cleaning up TMI?

In which case we are home free; right?

MR. GRIFFITH: That's possible.

DR. SIESS: Not very probable, but possible.

I was wondering if your programs allowed for that possibility?

So you don't get started now on developing methods that turn out not to be needed? The first effort is to see what happened at Three Mile and find out if new techniques are needed, new designs are needed?

DR. DAHLGREN: I think we would agree with that. The work we have so far is quite specific.

DR. SIESS: Now, when I come to the next item on that list, I got no questions. I think somebody needs to start working there.

DR. LAWROSKI: As I understand the situation at TMI it is a matter of finding where to ship the concentrated activated wastes.

MR. GRIFFITH: I think for the liquid right now that may well be true. I think that once we go into the reactor itself to decontaminate we may have a number of surprises.

DR. LAWROSKI: You are certainly going to have more liquids.

DR. SIESS: You'll probably have surprises of both kinds. You are going to find some things that aren't working and you are going to find some things that work very well when you didn't think they would.

DR. OKRENT: What do you see as the appropriate means for the NRC to act in accordance with the words that the representative of OMB used?

DR. SIESS: Let's finish this vugraph first.

DR. DAHLGRN: One clarification here: previously there was some discussion about this, and I would like to point out that this is in an early stage of development, and that which has been proposed have been essentially gathered together as a result of our canvassing a wide segment of the industry.

It's not even been approved by DOE. Also the kind of work I was talking about here, although there's an interface in safety, that work is really funded presently in DOE as part of the light water reactor technology improvement program and is not really presently funded or considered as a safety effort as far as budget categories are concerned.

DR. SIESS: Am I right that DOE coordinates with NRC -- you did touch on that.

DR. OKRENT: What do you propose that the NRC use so that it would be providing its guidance -- whatever was the OMB word -- to DOE concerning what it thought DOE should do, on DOE's program for research to improve reactor safety.

MR. GRIFFITH: Presently as I understand the situation, Sol Levine and representatives from EPRI have discussed this problem, and there is proposed to be a joint committee which NRC, Sol Levine, has the lead for setting up and getting established.

And other than that at this particular time the exact procedures for implementing this guidance have not really been worked out.

DR. OKRE[illegible] If I can pursue it one minute:

Would it be s[illegible]icient for them to send you a cryptic letter of the sort the ACRS sent --

(Laughter.)

-- saying we think you should work on, let me see, I'll find a statement out of Mr. Silberberg's presentation.

The ACRS recommends further that emphasis be given to scoping studies on topics relating to prevention and mitigating of the offsite consequences resulting from postulated core meltdown via the liquid radwaste pathway.

If you got a cryptic thing like that from Sol Levine or whoever, would that be adequate from your point of view; or would you need something much more specific, or what?

MR. GRIFFITH: I would hope there would be enough coordination in this coordinating committee that we'd get something a little more specific than that, and that there would be some substantiation before we received that as to what it would mean to the parties involved.

MR. NORIN: You must also remember the guidance from OMB it must in fact be useful, where we expect use to the end user.

DR. OKRENT: How would you judge that before you do it?

DR. DAHLGREN: You have to have at least some indication that it is going to be something that NRC is going to want, to really push hard to get in, or you are going to have to have an indication that it has significant enough safety benefit that the industry really says it's a good thing to really do; it's going to have to look to them like it has some kind of attractive advantage, like financial.

If you don't have something likethat it would be hard for us to see why we should pour a lot of money into it.

DR. OKRENT: Now if the NRC recommends that DOE do something solely in their considered judgment -- the NRC has decided it was worth having DOE do a certain amount of research -- it probably will not have arrived at a final decision that this thing is going to be something they are going to implement because when they reach that final decision they might not need that.

Sometimes you need the research just to know how to do it, so you may want to know which of two ways is better. Frequently you are doing the research to see if there is something you are going to want to recommend.

Does that constitute enough of a high mark or how ever you want to classify it that DOE would not interpose questions: well, I don't know whether the utilities will do it, or I don't know whether something that reduces the cost is there, and so forth?

MR. GRIFFITH: I think that we are going to have to look at that on an ad hoc basis, but it would be DOE's intent to cooperate with NRC to get that work done which they felt was important towards making their decisions in the licensing process.

DR. SIESS: We were told that DOE got a letter from McIntyre, OMB, on 1 February 1979, that contains something similar to what Dr. Hendrie got.

Would there be any objection to providing us with a copy of that?

MR. GRIFFITH: No, we can provide a copy.

DR. SIESS: Yes, because we just didn't know how things got communicated, whether the same kind of language appeared in both letters. Some of Mr. Kearney's language wasn't quite the same as was in the letter from Mr. McIntyre. It was fairly specific.

What is the status of this coordinating committee? It took about a year to get a memorandum of understanding before; I'm just wondering what the score is now?

MR. GRIFFITH: Dr. Siess, the ball is presently in NRC's court.

DR. SIESS: Sol Levine's?

MR. GRIFFITH: Yes.

Ray Di Salvo did indicate it was being worked on at least and being coordinated in RES.

DR. LAWROSKI: How many people does DOE have involved with the management at the present time with reactor safety research -- light water reactors?

DR. DAHLGREN: In our branch working on LER; there are two of us. There are some studies going on internally which would include about up to 5 or 6 other people within DOE, plus we have significant planning work in progress in some of the contractors like Sandia.

DR. LAWROSKI: This is for how many millions of dollars?

MR. NORIN: We really don't have any numbers to talk about right no w on this.

I can tell you what went in for fiscal 80 and what the Congress has done so far.

The request in fiscal 80 was the same as fiscal 79, $4 million.

The House added $5 million, primarily training; they amended it to an overall energy bill that not necessarily assigns it to this program.

The Senate Energy Committee has two amendments request, one by McClure and one by Church, which would add $5-to-$15 million. We don'thave the committee report.

So we are talking right now, assuming the Congressional resolution is between those two numbers, plus our request, we would be something like $20 million.

Now, as our expanded program develops it is possible we may make additional requests.

We expect in the current go around in Congress -- last year it took til mid-August to get that finalized; so it's about that time scale.

DR. LAWROSKI: With this limited manpower you must be quite strained.

MR. NORIN: We -- over the past several years ERDA and then DOE embarked on a decentralization mode of operation such that we have developed project offices; all the people that were full time on FTF stayed with the project. But we have a project office for CRBR. There are a number of technical management centers for various technical R&D programs. Sandia is a technical management center with DOE guidelines for what that center does. And they have a lot of direct responsibility.

DR. SIESS: You contract out the administration?

MR. NORIN: Basically, yes.

DR. SIESS: And the safety program is all handled at Sandia; how many in Sandia management?

MR. NORIN: About eight.

DR. LAWROSKI: Is that a different group than what NRC has out there?

MR. NORIN: Yes.

MR. DI SALVO: I just wanted to comment. I think it's very clear from the presentation that what DOE is doing is not just improved safety program.

But the point I want to make is that their safety technology program contains many elements which we would call confirmatory research. So I think it's important not to overestimate the amount of money in the program specifically for improved safety.

A specific example of the kinds of things I am thinking about are risk methods subsequent to TMI -- much of that work was also identified at NRC as being important work; and I think we will be making moves in that direction.

Again, the operations and evaluations group seems to be very slow.

DR. SIESS: Recognizing that difficulties still exist in defining what we mean by "improved safety" -- and maybe in a couple of years we'll get our definitions all straightened up, if nothing else by example, go through the whole list of contracts and label them -- but recognizing that difficulty I think as far as the ACRS is concerned that its comments regarding the NRC's improved safety system program, we are interested right now not in how much money DOE has but how much is being spent in direct support, either by request or by chance or not by chance, of the things NRC is looking out for.

So right now the physical experiments, if that's the language, that's required to supplement or compliment the NRC program -- and if you at some time wanted to go through the DOE's program, maybe the next time we meet, you can look at it and see how much of that either by chance or design fits your program, how much is the result of an NRC request by the coordinating committee or whatever.

MR. DI SALVO: I intend to do that. We are on the verge of doing that with the program plan that has been prepared, and I think we'll still do that with the program being prepared now.

We haven't any direct recommendations because we don't want to prejudice what they develop ahead of time. But our priorities in terms of risk reduction potential are well known.

DR. SIESS: I don't think any of us feel the DOE's reactor safety programs should all be devoted to improved safety systems. They have other objectives and they are quite legitimate objectives which DOE can do and NRC couldn't possibly do. So there's no reason they should be the same, but one has to support the other.

I want to also ask that the subcommittee, in the subcommittee s comments to the NRC budget, you may want to comment on the position of restricting experimental activity on the part of the NRC.

DR. SIESS: The subcommittee will not comment but the whole committee will; and the subcommittee has the intention of referring to the whole committee the matter that on some basis we would like to communicate to OMB in response to Mr. Kearney's request.

He invited us to offer some comments --

(Laughter.)

-- and I feel quite sure that some will be forthcoming.

We may also tell the Commissioners, and the Congress.

MR. NORIN: I would like to make the observation that in my opinion all the things we've been working on will in fact meet safety.

DR. SIESS: Yes, I think all the things NRC works on in its total budget would lead to improved safety, but they don't have that label.

(Laughter.)

The problem is in words.

Any other questions for DOE?

DR. OKRENT: I guess I might ask when you do have your program plan in some kind of a formal stage of writing, even if it's tentative because you don't know how much money you are getting, is it fair to ask that a copy be sent to the ACRS office?

MR. NORIN: I think we can do that. I'm not sure at what stage, but I'm sure it doesn't have to be a final report before we can send something that would be meaningful.

DR. SIESS: We would appreciate it.

Okay, then, on to the last item on the agenda, which will be a presentation by the representative of NUCLEDYNE Engineering Corporation on the passive containment system.

I assume Mr. Falls will do that?

I thank you for your patience, and I hope you found it an interesting day. You could have shown up at four o'clock and you wouldn't have been late.

MR. FALLS: Thank you very much.

MR. ETHERINGTON: Mr. Chairman, I would like to have the record show that I have a conflict of interest in this case, and I shall not be participating.

DR. SIESS: So noted. Since this is an open meeting, you may remain in the room, Mr. Etherington. And you may remain in that chair, if you find it comfortable.

(Laughter.)

MR. FALLS: I have not minded waiting, Dr. Siess, it has been a very illuminating day to me in many ways, one of the ways in which I may comment on as I go through my presentation.

I tried to make this presentation very short. I was told I would have 15 minutes. I have limited it to a little less than that.

Consequently you will find that within the formal presentation here, I will make certain statements which you may like to have more information on; some of this has been given to you in the form of handouts.

We appreciate this opportunity to make an oral presentation concerning the passive containment system and we trust that this is an idnication of a renewed interest in this PCS concept and our claims as to the improved safety of light-water power reactors resulting from its application.

The PCS concept has been known to NRC and ACRS for over three years. A direct request was made to NRC for a safety review of the concept in February '76.

Subsequently a presentation was made to the NRC Staff on July 21, 1976. This finally resulted in a letter from Chairman Hendrie on November 10, 1977, some 16 months later, which stated in part, and I quote:

"It seems to me, and I believe that the staff would agree, that your Passive Containment System has in principle the possibility of being engineered into a licensed light-water power reactor system".

However, our request for a review was refused for reasons as stated in that same letter, and I quote:

"that evaluation of the design and review for licensability would necessarily be a substantial undertaking."

We would venture to guestimate that this -- and I say "guestimate" -- that this undertaking would be substantially less than the effort required, both in research and regulatory activities, for the Three Mile Island incident and possibility some other forthcoming incidents. More on that a little later.

When our efforts to obtain NRC consideration had apparently failed, we submitted in September 1977, an unsolicited proposal to DOE, at that time ERDA, and the Electric Power Research Institute, for a research and development program.

NUCLEDYNE's proposal was accepted, docketed and arrangements made with the NRC's Office of Nuclear Regulatory Research to evaluate the performance of the PCS over the full spectrum of pipe breaks.

Again, no work was performed. DOE then assigned that task to Sandia Laboratories, where a limited technical evaluation is now underway. We are indeed grateful for this DOE effort, but it will not substitute for the initially requested NRC-ACRS review.

After having written that, we realized that might leave you with the wrong impression, so let me add this further statement:

It should be noted that DOE has not made a final commitment to undertake the R&D program originally proposed by NUCLEDYNE. As I already stated, DOE has given Sandia Laboratories an assignment to undertake certain review and analysis work on the PCS concept. The results of that effort will be used by DOE as a basis for determining their future involvement in the PCS R&D program and possible industry support of the program and funding of the program.

I thought you probably should have that explanation.

I didn't want to leave the wrong impression.

On January 9, 1979 we again wrote to Chairman Hendrie. We submitted a document which discussed how PCS would respond to each of the five research projects and 11 research topics identified in NUREG 0438.

Copies of this document, dated June 12, 1978, have already been provided to the ACRS.

In our letter we requested a renewed study and consideration of this unique concept by the NRC.

Dr. Saul Levine replied on February 9, 1979 that other concepts to improve safety merit higher priority, and that we have identified no basis for changing our priorities at this time.

Gentlemen, all of this adds up to our belief that the only consideration NRC and, consequently, ACRS, intends to give to improved LWR safety is to fix up existing concepts via the ratcheting route.

We do not disagree that some such fixing up is reuired to improve existing plants and those under construction. However, there willbe more nuclear plants built to provide energy independence for this country and consideration must be given now to the concepts to be utilized in the design of this next generation of LWR plants.

And I might interpolate here that I was happy to hear several references during the day to total plant concepts rather than just simple systems or pieces of systems or pieces of equipment.

In NUREG 0006, Section 1.2.4 stated that "research for improved safety is research on advanced concepts, systems and processes believed to have potential for improving the safety of nuclear power."

The fiscal year 1978 budget authorization act requires the NRC to develop a long-range plan for the development of new or improved safety systems for nuclear power plants. NUREG 0438, which responds to this requirement makes numerous references to the necessity for advanced concepts and alternate concepts.

We emphatically ask, how can the NRC and ACRS continue to refuse to consider the PCS in the face of this requirement and when the PCS has so much to offer for our country's needs?

PCS, as we've said many times before, addresses generic issues. It anticipates solutions to such generic items, including those surfacing at TMI.

No one in the industry with whom we have discussed the PCS -- and this involves a large number of utilities, architect-engineers and manufacturers -- none of them has concluded that our claims for the safety improvements by use of the PCS cannot be substantiated.

To support these claims we provided to your ACRS staff a few days prior to this meeting a number of documents concerning the PCS and its latest development. We have also handed to you today certain other documents including a copy of these remarks.

Let me now get specific and illustrate how effective the PCS is in improving safety by relating it to the identified events as they occurred at TMI.

First, I should point out that in the PCS design all relief and safety valves, both primary and secondary system, relieve into a number of large tanks containing chilled water.

Second, had TMI included the PCS in its design, there would have been no core damage and no release of radioactivity outside of the containment.

Here, briefly, are the reasons why:

Information providing backup to these claims is provided in the separate handouts.

Let me take the TMI events one at a time, six of them, as we have seen then published.

TMI event number one was loss of normal emergency feedwater and the steam generators boiled dry.

The PCS response would be this:

On the loss of feedwater flow, relief valves provided at the steam headers within primary reactor containment automatically open, initiating steam flow through steam jet injectors. The steam jet entrains water from quench tanks and injects the mixture into feedwater headers. A sufficient amount of feedwater is injected into the secondaries to gradually increase the liquid level resulting from the steam blowdown. The steam blowdown transfers the energy resulting from core decay heat and reactor coolant system cooldown.

The second TMI event, the natural circulation of reactor coolant was lost reactor cooland pressure sustained a transient; the pressurizer electromatic relief valves opened.

The PCS response: Passive feedwater injection into the steam generator secondaries maintains water level for natural circulation transferring heat from the primary to the secondary system. At 50 F per hour cooldown rate, of reactor coolant, pressure transients and relief valve openings at the pressurizer are eliminated.

The third TMI event -- yes, sir?

DR. OKRENT: What I heard was that you continue to put water into the secondary side via PCS?

MR. FALLS: Yes.

DR. OKRENT: But we were losing water on the primary side, and you did not at this point at least mention how you are going to make up water on the primary side.

MR. FALLS: May I get to the next event?

DR. OKRENT: All right.

(Laughter.)

MR. FALLS: THis event was the natural circulation of reactor coolant was lost, the reactor coolant pressure sustained a transient; the pressurizer electromatic relief valves were open, and began to discharge.

The passive feedwater injection into the steam generator secondaries maintains the water level for natural circulation transferring heat from the primary to the secondary system. That's one step.

Now, the next step is this, this is what we classify as the third TMI event:

Pressurizer relief valves failed to reseat, the pressurizer relief tank rupture disk gurst; the reactor building was flooded with reactor coolant containing fission product

The PCS response was this:

Two deluge tanks of which four are provided have sufficient heat capacity and freeboard space for the blowdown of the stored energy in the reactor coolant, thus eliminating any possibility of pressurizing the deluge tanks or flooding the primary reactor containment.

So we've got four of these tanks, and two of these are sufficient to have sufficient heat capacity to take the stored energy in the reactor coolant.

The fourth event, the core became uncovered, there was degraded cooling, and there was zircalloy clad damage with fission product release.

The PCS response to this:

Adequate heat transfer by natural circulation prevents reactor coolant pressure transients and -- it prevents those in the first place-- and relief valve liftings thus also prevent it -- thus retaining the coolant within the reactor system.

The passive safety injectin system then maintains the reactor coolant mass inventory and system pressure for continued natural circulation. These injection systems cannot be compromised by operator action.

Now, your point, you see, we would not have had the pressurizer valves operate, and therefore you would not have lost the primary coolant in the way in which it was lost.

DR. OKRENT: That I don't understand.

The TMI-2 event if I understand it involved opening of the power operated relief valves for if you had any need of achieving natural circulation and before you had any opportunity to try to pour water into the primary system; but that's the way water was lost.

Now, maybe your PCS will make up the water that's lost. But I don't see how you keep the valves from opening.

There may be something, but at the moment I don't see how you keep the power operated relief valves from opening.

MR. FALLS: Well, as we walk through this, taking that number one, which is shown here, we felt that event number one would never have happened if it had the PCS design.

And we give the reasons why here.

Then we said, well, let's assume that that did happen. How about number two, the second event in sequence?

And we came to the conclusion that that would not have happened.

Then we went on to each of those events, and said what happens if everything else happened ahead of this up to this point? That's the sequence in which we made this analysis.

It led us then to the general overall conclusion that if TMI had been designed using the PCS, there would have been no situation develop that would have caused damage; and there would have been no release of radioactivity.

DR. OKRENT: Well, again, at the moment I am at a loss to see -- and I must confess I don't have enough information in the reports I have to tell exactly how your passive system, makeup system, or whatever is the right name,

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works; there must be a more detailed report which we have received in the past.

But these reports are rather short.

MR. FALLS: Yes, they are. There are more detailed reports that have been provided to you in the past. The latest report is the blue covered one which is the paper which we gave at the American Power Conference in April, which described a modification of the original PCS design, which eliminated the deep wells we had originally designed for, and eliminated the rupture disks in the deluge tank system; and were replaced by another series of tanks.

The deep weel was in effect replaced by four separate tanks that were mounted up in the structure; instead of having rupture disks, they had a rather unique inverted U-tube kind of an arrangement, so that the water would be discharged as the pressure built up in the restricted free volume, the water would be discharged from the quench tanks, to then flood the compartment.

DR. OKRENT: Which is the document in the bibliography given at the back of the little brown folder, which of the documents would you say gives the detailed description of the PCS as it is now composed?

MR. FALLS: The best one to refer to would be -- there are two of them:

The basic system as originally conceived is described in the first one, NEC 1; that was the original one. And you should have copies of that in your files.

The latest is the last one, and that describes -- this item 18 -- and that described the latest version which is essentially the same as the first one, as the first bibliography item, except for the elimination of the deep wells and the change from using rupture disks and the intended U-tube type of release.

I would suggest if you want to get the detailed versions of it, that those two would be good, the best documents to take a look at.

DR. OKRENT: Have you done any failure modes and effects analyses or other kinds of logic studies to see whether there are kinds of events wherein the PCS either would not have the necessary capacity or might run out of adequate water, such a situation and so forth and so on.

Is there some document which looks at the PCS and sort of establishes its capabilities and its minimums? I mean you don't have an infinite amount of water. I am sure I could think up some scenario that could use up all the water in one of your deep wells or whatever.

MR. FALLS: I am sure that you could.

DR. OKRENT: I get paid for dreaming up scenarios while sitting here.

(Laughter.)

Have you done it for the PCS and try, as I say, look at the capabilities and also its limits; and if that's one of these documents?

MR. FALLS: We have done some of that.

The reason that DOE had originally agreed to undertake some work was because we had not had an opportunity to for example do analysis of the response of the ECCS over a full spectrum of pipe breaks.

We started with a LOCA, the DBA, and our analyses were done in some detail, including some computer programs which, incidentally Commonwealth Associates in Michigan did for us.

They showed that the information, some of which is included in that number one report I just referred to, -- however, this is limited in how far down in pipe size it can go and get results from that particular program.

We have not been able to do an analysis all the way down for the full spectrum.

The question which I guess was first raised by you, by Mr. DiSalvo, and later in DOE was: how will this respond over the full spectrum of pipe breaks. And we admitted we did not know.

We can postulate some things which we thought would be good, it was responsive and we weren't sure. And so this was a part that they felt they needed to have answers to before they were willing to go ahead with the rest of the R&D program

So a direct answer to your question: we have done some in the upper end of the major accident range, but we have not done the full spectrum. But it does need to be done.

DR. OKRENT: I probably should amplify on that remark.

I said I am paid to do things like asking questions.

My wife always reminds me that in 1957 when I was together with Mr. Palladino before the Joint Committee on Atomic Energy, the Congressman asked us, was the ACRS paid enough? And I said yes.

And she points to the low hourly rate.

(Laughter.)

DR. SIESS: That's because you work fast.

DR. FALLS: I suspect if everyone involved in the work done to date on PCS figured what their hourly rate was, they'd be in trouble with the minimum wage law.

(Laughter.)

By maybe a factor ten-to-one.

(Laughter.)

Well, I'll leave it to you to read through these six events of TMI. I won't go into that.

Let me just spend -- did I answer your question?

DR. OKRENT: Yes.

MR. FALLS: As a result of their being no core damage or release of radioactivity with the PCS as we claim, there would be no problem of cleanup and decontamination afterwards.

If for any reason it was desired to inspect the fuel the refueling enclosure in the PCS design, which is removed from the primary reactor containment, would provide a controlled atmosphere for fuel removal operations.

We would like to bring one other aspect of PCS to your attention, and that's the matter of retrofit.

Actually PCS consists of a series of several different systems and subsystems, any one of which might well be pulled out, looked at, and considered for retrofit as a possibility.

Our preliminary review of a number of existing nuclear plants has convinced us -- including TMI, incidentally -- that some aspects, but not all, of the PCS safety features can be retrofitted to some of these plants.

We believe that the physical piping and structural arrangements are such that the emergency core cooling system and the emergency feedwater injection system portions of the total PCS concept can be retrofitted to some of the existing PWR plants.

From a functional viewpoint these systems could be added with essentially no changes in the present basic piping or equipment arrangements.

The ECCS would call for the addition of the refill tanks of the PCS. The present accumulators could be used in a slightly different manner, that is, they would be completely filled with chilled water, or approximately half-filled, to provide double the heat sink capacity of these devices as they are now used.

The potential retrofit of these PCS safety features requires investigation on an individual plant basis.

The extent of this retrofit is subject to space and structural limitations of the existing structure.

The retrofit of the emergency feedwater backup and reactor cooldown system, involving steam jet injectors in conjunction with quench tanks, is subject to space-available and structural support for those tanks.

Also the retrofit of the passive safety injection portion of the ECCS involving steam jet injectors in refill tanks is dependent on space available and structural support of these tanks.

Finally, what is it that we now seek by appearing here before you?

We hope that your deliberations will result in a recommendation that the complete PCS concept be actively considered in any of the evaluation and research work planned on alternate and advanced concepts as called for in NUREG 0438 and other NRC and DOE documents.

Furthermore, to the extent consistent with your scope of responsibility, we urgently request your support for the funding of the PCS research and development program.

This would include both authorization and appropriation of sufficient monies to carry out the program in an expeditious manner.

If we do not take immediate steps to encourage the continued construction of nuclear power plants we are going to be faced with economic and electricity blackouts in this country in the very near future. Improvements in the light water safety promotes public acceptance of nuclear power, enabling energy independence.

Gentlemen, that's the end of my formal presentation. I would be glad to answer any further questions that you might have.

DR. SIESS: Any further questions, gentlemen?

DR. OKRENT: I have one.

Do you recall when DOE expects to have the review it's having performed of the PCS?

MR. FALLS: The latest was that Sandia -- Dr. Dahlgren, do you remember what the date was?

As I remember the date was in the neighborhood of September, they would have the work done with a report back to DOE.

And at that time DOE will consider what the report covers and make their decision as to what they propose to do from there on. And this could range all the way from nothing to continuation of the program.

DR. OKRENT. And that will be publicly available?

MR. FALLS: I assume so.

Well, again I thank you for allowing me to appear here. If there is more we can do to provide you with additional information, please let us know.

DR. SIESS: We will.

Gentlemen, the remaining items on our agenda have to do with comments by the subcommittee.

And I have written down what I think are questions we need to discuss, or at least have to have answers to by the subcommittee.

What I propose to do now is read those questions, and let you decide whether, considering the hour, we want to try to get some answers now; or whether it might be possible since three other members of the subcommittee as well as I will be here tomorrow, to think it over tonight, jot down some answers, and get them back to me tomorrow in time for me to take home and work on. I have some paragraphs to write for that report, before I start getting other peoples' in.

These are the questions that I have written out.

The FY 80 supplemental budget request for research to improve reactor safety systems is $4.4 million. This is compared to the $1. million to which the original request of $4.4 million was reduced. That's a 3.4 million increase.

The questions are:

Is this amount sufficient?

Is it an appropriate portion of the approximately $30 million total of the FY 80 supplemental request?

And are the levels of support for the seven areas -- that's the five concepts and the scoping and value impact -- are the levels of support for the seven areas appropriate?

Those levels are indicated about the fourth page of the handout.

So the first question has to do with the FY 80 supplement, at this point $4 million.

The second question relates to the FY 81 budget request, keeping in mind that this is all we have to comment upon at this stage. This has not been approved by the budget review group or the Commission. It is what Research has submitted, presumably it's what the Commission asked us to comment on.

What they see from the budget review group may not be research proposed. We will not be able to address that.

The FY 81 budget request for improved safety systems is $4.7 million, assuming they only get the $1 million this year; $1 million in 80; and 6.6 million assuming they get the 4.4 in FY 80.

Is this amount appropriate for levels of support for the various areas?

For FY 80, I guess there's not much they can do to initiate a lot of new areas; in FY 81 they could.

The third item:

Should the report to the Commissioners contain comments on OMB restrictions on physical experimentation?

Such comments could advise the NRC to protest or appeal this prohibition -- to put that in a letter to the Commission.

Alternatively, the ACRS could inform OMB directly of its opinion, as requested by Mr. Kearney.

He said, "send us your minutes", I guess; but the minutes of the subcommittee are not going to Mr. Kearney as an ACRS opinion. It would have to be a letter from ACRS; I am not sure we should be writing OMB.

The fourth question:

What should ACRS do about NUCLEDYNE's PCS, which is clearly something in the way of an improved safety system?

I have indicated some choices:

Initiate a review by the ACRS. Can we do this? I don't know that we can initiate a review if the Commission hasn't.

Recommend that the NRC Regulatory Staff review it, which would mean automatically that the committee would review it.

Recommend that NRC Research fund a contract to review it under the improved safety systems effort.

Forget about it, or other.

I think that's all the choices.

And out of those, only the item that says that NRC Research should fund a contract to review it would lead to a comment on our report to the Commission on the budget.

Wait until Sandia reports on DOE funding -- but again, for the letter for the Commissioners next month, the only one in here that would affect that would be a recommendation that NRC do something; and I doubt if we'd do that until we'd heard from Sandia.

Now, would you like to discuss those items now? Would you like to think of them overnight, put something down in writing. You could get this Xerox'd. I think it's readable.

The information you need is in Ray DiSalvo's handouts, the dollars are on page 4, okay we'll get Xerox copies for you and you'll think about it tonight.

Any other business?

(No response.)

jrb254

Thank you.

Meeting is adjourned.

(Whereupon, at 5:45 p.m., the meeting was adjourned.)

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DR. RAYMOND DiSALVO

PROBABILISTIC ANALYSIS STAFF

OFFICE OF NUCLEAR
REGULATORY RESEARCH

CONCEPTS TO IMPROVE LWR SAFETY

PRESENTED TO THE IMPROVED SAFETY SYSTEMS
SUBCOMMITTEE OF THE ADVISORY COMMITTEE
ON REACTOR SAFEGUARDS

CONTENT OF PRESENTATION

ADMINISTRATIVE STATUS

NRC-DOE COORDINATION

TECHNICAL STATUS

- PROGRAMS IN PLACE
- PROGRAMS PENDING
- PROGRAMS PLANNED

SPECIAL TOPICS

FY 1979 PROGRAMMING

COMMITTED

VENTED CONTAINMENT	0.3M
HUMAN ERROR SENSITIVITY STUDY	0.1M
SHUTDOWN HEAT REMOVAL	

PENDING

IN-PLANT ACCIDENT RESPONSE	0.2M
VALUE-IMPACT METHODS	0.1M
SHUTDOWN HEAT REMOVAL	0.1M

EFFECT OF TMI-2 ON PROGRAMMING

	1979		1980		1981	
	PRE	POST	PRE	REQUESTED	REQUESTED	AMENDED
ALTERNATE CONTAINMENT	0.3	0.3	0.3	0.6	0.6	0.8
ALTERNATE DECAY HEAT REMOVAL	0.2	0.1	0.2	0.4	0.4	0.4
ALTERNATE ECCS	--	--	--	0.3	0.3	1.0
HUMAN INTERACTION	--	0.3	0.4	2.1	2.3	2.7
ADVANCED SEISMIC DESIGN	--	--	--	0.3	0.4	1.0
SCOPING STUDIES	--	--	--	0.4	0.4	0.4
IMPROVED METHODOLOGY	0.3	0.1	0.1	0.3	0.3	0.3
TOTAL ($M)	0.8	0.8	1.0	4.4	4.7	6.6

HUMAN INTERACTION

TOPIC	FY 1979	FY 1980 PRESIDENT'S	FY 1980 REVISED	FY 1981 REQUESTED
HUMAN ERROR SENSITIVITY	0.1	--	0.1	--
ACCIDENT MONITORING AND DIAGNOSTICS	0.1	0.2	0.8	0.9
REQUIREMENTS FOR IMPROVED INSTRUMENTATION	--	--	0.4	0.4
HUMAN INTERACTIONS REVIEW	0.1	0.1	0.1	0.1
CLASS 9 SIMULATOR CAPABILITY	--	--	0.3	0.4
SAFETY SYSTEM INTERLOCK	--	0.1	0.2	0.3
INFORMATION FLOW DURING REACTOR ACCIDENTS	--	--	0.2	0.2
TOTAL ($M)	0.3	0.4	2.1	2.3

TABLE 3-1. CONCEPTS FOR THE IMPROVEMENT OF REACTOR SAFETY

RESEARCH TOPIC	SOURCE								QUALITATIVE ASSESSMENT MATRIX								
									RISK REDUCTION POTENTIAL			GENERIC APPLICABILITY			ESTIMATED COST OF IMPLEMENTATION		
	ACRS NUREG 0392[a]	NRC STAFF	CONSULTANTS	APS STUDY GROUP REPORT[b]	FORD FOUNDATION STUDY[c]	ECCS ACCEPTANCE CRITERIA[d,e]	ENVIRONMENTAL QUALITY LABORATORY[e,f]		H	M	L	H	M	L	H	M	L
PLANT SURVEILLANCE AND OPERATION																	
1. NDE and On-Line Monitoring		O	O	O						O →	→	O					O
2. Improved Plant Controls		O	O	O	O						O	←	← O				O
3. Improved In-Plant Accident Response		O	O	O					O →	→		O					O
4. Reduced Occupational Exposure	O	O	O							O →	→	←	← O				O
SAFETY SYSTEMS																	
5. Alternate Emergency Core Cooling Concepts	O	O	O	O	O	O	O			O			O			←	← O
6. Alternate Decay Heat Removal Concepts	O	O	O	O					O			←	← O			O	
7. Alternate Containment Concepts	X	O	O	O	O				O			O →	→	→	←	← O	
8. Improved Reactor Shutdown Systems			O		O					O			O →	→		O	
9. Reactor Vessel Rupture Control	R				O						O			O	←	← O	
10. Core Retention Measures	O		O	O							O		O →	→		O →	→
11. Equipment for Reducing Radioactivity Releases	R	O	O								O	←	← O			←	← O
PLANT CONFIGURATION AND DESIGN																	
12. Advanced Seismic Designs	O	O	O						O →	→			←	← O	←	← O	
13. Improved Plant Layout and Component Protection	O	O	O							O →	→		←	← O		←	← O
14. Protection Against Sabotage	O	O	O	O	O								O			←	← O
SITING AND EMERGENCY RESPONSE																	
15. New Siting Concepts	X	O	O	O						O			←	← O		O →	→
16. Improved Off Site Emergency Response Planning	O		O	O	O					←	← O	O					O

[a] The symbol R indicates recommendations made in ACRS reports but not identified in NUREG 0392; X indicates that recommendation could be interpreted as being in more than one concept category.

[b] Published in Reviews of Modern Physics, Vol. 47, Supplement No. 1, Summer 1975.

[c] Published as Nuclear Power Issues and Choices, Ballinger Publishing Company, Cambridge, Mass., 1977.

[d] Acceptance Criteria for Emergency Core Cooling Systems for Light-Water-Cooled Nuclear Power Reactors, U.S. Atomic Energy Commission, Washington, D.C., Docket No. RM-50-1, December 1973.

[e] ECCS was the principal focus of this document.

[f] F.C. Finlayson, Assessment of Emergency Core Cooling System Effectiveness for Light Water Nuclear Power Reactors, EQL Report No. 9, Environmental Quality Laboratory, California Institute of Technology, May 1975.

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STATUS OF IMPROVED REACTOR SAFETY RESEARCH

TOPIC	WORK SCOPE	PROPOSALS	CONTRACT
CONTAINMENT			
VENTED	COMPLETE	SELECTED	SANDIA
OTHERS	COMPLETE	BEING SOLICITED	--
DECAY HEAT REMOVAL			
US	COMPLETE	SELECTED	SANDIA
FOREIGN	BEING DEVELOPED	BEING EVALUATED	--
ALTERNATE ECCS	DRAFT	--	--
HUMAN INTERACTION			
HUMAN ERROR SENSITIVITY	COMPLETE	SELECTED	BNL
MONITORING AND DIAGNOSTICS	DRAFT	SELECTED	PENDING
INSTRUMENTATION REQUIREMENTS	--	--	--
HUMAN INTERACTIONS REVIEW	COMPLETE	SELECTED	PENDING
SAFETY INTERLOCKS	DRAFT	--	--
CLASS 9 SIMULATOR	BEING DEVELOPED	--	--
INFORMATION FLOW	--	--	--

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STATUS OF IMPROVED REACTOR SAFETY RESEARCH (CONT.)

TOPIC	WORK SCOPE	PROPOSALS	CONTRACT
SEISMIC DESIGN			
ENERGY ABSORBING DEVICES	DRAFT	BEING EVALUATED	--
TOPOGRAPHIC MODIFICATIONS	BEING DEVELOPED	--	--
ISOLATION	BEING DEVELOPED	--	--
SCOPING STUDIES	--	--	--
IMPROVED METHODOLOGY	COMPLETE	SELECTED	PENDING

INPUTS TO FUTURE PLANNING

ACRS RECOMMENDATIONS

LESSONS LEARNED TASK FORCE

PRESIDENT'S COMMISSION

STAFF, CONTRACTORS AND PUBLIC

NUCLEAR SAFETY ANALYSIS CENTER

OPERATING EXPERIENCE

CONFIRMATORY RESEARCH

SUMMARY OF ADMINISTRATIVE STATUS

FY 1979

- $0.4M COMMITTED
- $0.4M PENDING CONGRESSIONAL APPROVAL

FY 1980

- $1.0M IN PRESIDENT'S BUDGET
- $4.4M FLOOR IN PROPOSED AUTHORIZATION
- $1.0M IN PROPOSED APPROPRIATION
- WORK SCOPES IN VARIOUS STAGES

FY 1981

- $4.7M REQUESTED (ASSUMES $1.0M IN 1980)
- $6.6M AMENDED (ASSUMES $4.4M IN 1980)

NRC-DOE COORDINATION ON IMPROVED SAFETY

STAFF CONTACTS

EXCHANGE DOCUMENTS

- WORK PLANS
- PROGRESS REPORTS
- BUDGET PLANNING

REVIEW GROUPS

COORDINATING COMMITTEE

CHARTER OF NRC RESEARCH TO IMPROVE LWR SAFETY

SAFETY-MOTIVATED

DEVELOP AND EVALUATE CONCEPTS

- ASSESS FEASIBILITY
- NET EFFECT ON RISK
- VALUE/IMPACT

PROPOSE NEW OR REVISED REQUIREMENTS

- FUNCTIONAL
- PERFORMANCE
- SAFETY DESIGN

CONTENT OF PRESENTATION

ADMINISTRATIVE STATUS

NRC-DOE COORDINATION

TECHNICAL STATUS

- PROGRAMS IN PLACE
- PROGRAMS PENDING
- PROGRAMS PLANNED

SPECIAL TOPICS

VENTED CONTAINMENT

CONTRACTOR: SANDIA LABORATORIES

OBJECTIVE: TO PERFORM ENGINEERING INVESTIGATIONS OF VENT-FILTERED CONTAINMENT CONCEPTS, RESULTING IN THE DEFINITION OF SYSTEM DESIGN REQUIREMENTS AND THE RISK REDUCTION VALUE AND COST IMPACT ASSOCIATED WITH THESE REQUIREMENTS

FUNDS: FY 1979 - 300K
FY 1980 - 300K

VENTED CONTAINMENT

TASK	SCHEDULE
DRAFT PROGRAM PLAN	COMPLETED
DEVELOP DESIGN CONCEPTS	2/80
PERFORM ENGINEERING ANALYSES	6/80
INTERIM REPORT	6/80
DEVELOP ANALYTICAL MODELS, CALCULATE CONSEQUENCES	3/81
PERFORM VALUE-IMPACT ASSESSMENT	4/81
PROPOSE DESIGN REQUIREMENTS	5/81
FINAL REPORT	6/81

ALTERNATE SHUTDOWN HEAT REMOVAL CONCEPTS

CONTRACTOR: SANDIA LABORATORIES

OBJECTIVE: TO DEVELOP DESIGN REQUIREMENTS WHICH ENHANCE THE RELIABILITY AND AVAILABILITY OF DECAY HEAT REMOVAL SYSTEMS AND TO ASSESS THE VALUES AND IMPACTS OF IMPLEMENTING THESE REQUIREMENTS

FUNDS:

FY 1979 - 100K

FY 1980 - 300K

FY 1981 - 200K

ALTERNATE SHUTDOWN HEAT REMOVAL CONCEPTS

TASK	SCHEDULE
IDENTIFY CURRENT DESIGNS AND CRITERIA	9/79
IDENTIFY EVENTS REQUIRING OR THREATENING SHR OPERATION	2/80
DEVELOP SHR LOGIC MODELS	3/80
SELECT CONCEPTUAL DESIGN OPTIONS (DESIGN REQUIREMENTS)	9/80
SELECT VALUE AND IMPACT MEASURES	9/80
ANALYZE OPTIONS	4/81
DOCUMENT RESULTS	7/81

HUMAN ERROR SENSITIVITY ANALYSIS

CONTRACTOR: BROOKHAVEN

OBJECTIVE: TO IDENTIFY HUMAN ERRORS WHOSE REDUCTION WOULD MOST EFFECTIVELY REDUCE RISK

FUNDS: FY 1979 - 100K
FY 1980 - 100K

HUMAN ERROR SENSITIVITY ANALYSIS

TASK	SCHEDULE
CATEGORIZE HUMAN ERRORS IN WASH-1400	7/79
RANK THE CONTRIBUTIONS OF THESE ERRORS.	10/79
VARY HUMAN ERROR RATES	4/80
RANK RISK REDUCTION POTENTIALS	9/80

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PRESSURIZED WATER REACTOR's

HUMAN ERROR LIST FROM WASH-1400

DRAFT

Brookhaven National Laboratory
Associated Universities, Inc.
Upton, New York 11973

A. Azarm
J.M. Dickey
A. Swoboda

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TION	SYSTEM	COMPONENT	CODE	TABLE	FIG. (sheet)	UNAVAILABILITY/EI
	SICS	No Component	M00B038X	II 5-25	II 5-48	$3.0\times10^{-4}/3$
	CSRS	Pump	DPM2A03X(B)	II 5-27	II 5-54	$1.0\times10^{-3}/3$
	CSRS	No Component	D00CS1AX(B)	II 5-27	II 5-55	$1.0\times10^{-2}/3$
	CSRS	No Component	D00CS3AX(B)	II 5-27	II 5-55	$1.0\times10^{-3}/3$
	CSRS	No Component	D00CS2AX(B)	II 5-27	II 5-55	$1.0\times10^{-2}/3$
	CHRS	Manual Valve	KXV1A20X (B,C,D)	II 5-29	II 5-60	$3\times10^{-5}/3$
	CHRS	Manual Valve	KXV1A21X (B,C,D)	II 5-29	II 5-60	$3\times10^{-5}/3$
	CHRS	Control Switch	KCS4A43X (B,C,D)	II 5-29	II 5-60	$1\times10^{-3}/3$
	CHRS	Heat Exchanger	KHEVENTY	II 5-29	II 5-60	$1\times10^{-5}/3$
	CHRS	Circuit Breaker	KCBWAVPY	II 5-30	II 5-61	E
	CHRS	Control Switch	KCS5A43X (B,C,D)		II 5-60	not listed
ht	LPRS	Motor Oper. Valve	EMV0001X	II 5-32	II 5-64(1)	$1.0\times10^{-5}/3$
ht	LPRS	Motor Oper. Valve	EMVA005X(B)	II 5-32	II 5-64(1&2)	E
ht	LPRS	Motor Oper. Valve	EMV890CX	II 5-32	II 5-64(3)	$1.0\times10^{-3}/3$

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2/

REDUCING OPERATOR CONTRIBUTION TO RISK

WHAT IS THE STATUS OF THE PLANT?

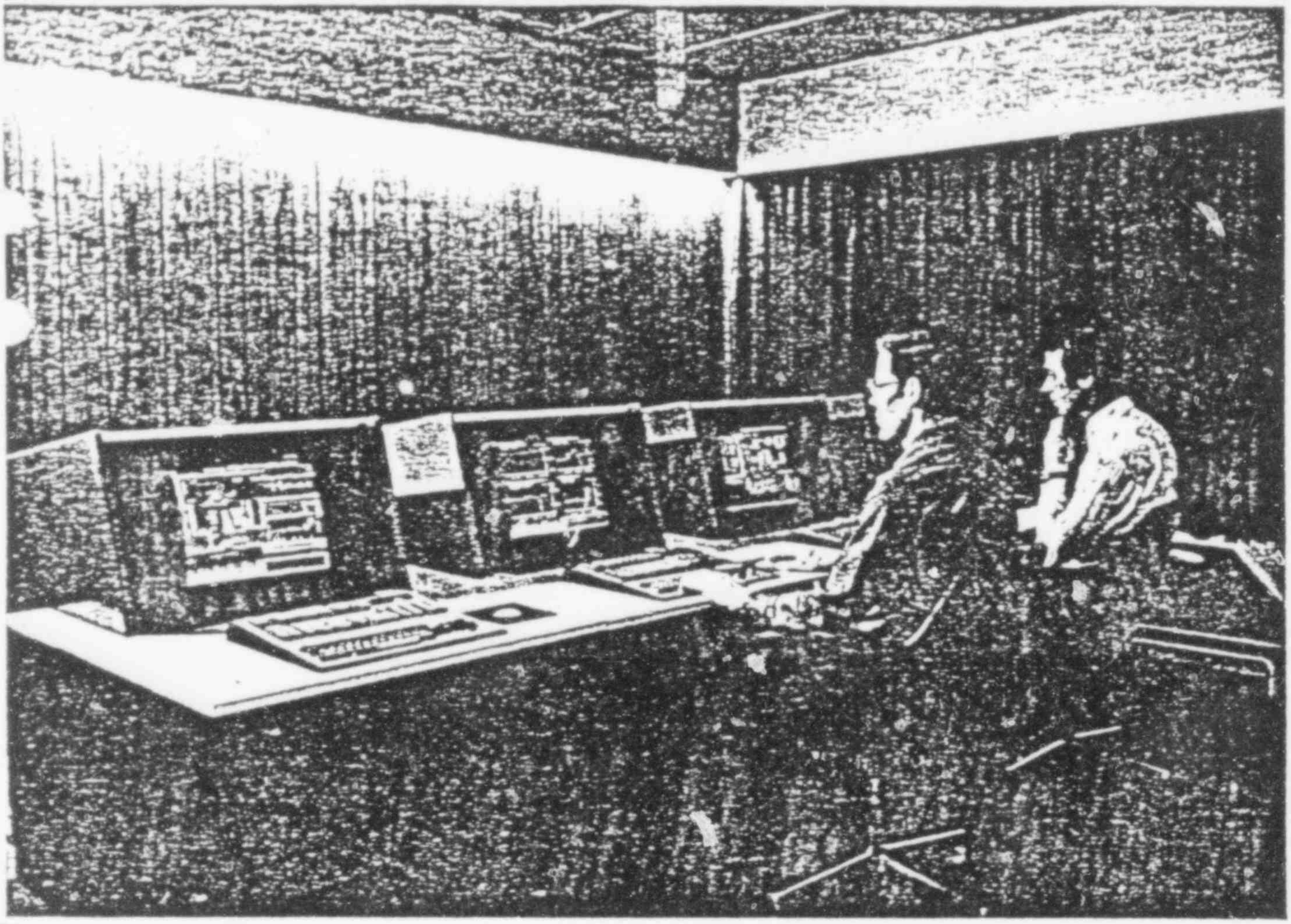
HOW IS STATUS BEST DISPLAYED?

WHAT DOES THE DISPLAY MEAN TO THE OPERATOR?

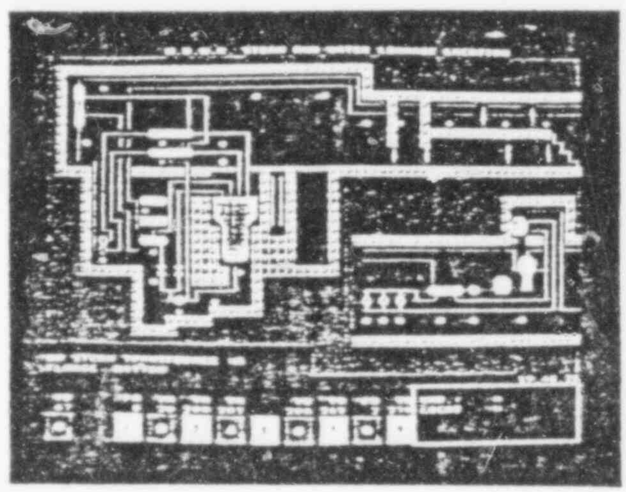
- BASIC KNOWLEDGE
- TRAINING
- PREVIOUS EXPERIENCE
- PHYSICAL AND MENTAL AWARENESS

WHAT SHOULD THE OPERATOR DO?

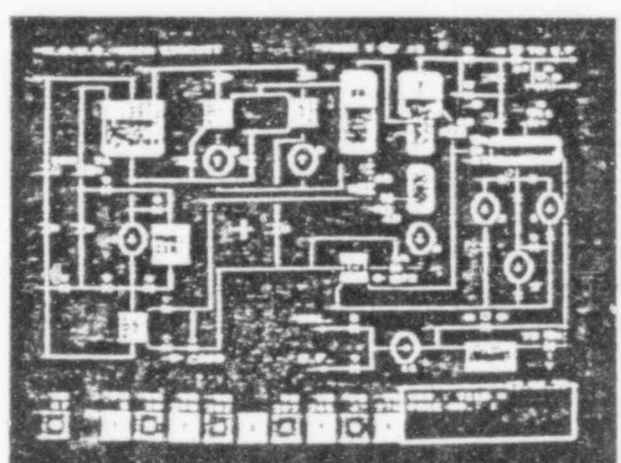
- DIAGNOSTIC AIDS
- PROCEDURES
- CORRECTIVE ACTION AIDS



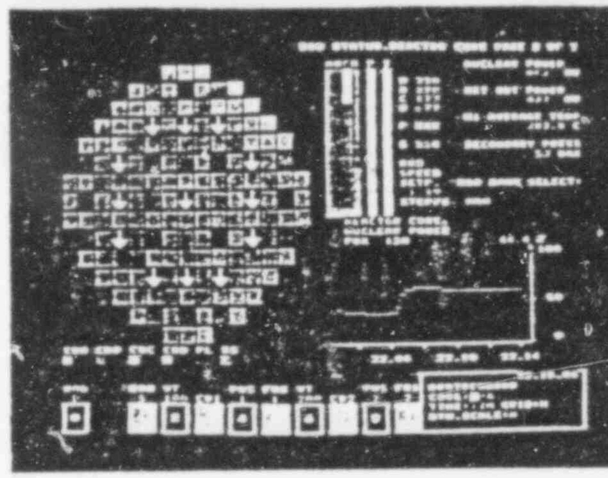
1 Experimental Control Room Facility



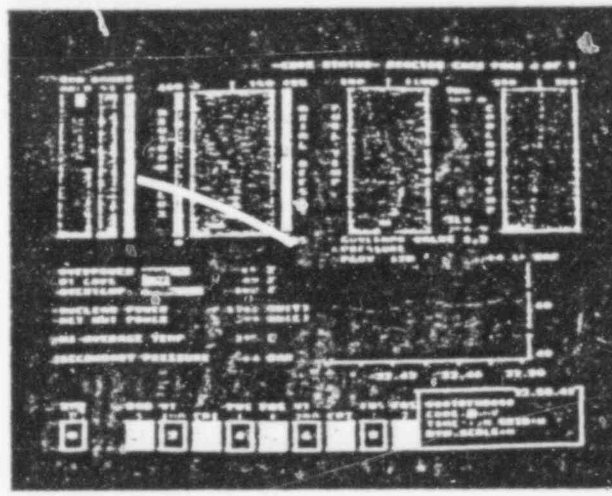
2 Physical Lay-Out Format - Leakage Location



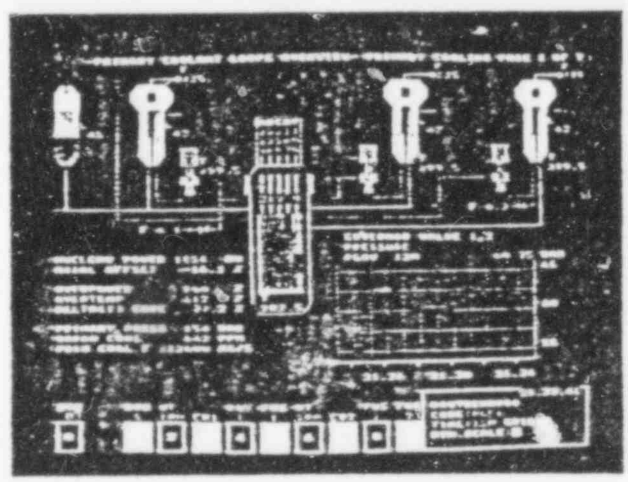
3 Circuit Diagram - Survey of Halden Reactor Main Circuits



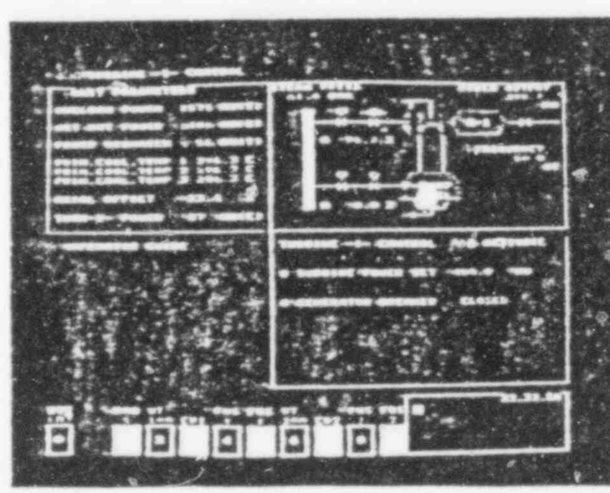
4 Pressurized Water Reactor (PWR) - Control Rod Status



5 Pressurized Water Reactor (PWR) - Core Status



6 Pressurized Water Reactor (PWR) - Primary Coolant Loops Status



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7 Turbine Control Diagram

IN-PLANT ACCIDENT RESPONSE

CONTRACTOR: ORNL (PENDING)

OBJECTIVE: EVALUATE THE FEASIBILITY OF AND PROPOSE REQUIREMENTS FOR IMPROVED SYSTEMS TO ASSIST REACTOR OPERATORS

FUNDS: FY 1979 - 200K
FY 1980 - 200K

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IN-PLANT ACCIDENT RESPONSE

TASK	SCHEDULE (MONTHS)
REVIEW INFORMATION AVAILABLE TO OPERATOR	+4
REVIEW SYSTEMS FOR SAFETY INTERLOCK POTENTIAL	+4
IDENTIFY STATE-OF-ART IN COMPUTERIZED MONITORING AND DIAGNOSTICS	+6
PROPOSE PRELIMINARY GENERAL DESIGN REQUIREMENTS	+8

VALUE-IMPACT METHODOLOGY

CONTRACTOR: BATTELLE NORTHWEST LABORATORY (PENDING)

OBJECTIVE: TO DEVELOP AND APPLY METHODS FOR ASSESSING THE VALUES AND IMPACTS OF PROPOSED IMPROVED SAFETY CONCEPTS

FUNDS: FY 1979 - 100K

FY 1980 - 300K

VALUES AND IMPACTS

<u>WHO BENEFITS?</u>

PUBLIC
PLANT PERSONNEL
NRC
LICENSEE
OTHERS

<u>HOW?</u>

REDUCED RISK
- ACUTE
- CHRONIC
- PROPERTY

REDUCED LICENSING TIME
REDUCED COST

<u>WHO PAYS?</u>

PUBLIC
PLANT PERSONNEL
NRC
LICENSEE
OTHERS

<u>FOR WHAT?</u>

INCREASED RISK
INCREASED LICENSING TIME
INCREASED COST
- R&D
- LICENSING
- CONSTRUCTION
- OPERATION
- MAINTENANCE

VALUE-IMPACT METHODOLOGY

OBJECTIVE

TO DEVELOP AND APPLY METHODS FOR ASSESSING THE VALUES AND IMPACTS OF PROPOSED CONCEPTS FOR IMPROVING REACTOR SAFETY

SCOPE

DEVELOP METHODOLOGY

- DEFINE CATEGORIES AND MEASURES OF VALUE & IMPACT
- DEFINE SPECTRUM OF ACCIDENTS TO BE CONSIDERED
- DEFINE BASELINE CONDITIONS
- DEVELOP SYSTEM TO ASSESS RISK REDUCTION POTENTIAL AND OTHER KEY VALUES AND IMPACTS
- DEVELOP TECHNIQUES TO TEST SENSITIVITY
- DEVELOP FORMATS FOR PROVIDING INPUT AND PRESENTING RESULTS
- CODIFY METHOD OF CHOICE

APPLY METHODOLOGY

- SPECIFY DATA NEEDS FOR ASSESSMENTS OF INDIVIDUAL CONCEPTS
- ASSIST OTHERS IN ASSESSMENTS OF INDIVIDUAL CONCEPTS
- PERFORM COMPARATIVE ASSESSMENTS OF CONCEPTS

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ALTERNATE CONTAINMENT CONCEPTS

OBJECTIVE: ASSESS THE VALUES AND IMPACTS OF ALTERNATE CONTAINMENT CONCEPTS

SCOPE:

- o REVIEW PREVIOUS ANALYSES, CONCEPTUAL DESIGNS AND PERTINENT EXPERIMENTAL INFORMATION
- o ASSESS FEASIBILITY
- o ASSESS RELATIVE VALUES AND IMPACTS

EXAMPLES OF ALTERNATE CONTAINMENT CONCEPTS

- o VENTED FILTERED CONTAINMENT
- o LARGER VOLUMES
- o HIGHER PRESSURE CAPABILITIES
- o REPRESSURIZATION
- o PASSIVE CONTAINMENT SYSTEMS
- o HYDROGEN RECOMBINERS
- o REDUCED INITIAL OPERATING PRESSURES
- o AUXILIARY BUILDING SHIELDING AND FILTERS
- o MITIGATION OF STEAM EXPLOSION
- o MITIGATION OF HYDROGEN EXPLOSION OR BURNING
- o MOL[illegible]E RETENTION DEVICES
- o VARIATIONS IN BASE MAT DESIGN
- o IMPROVEMENTS IN PENETRATION DESIGN
- o IMPROVEMENTS IN FISSION PRODUCT CONTROL

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ALTERNATE EMERGENCY CORE COOLING CONCEPTS

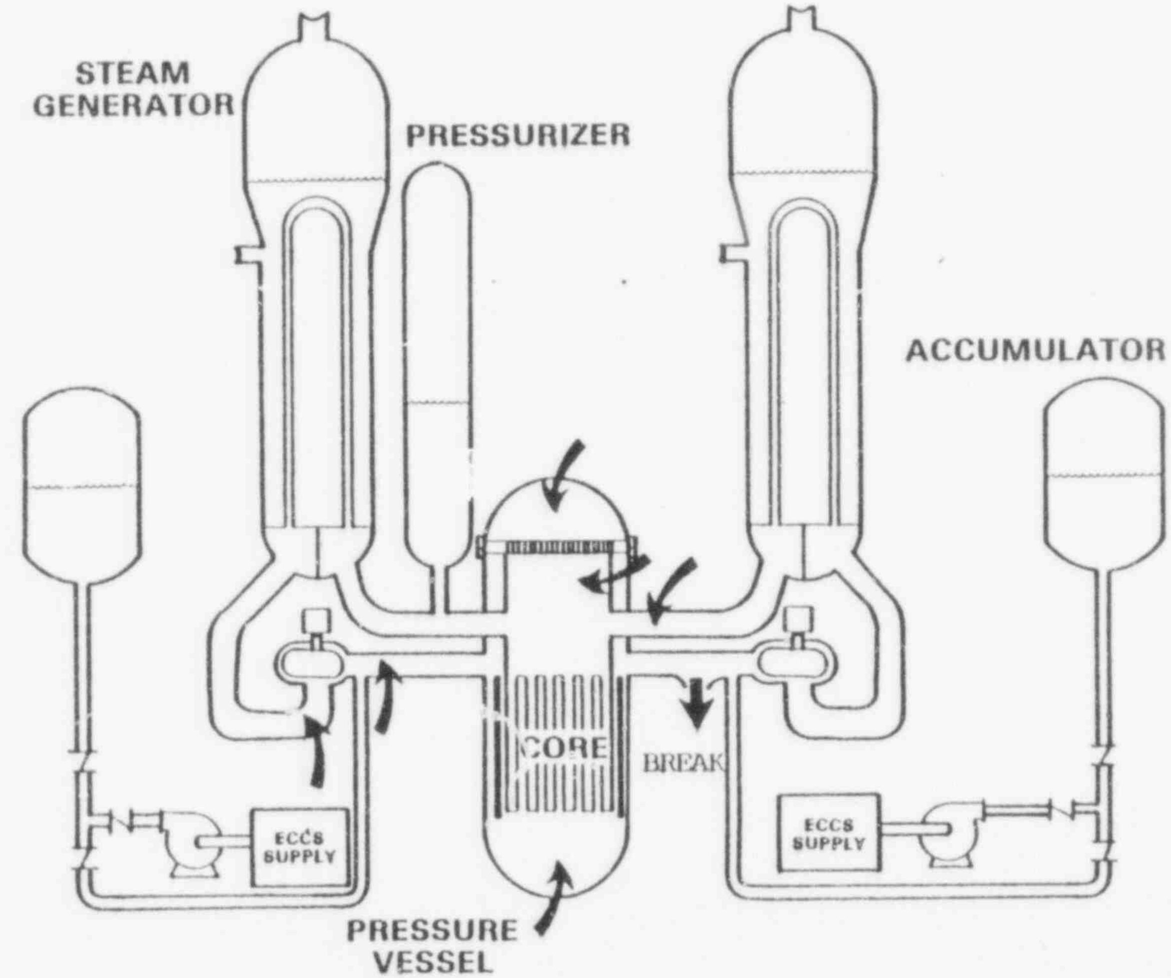
<u>OBJECTIVE</u>

ASSESS THE VALUES AND IMPACTS OF ALTERNATE ECCS HAVING EASILY ANALYZABLE AND CLEARLY DEMONSTRABLE CAPABILITY FOR CORE COOLING

<u>SCOPE</u>

- IDENTIFY CONCEPTS
- PERFORM PRELIMINARY VALUE/IMPACT
- REVIEW EXISTING AND PLANNED ANALYSES AND EXPERIMENTS
  - RELAP AND ADVANCED CODES
  - SEMISCALE
  - LOFT
  - 2D/3D
  - TLTA
- ANALYZE PERFORMANCE OF ALTERNATE ECCS WITH ADVANCED CODES
- PROPOSE ADDITIONAL EXPERIMENTS AS NECESSARY TO VERIFY MOST PROMISING CONCEPT(S)
- PERFORM DETAILED VALUE/IMPACT

ALTERNATE EMERGENCY CORE COOLING INJECTION POINTS SUGGEST IMPROVED COOLING



ADVANCED SEISMIC DESIGNS

OBJECTIVE

ASSESS THE VALUES AND IMPACTS OF DESIGNS TO REDUCE THE CONTRIBUTION TO RISK FROM SEISMIC EVENTS

SCOPE

REVIEW CANDIDATE CONCEPTS TO DETERMINE FEASIBILITY
- STRENGTHEN CURRENT DESIGNS
- INCREASED ENERGY ABSORPTION CAPABILITY
- COMPONENT ISOLATION
- FOUNDATION ISOLATION

DEFINE PRELIMINARY SYSTEM DESIGN REQUIREMENTS

IMPROVE ANALYTICAL MODELS

PERFORM PRELIMINARY VALUE – IMPACT ASSESSMENT

CONDUCT VERIFICATION EXPERIMENTS AS NEEDED

EDAC 198.01R

CONCEPTS FOR ATTENUATION OF SEISMIC EFFECTS FOR NUCLEAR POWER PLANT CONTAINMENTS

by

Philip J. Richter
Robert P. Kennedy

As part of a Sandia Laboratories effort on means of increasing safety of nuclear power plant containment structures and equipment, this study reviews enchancement of seismic safety by methods of response attenuation. After a quick look at several concepts, the effort provides some preliminary development of four selected concepts. The attenuation method selected as most promising for both the containment and equipment is horizontal isolation utilizing low friction bearings plus hysteretic energy absorbing devices. This method is promising because of its simplicity, but much development to assure proper design and function is required prior to deployment.

prepared for

SANDIA LABORATORIES

Albuquerque, New Mexico

July 1977

EDAC

ENGINEERING DECISION ANALYSIS COMPANY, INC.

480 CALIFORNIA AVE., SUITE 301	2400 MICHELSON DRIVE	BURNITZSTRASSE 34
PALO ALTO, CALIF. 94306	IRVINE, CALIF. 92715	6 FRANKFURT 70, W. GERMANY

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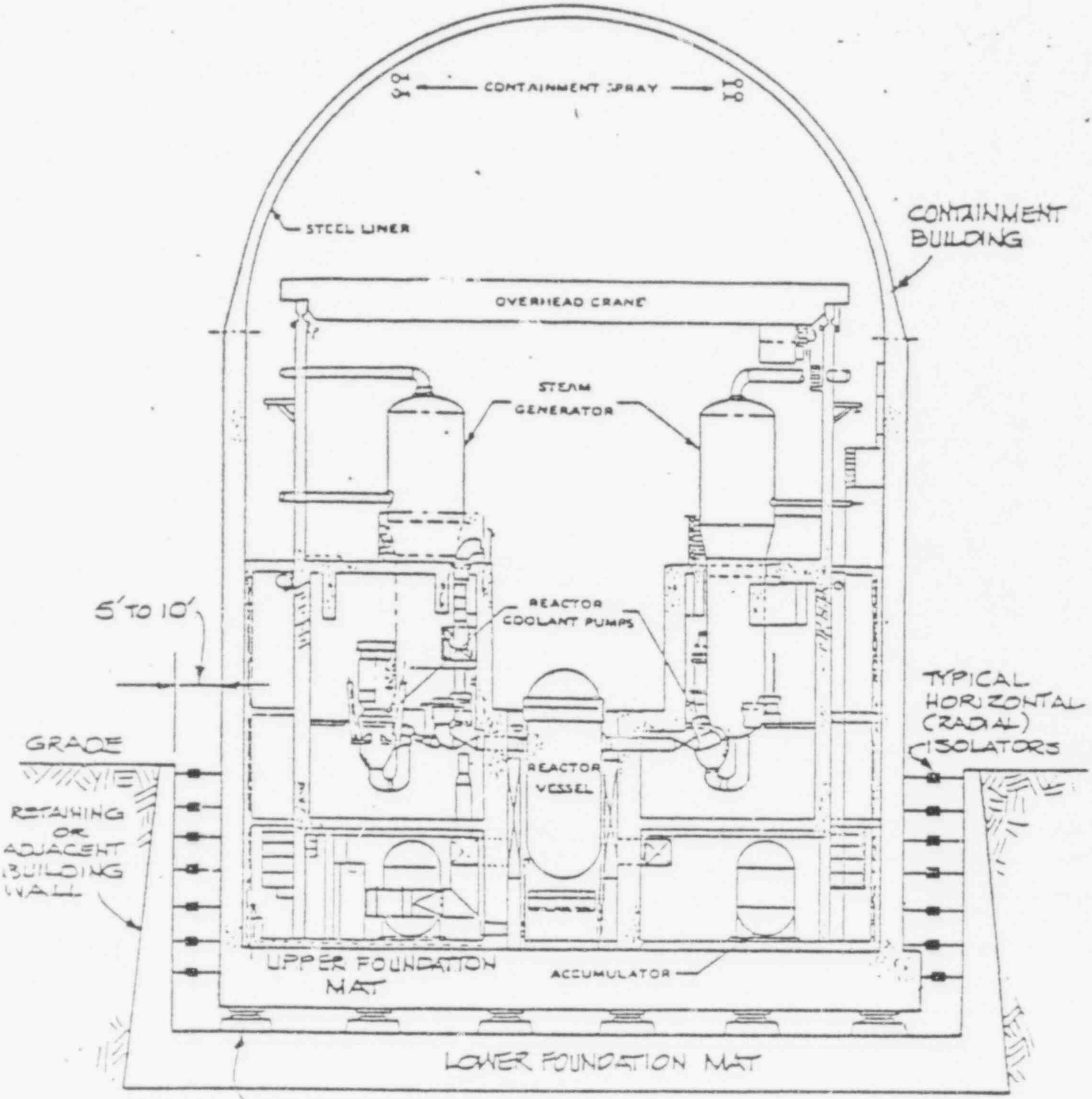

FIGURE 5-1. CONCEPT A-1 BASE MOUNTED SEISMIC ISOLATION

TABLE 5-1

CONCEPT A-1 BASE MOUNTED SEISMIC ISOLATION

ADVANTAGES AND DISADVANTAGES

ADVANTAGES

- Major Components - Slide Bearings, Isolators, and Dampers have Considerable Development and Some Analogous Deployment
- Relatively Simple Overall Design Concept
- Can Reduce Seismic Forces to Low Levels for Entire Structure and Internal Equipment
- May Minimize Additional Relative Displacements
- High Degree of Redundancy and Overall Structural Safety
- Applicable to Entire Nuclear Plant as well as Containment Alone
- Potential for Cost Effectiveness after Development

DISADVANTAGES

- Because of Massiveness, Weight and Size, Overall Concept Requires Extensive Development, Design and Verification
- Lateral Isolators such as TOR-SHOKS with Bilinear Characteristics and Large Damping, Require Development for Higher Force Levels
- Possible Large Relative Displacement May Require Considerable Modification to Piping Design for Flexibility and Possibly Rearrangement of Overall Architectural Layout to Provide Additional Space
- Innovative Concept Requires Considerable Time and Verification to Assure Function and to Gain Acceptance by Regulatory Commission

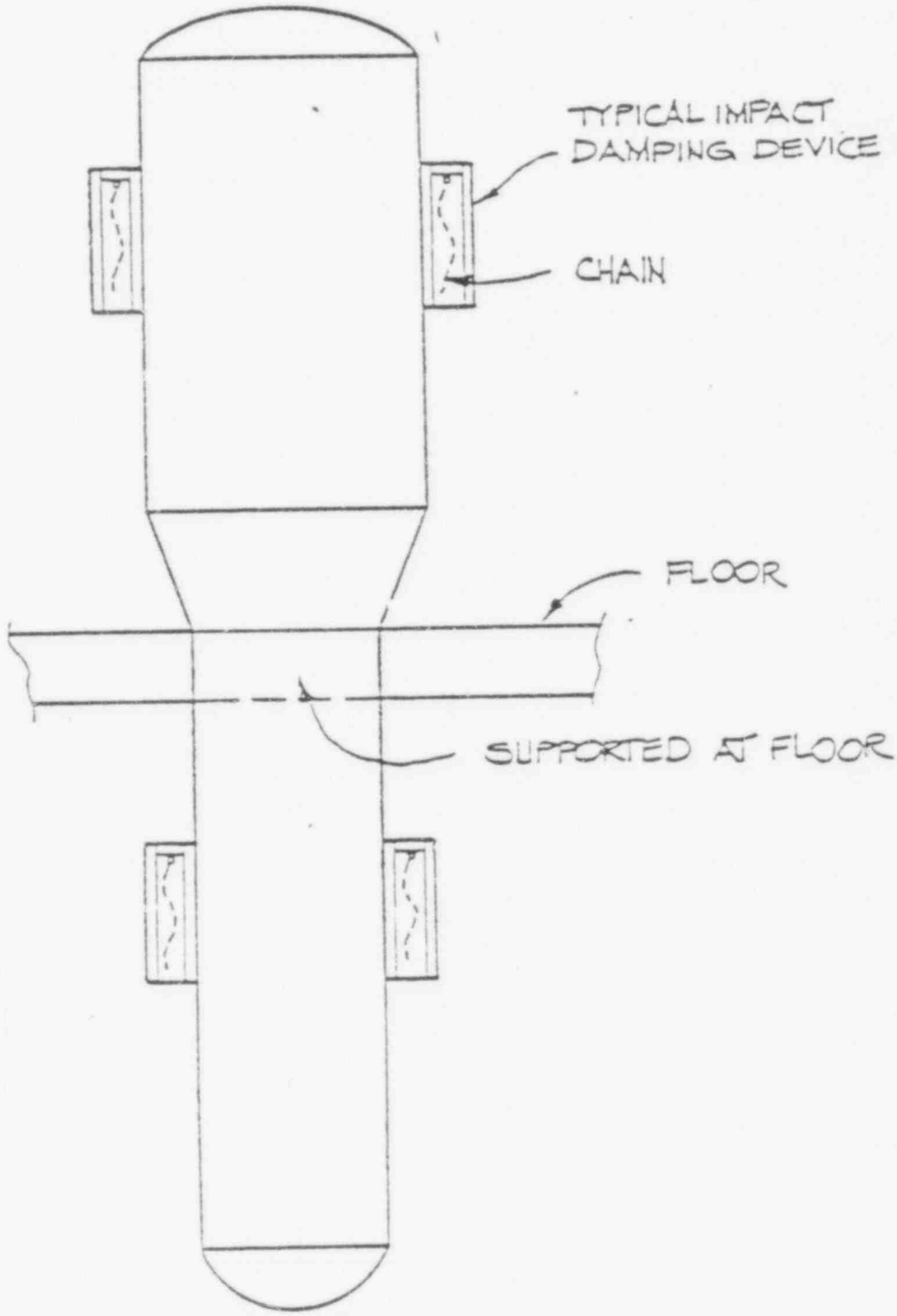

FIGURE 5-12. CONCEPT B-2 ENERGY ABSORPTION - STEAM GENERATOR

TABLE 5-4

ADVANTAGES AND DISADVANTAGES

CONCEPT B-2 ENERGY ABSORPTION

STEAM GENERATOR

ADVANTAGES

- Simplicity of Concept
- Can be Retrofitted in Some Cases
- May Minimize Relative Displacement
- Relatively Low Cost after Development
- Concept in General Well Proven

DISADVANTAGES

- Only Efficient for Fairly Flexible Equipment
- Requires Relatively Large Surface Area of Equipment for Mounting
- May Require Adjustment of Surrounding Layout to Accommodate Mounting Space
- Requires Additional Verification for Seismic Environment

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SCOPING STUDIES OF OTHER CONCEPTS

OBJECTIVE

TO IDENTIFY THE NEED FOR FURTHER RESEARCH AMONG ALTERNATIVE CONCEPTS SUGGESTED TO IMPROVE SAFETY

SCOPE

REVIEW AND EVALUATE ADDITIONAL CONCEPTS

- OFF-SITE EMERGENCY RESPONSE*
- PROTECTION AGAINST SABOTAGE*
- NDE AND ON-LINE MONITORING*
- NEW SITING CONCEPTS*
- REDUCED OCCUPATIONAL EXPOSURE*
- IMPROVED REACTOR SHUTDOWN SYSTEMS*
- IMPROVED PLANT LAYOUT
- IMPROVED PLANT CONTROL
- CORE RETENTION MEASURES*
- REDUCED RADIOACTIVITY RELEASES
- REACTOR VESSEL RUPTURE CONTROL

*WORK IN THESE AREAS IS PART OF NRC'S ONGOING PROGRAMS

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SUMMARY OF TECHNICAL STATUS

- o PRIORITIES REVISED TO REFLECT TMI-2 CONCERNS
- o WORK INITIATED ON HIGHEST PRIORITY TOPICS

  VENTED CONTAINMENT

  HUMAN INTERACTION

  ALTERNATE DECAY HEAT REMOVAL

- o RATE, DEPTH, AND BREADTH OF FUTURE PROGRESS DEPENDS ON AVAILABILITY OF FUNDS

NRC CORE RETENTION RESEARCH

PRESENTATION BY
M. SILBERBERG, RSR
TO ACRS SUBCOMMITTEE
ON IMPROVED REACTOR SAFETY RESEARCH
JUNE 26, 1979

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NRC CORE RETENTION RESEARCH

- 1978 ACRS REVIEW / EVALUATION OF RES PROGRAM

  "ACRS RECOMMENDS FURTHER THAT EMPHASIS BE GIVEN TO . . . SCOPING STUDIES ON THE TOPICS RELATING TO PREVENTION OR MITIGATION OF THE OFFSITE CONSEQUENCES RESULTING FROM POSTULATED CORE MELT ACCIDENTS VIA LIQUID PATHWAYS"

CURRENT NRC CORE MELT RESEARCH (SANDIA)

LWR (WRSR)

- OBJECTIVE - IMPROVED MODELS FOR RISK ANALYSIS
- SCOPE
  - MELT / CONCRETE INTERACTIONS
  - INTERACTION MODELING (INTER / CORCON)
  - MODEL VERIFICATION (EXCHANGE WITH FRG - KFK)

CURRENT NRC CORE MELT RESEARCH (SANDIA)

ADVANCED REACTOR (ARSR)

- OBJECTIVE
  - DATA BASE FOR CONTAINMENT CODE DEVELOP. / VERIFICATION
  - CORE RETENTION SYSTEM ASSESSMENT
  - NRR USER NEEDS (CRBR - 1976; FFTF - 1978)

- SCOPE
  - MELT / CONCRETE INTERACTIONS (SMALL AND LARGE SCALE)
  - MELT / RETENTION MATERIAL INTERACTIONS
  - LARGE FIELD SCALE FACILITY DEVELOPMENT (100 - 500 KG)
  - ADVANCED INSTRUMENTATION - QUANTIFICATION

NRC / ARSR CORE RETENTION RESEARCH

- OBJECTIVE
  - SCOPING STUDIES TO IDENTIFY IMPORTANT PHENOMENA FOR RETENTION MATERIALS
  - QUANTITATIVE DATA BASE FOR CANDIDATE RETENTION MATERIALS EVALUATION
  - ESTABLISH FRAMEWORK FOR INTERACTION MODELS
- SCOPE
  - LARGE SCALE (200 KG) SCOPING TESTS WITH MOLTEN S.S. (1,700^{o}C)
  - SMALL SCALE TESTS WITH STEEL & UO_2 / STEEL MELTS (PARAMETERS)
  - SUPPORTING SEPARATE EFFECTS TESTS (CHEMICAL ATTACK)

CANDIDATE CORE RETENTION MATERIALS

- CRUCIBLE MATERIALS
  - MgO*
  - UO_2
  - ZrO_2
  - TaC
- SACRIFICIAL MATERIALS
  - BORAX*
  - LEAD
  - Fe_3O_4
- MISC. MATERIALS
  - FIREBRICK*
  - HIGH ALUMINA CEMENT*

*USED IN INITIAL SCOPING STUDY

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KEY QUESTIONS FOR CORE RETENTION MATERIALS (MgO)

- MECHANISM AND RATE OF MELT ATTACK
- MELT PENETRATION OF JOINTS
- EXFOLIATION OF LAYERS OF BRICK
- SLAG-LINE ATTACK
- HEAT FLUX DISTRIBUTION
- CREEP AND THERMAL SHOCK
- WATER FLOODING

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FUTURE NRC CORE RETENTION RESEARCH

- GENERIC LARGE SCALE SUSTAINED MELT TESTS (500KG)
  - QUANTITATIVE
  - ENGINEERING FEATURES
- SUPPORT FOR NRR REVIEW OF FNP
- ASSESS RISK REDUCTION POTENTIAL

RELATED NRR USER REQUESTS

- RR-NRR-76-2 (MARCH 1976)
  - CRBR CORE DEBRIS RETENTION CAPABILITY
  - MgO
- RR-NRR-76-2 MODIFICATION (MARCH 1978)
  - FFTF CONTAINMENT MARGIN VERIFICATION
  - FIREBRICK
  - GENERIC DIRECTION
- RR-NRR-79-10 (APRIL 1979)
  - LICENSING REVIEW OF FLOATING NUCLEAR PLANT (MgO)
  - GENERIC INTEREST

NRC STAFF REQUIREMENTS FOR FNP RETENTION DEVICES

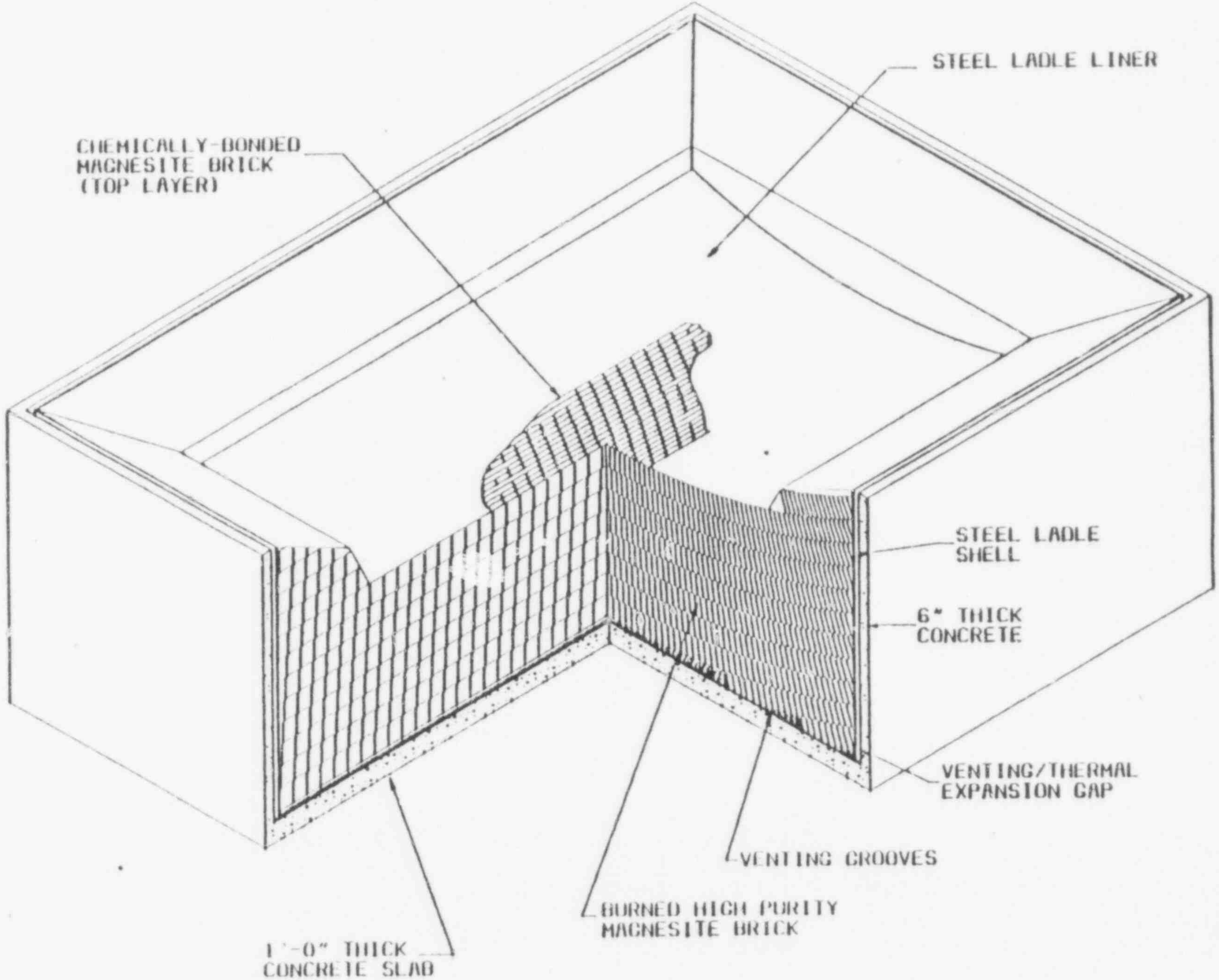
- SHALL PROVIDE INCREASED RESISTANCE TO CORE DEBRIS MELT-THROUGH
- SHALL NOT REACT WITH CORE DEBRIS TO FORM LARGE VOLUMES OF GAS
- SHALL BE AT LEAST AS THICK AS CURRENT CONCRETE PAD (4 FT.) AND AS THICK AS PRACTICABLE
- SHALL NOT COMPROMISE SAFETY

NRR USER REQUEST

FLOATING NUCLEAR PLANT

- CONFIRM FEASIBILITY OF REFRACTORY MATERIAL RETENTION DEVICE
- KEY TEST NEEDS
  - QUASI-STEADY STATE CONDITIONS (SUSTAINED HEATING)
  - SCALING (GEOMETRY, SIZE)
  - EXAMINE MgO + ONE OTHER ATTRACTIVE CANDIDATE
  - $\sim$ 3 YR. TIMEFRAME FOR MgO
- RES DEVELOPING RESPONSE

FLOATING NUCLEAR PLANT



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Status of the Passive Containment System

NucleDyne Engineering Corporation

The Passive Containment System (PCS) was developed by Mr. Frank W. Kleimola who holds a number of patents on the concept. Since 1976 a number of technical documents and other publications have been prepared describing the concept and the manner in which it functions to improve the safety of light water reactor power plants. (See attached Bibliography).

The major innovations in the PCS are the severely restricted free volume and a unique arrangement of water tanks so designed as to absorb the energy released in the LOCA thereby preventing core damage and release of radioactivity and, additionally, providing for dissipation of core decay heat - all without any sources of power or operator action being required.

An improved version of the PCS (referred to as PCS-2) was presented in early 1979. It is described in Item 18 of the attached Bibliography. The more important modifications incorporated into PCS-2 are noted:

1. Primary reactor containment free volume increased from the range of 100,000 ft^3 to the range of 250,000 ft^3. This reduces containment peak pressure in LOCA from 300 psia range to the 75 psia range.

2. Reverted to currently used equipment supports for reactor coolant system components.

3. Replaced rupture disks at deluge tanks with vents at top ends of tanks; vapor suppression is immediately effective. Containment is not necessarily flooded for the smaller pipe breaks.

4. Bottom ends of the deluge tanks are interconnected to the passive emergency core cooling system extending passive ECCS from the previous 10 minutes to four hours with deluge tank flow. Passive ECCS flow from deluge tanks overflow through pipe break flooding the primary containment.

5. Deluge tanks serve as a heat sink for any overpressure discharge from electromatic relief valves and safety valves on the pressurizer; two deluge tanks have a heat sink capacity equal to the stored energy in the reactor coolant.

6. Replaced deepwell with quench tanks; quench tanks are mated to the steam generator secondaries as a heat sink and a continuing source of emergency feedwater. This permits re-

DOE LWR SAFETY TECHNOLOGY PROGRAM

PRESENTATION TO ACRS, JUNE 26, 1979

INTRODUCTORY REMARKS
M. P. NORIN, DOE

PROGRAM DESCRIPTION
D. A. DAHLGREN, SANDIA LABORATORIES

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DOE LWR SAFETY TECHNOLOGY PROGRAM

CHARTER

ALL SAFETY RELATED CONCERNS

448 310

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DOE LWR SAFETY TECHNOLOGY PROGRAM

CURRENT PLAN

IMPROVED SYSTEMS

MAN-MACHINE INTERACTION

RISK METHODS UTILIZATION

SAFETY DATA

EXPANDED PROGRAM

- o TMI EMPHASIS
- o ADD
  - UTILITY TRAINING
  - EMERGENCY AND RECOVERY PROCEDURES
  - TMI EXAMINATION AND ANALYSIS

DOE LWR SAFETY PROGRAM

ACTIVITIES 3/79 TO 6/79

CONTINUE IMPLEMENTING FY79 PROGRAM

COMPLETE DRAFT PROGRAM PLAN

STUDY THREE MILE ISLAND

REVISE PROGRAM

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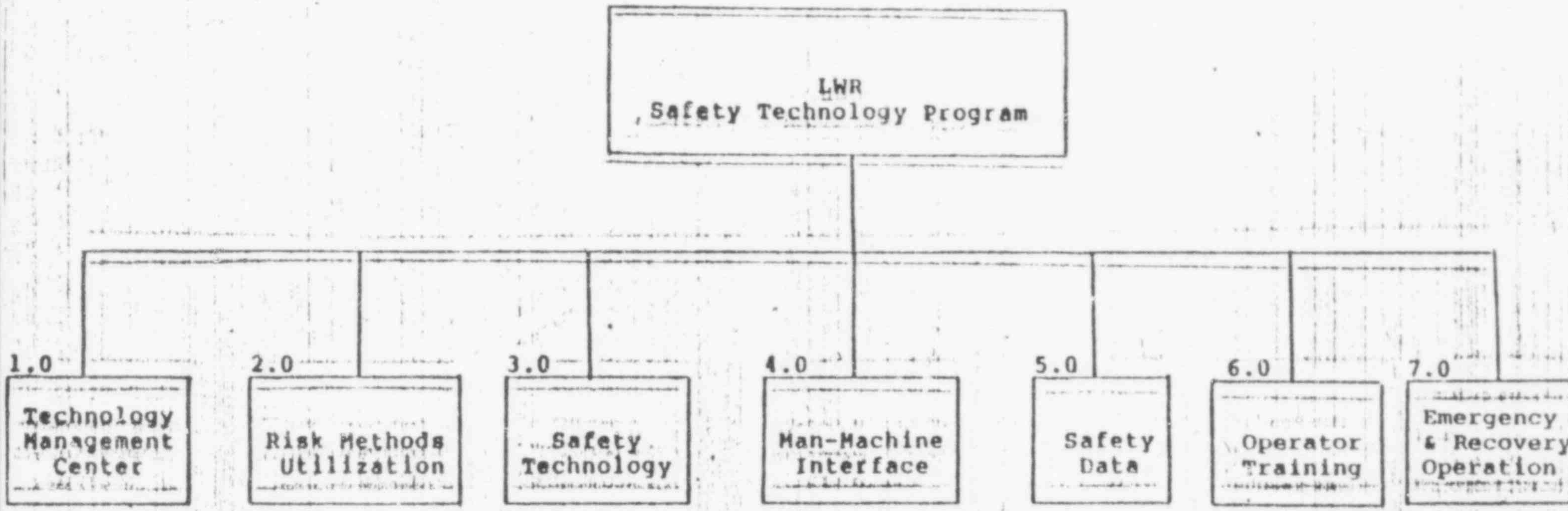
DOE LWR SAFETY TECHNOLOGY PROGRAM

CURRENT PROGRAM

	STATUS 3/79	STATUS 6/79
RISK METHODS UTILIZATION		
R&D SELECTION METHODOLOGY	FUNDED	FUNDED
QUANTITATIVE METHODS FOR DESIGN DECISIONS	STUDY	RFP OUT
DATA BASE DESIGN	FUNDED	FUNDED
ACCEPTABILITY CRITERIA	FUNDED	FUNDED
RELIABILITY & SAFETY METHODS DEVELOPMENT	FUNDED	FUNDED
SAFETY/RELIABILITY/DESIGN INTEGRATION	FUNDED	FUNDED
TECHNOLOGY DEVELOPMENT		
ACCIDENT INITIATOR FORMATION	RFP OUT	FUNDED
VALVE IMPROVEMENTS	WRITE RFP	FUNDED
INELASTIC BEHAVIOR	WRITE RFP	FUNDED
FIRE SAFETY	FUNDED	FUNDED
IMPROVED MAINTENANCE DESIGN	RFP OUT	FUNDED
IMPROVED CONTAINMENT	FUNDED	FUNDED
MAN-MACHINE INTERACTIONS		
ADVANCED MONITORING & CONTROL		
PROGRAM DEVELOPMENT	FUNDED	FUNDED
EXPLORATORY CONTROL	FUNDED	FUNDED
IMPROVED MAINTENANCE		
SAFETY DATA		
FUEL DAMAGE LIMITS/DNBR LIMIT	STUDY	FUNDED
LONG LIFE FUEL DESIGN SAFETY	STUDY	HOLD
UNRESOLVED SAFETY ISSUES	STUDY	FUNDED



LWR Safety Technology Program Structure

RISK METHODS

- SYSTEMS AND COMPONENT FAILURE DATA COLLECTION AND DISSEMINATION
- SYSTEMS ANALYSIS INCLUDING PARTIAL AND INTERMITTENT SYSTEMS OPERATIONS
- FACTORING HUMAN ERROR INTO ANALYSES
- REVIEWING ACCIDENT ANALYSES TO IDENTIFY GENERAL CLASSES OF ACCIDENTS WHICH HAVE NOT HERETOFORE BEEN CONSIDERED IN THE LICENSING PROCESS

IMPROVED SAFETY SYSTEMS

- SIMPLIFIED PLANT LAYOUTS TO REDUCE THE PLANT'S SENSITIVITY TO COMMON-CAUSE ACCIDENT INITIATORS, SUCH AS INCORRECT MAINTENANCE ACTIVITIES, ADVERSE ENVIRONMENTAL CONDITIONS, AND FIRES: AND
- UNIQUE CONTAINMENT SYSTEMS
- IMPROVED SAFETY VALVES
- IMPROVED SHUTDOWN HEAT REMOVAL SYSTEMS
- PUMP APPLICATION AND PERFORMANCE UNDER EMERGENCY CONDITIONS
- CONTAINMENT ISOLATION RESPONSE
- HYDROGEN RECOMBINER REQUIREMENTS
- IMPROVED COMPONENT RELIABILITY UNDER A BROAD SPECTRUM OF ENVIRONMENTS AND OPERATING NEEDS
- SYSTEMS INTERACTIONS, PARTIAL AND INTERMITTENT OPERATION
- SYSTEMS/COMPONENT/EQUIPMENT QUALIFICATION AND OPERATION IN ACCIDENT ENVIRONMENTS
- EQUIPMENT QUALIFICATION FOR LONG TERM RADIATION

MAN-MACHINE INTERFACE

IMPROVED QA OF DESIGN AND OPERATING PROCEDURES

DIAGNOSTICS ASSISTANCE

SAFETY SYSTEMS STATUS BOARD

NORMAL, ACCIDENT AND POST ACCIDENT INSTRUMENTATION REQUIREMENTS AND QUALIFICATIONS

HUMAN ERROR AVOIDANCE

INTERLOCKS TO ASSURE NON-VIOLATION OF TECH SPECS

REMOTE OPERATION

SAFETY DATA

THREE MILE ISLAND FUEL/CORE AND HARDWARE EXAMINATION. THIS ACTIVITY WILL BE PURSUED ON A PRIORITY BASIS TO ASSURE THAT VALUABLE DATA IS NOT LOST

PRIMARY SYSTEMS BEHAVIOR, NATURAL CIRCULATION WITH AND WITHOUT FLOW BLOCKAGE, VOID GENERATION, NATURAL CONVECTION LIMITS, ETC.

FISSION PRODUCT RELEASE AND METEOROLOGICAL MODEL VALIDITY VERIFICATION

HYDROGEN EXPLOSIONS GENERATION AND PHYSICAL AND CHEMICAL BEHAVIOR

UTILITY TRAINING PROGRAM

ACCIDENT RESPONSE, INCLUDING SIMULATOR TRAINING

INCREASED CONSCIOUSNESS OF SAFETY IMPLICATIONS AT ALL ORGANIZATIONAL LEVELS

IMPROVED MAINTENANCE AND TEST PROCEDURES

PARTIAL SYSTEMS FAILURE AND USE OF ALTERNATIVE SYSTEMS TO ACCOMPLISH OBJECTIVES

UPGRADED OPERATOR CERTIFICATION AND TRAINING

EMERGENCY AND RECOVERY MEASURES

DEVELOP DESIGN GUIDANCE TO FACILITATE DECONTAMINATION AND ACCIDENT RECOVERY

DEVELOP PROCEDURES FOR INPLANT AND NATIONAL EMERGENCY RESPONSE ORGANIZATIONS

DOE COORDINATION WITH NRC

DOCUMENTS

- WORK STATEMENTS
- PROGRAM MONTHLY REPORTS

MEETINGS

- APPROXIMATELY 30 DURING PA YEAR

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CONTENTS

Information furnished to ACRS

Subcommittee on Improved Reactor Safety

by

NucleDyne Engineering Corporation

June 26, 1979

Presentation to Subcommittee on Improved Reactor Safety
Advisory Committee on Reactor Safeguards
June 26, 1979
by
NucleDyne Engineering Corporation

448 328

We appreciate this opportunity to make an oral presentation concerning the Passive Containment System (PCS) as developed by NucleDyne Engineering Corporation. We trust that this is an indication of renewed interest in this PCS concept and our claims as to the improved safety of light-water power reactors resulting from its application. If the TMI incident is the catalyst for this new interest and if this interest results in positive action toward licensing by the NRC and ACRS one can say "Some good must come from adversity"!

The PCS concept has been known to NRC and ACRS for well over three years. A direct request was made to NRC for a safety review of the concept in February 1976. Subsequently a presentation was made to the NRC Staff on July 21, 1976. This finally resulted in a letter from Chairman Hendrie on November 10, 1977, 16 months later, which stated in part "It seems to me, and I believe that the staff would agree, that your Passive Containment System has in principle the possibility of being engineered into a licensed light-water power reactor system". However, our request for a review was refused for reasons, as stated in the same letter, "that evaluation of the design and review for licensability would necessarily be a substantial undertaking".

We would venture a guestimate that this undertaking would be substantially less than the effort required, both in research and regulatory activities, for the Three Mile Island (TMI) incident and possibly some other forthcoming incidents. More on this later.

When our efforts to obtain NRC consideration had apparently failed, we submitted in September 1977, an unsolicited proposal to DOE (at that time ERDA) and the Electric Power Research Institute for a research and development program. NucleDyne's proposal was accepted, docketed and arrangements made with the NRC's Office of Nuclear Regulatory Research to evaluate the performance of the PCS over the full spectrum of pipe breaks. Again, no work was performed. DOE then assigned that task to Sandia Laboratories where a limited technical evaluation is underway. We are indeed, grateful for this DOE effort but it will not substitute for the initially requested NRC/ACRS review.

On January 9, 1979 we again wrote to Chairman Hendrie. We submitted a document which discussed how PCS would respond to each of the 5 research projects and 11 research topics identified in NUREG-0438. Copies of this document, dated June 12, 1978, have been provided to the ACRS. In our letter we requested a "renewed study and consideration of this unique concept" by NRC. Dr. Saul Levine replied on February 9, 1979 that "other concepts to improve safety merit higher priority" and that "we have identified no basis for changing our priorities at this time."

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from the steam blowdown. The steam blowdown transfers the energy resulting from core decay heat and reactor coolant system cooldown.

2. TMI EVENT: Natural circulation of reactor coolant lost - reactor coolant pressure transient - pressurizer electromatic relief valves open.

   PCS RESPONSE: Passive feedwater injection into the steam generator secondaries maintains water level for natural circulation transferring heat from the primary to the secondary system. At 50F per hour cooldown rate of reactor coolant system, pressure transients and relief valve openings at pressurizer are eliminated.

3. TMI EVENT: Pressurizer relief valves failed to reseat - pressurizer relief tank rupture disk burst - reactor building flooded with reactor coolant containing fission products.

   PCS RESPONSE: Two deluge tanks (four are provided) have sufficient heat capacity and freeboard space for the blowdown of the stored energy in the reactor coolant thus eliminating any possibility of pressurizing deluge tanks or flooding the primary reactor containment.

4. TMI EVENT: Core uncovered - degraded cooling - zircalloy clad damage with fission product release.

   PCS RESPONSE: Adequate heat transfer by natural circulation prevents reactor coolant pressure transients and relief valve liftings thus retaining coolant within reactor system. Passive safety injection system maintains reactor coolant mass inventory and system pressure for continued natural circulation. These injection systems cannot be compromised by operator action.

5. TMI EVENT: "Bubble" in upper head of reactor vessel - hydrogen present - noncondensables (dissolved gas) coming out of solution - saturated vapor.

   PCS RESPONSE: By maintaining reactor coolant mass and system pressure, bubble formation is prevented. The fuel is not oxidized, and natural circulation recombines hydrogen and oxygen in core region thus maintaining an equilibrium concentration. Refueling enclosure, removed from primary reactor containment, permits access to reactor vessel head region for venting non-condensables from upper head of reactor vessel into gaseous radwaste storage tanks.

and research work planned on alternate and advanced concepts as called for in NUREG-0438 and other NRC and DOE documents. Furthermore, to the extent consistent with your scope of responsibility, we urgently request your support for the funding of the PCS research and development program. This would include both authorization and appropriation of sufficient monies to carry out the program in an expeditious manner.

If we do not take immediate steps to encourage the continued construction of nuclear power plants we are going to be faced with economic and electricity blackouts in this country in the very near future. Improvements in LWR safety promotes public acceptance of nuclear power enabling energy independence.

O. B. Falls, Jr.,
Consultant

Support Material for NucleDyne's Statement
on
"Passive Containment System
response to
Sequence of Events at Three Mile Island
dated
May 7, 1979"

The following is representative for a 3425 MWe (1000 MWe) pressurized water reactor. For description of systems see paper, "Passive Containment System - A New Concept to Solve Safety Concerns" by O. B. Falls, Jr. and F. W. Kleimola, NucleDyne Engineering Corporation, presented at American Power Conference, Chicago, Illinois (4/24/79).

1. Heat sink capacity required for cooldown of reactor coolant system from the normal operating temperature to 350F in four hours enabling operation of the residual heat removal system.

Reactor Coolant

Operating at 600F	545,700 lb	336.4×10^6 Btu
At 350F		223.6×10^6
Energy transferred		112.8×10^6 Btu

Sensible heat within reactor vessel

Core	29.4×10^6 Btu
Internals	25. 10^6
	54.4×10^6 Btu

Assume cooldown from approximately 600F to 350F transfers 50 percent of sensible heat - energy transferred,	27.2×10^6 Btu

Secondary system at 1000 psia

Operating	218×10^6 Btu
At 212F	172×10^6
Energy transferred	46×10^6 Btu

Mass and Sensible Energy in RCS components

Reactor vessel	695,000 lb
4-Steam generators	3,700,000
4-Pump casings	212,000
Pressurizer	247,000
Total	4,354,000 lb

Economy of steam jet injectors at 1000 psia (see table 1) $1.24 \frac{\text{lb. water}}{\text{lb. steam}}$

Steam required

$$\frac{359{,}569 \text{ lb/hr feedwater}}{2.24 \frac{\text{lb. feedwater}}{\text{lb steam}}} = 160{,}522 \text{ lb/hr}$$

Chilled water required

$$160{,}522 \frac{\text{lb}}{\text{hr}} \text{ steam} \times 1.24 \frac{\text{lb. water}}{\text{lb. steam}} = 199{,}047 \text{ lb/hr}$$

Feedwater flow at 1000 psia

$$\frac{359{,}569 \text{ lb}}{\text{hr}} \quad \frac{\text{hr}}{60 \text{ min}} \quad \frac{.0216 \text{ ft}^3}{\text{lb}} \quad \frac{7.48 \text{ gal.}}{\text{ft}^3} = 968 \text{gpm}$$

Feedwater flow from each of four quench tanks, approximately 250 gpm.

Each quench tank provides feedwater flow to a number of injectors in parallel, interconnected to the steam and feedwater headers positioned immediately above tanks. Steam lines branching from the steam headers are routed to the injector nozzles; the suction chambers receive water from the quench tanks, and the discharge lines from the injector diffusers branch into the feedwater lines thus supplying emergency makeup to the secondary system.

2. Heat sink capacity of quench and deluge tanks for energy transferred via secondary system steam blowdown into the tanks containing chilled water.

Mass of chilled water

8 tanks each 15,000 ft^3 — 6,660,000 lb.
Energy in water at 50F — $120. \times 10^6$ Btu

Energy sources during four hour cooldown of RCS to 350F

Reactor Coolant System	Mass lb.	Energy Btu
Normal operation	545,600	336.4×10^6
Released on blowdown to 1000 psia	313,300	187.4×10^6
Retained in RCS	232,300	$149. \times 10^6$

Component In 1000 psia range	Mass lb	Energy Btu
Reactor vessel - liquid filled, 4650 ft^3	215,300	$116. \times 10^8$
Balance of RCS - Steam filled, 7962 ft^3	17,900	21×10^8
Total	233,200	137×10^8

From the above tabulations it can be seen that the mass and energy for the reactor vessel liquid filled, approximates the mass and energy retained in the RCS on blowdown to the 1000 psi range.

The refill system has available a sufficient mass of borated liquid to assume adequate core cooling for any adverse event. The secondary system steam provides sufficient energy for safety injection.

Secondary System

Fluid mass	398,000 lb.
Energy	218×10^6 Btu

Refill Tanks

. Volume of borated water	23,000 ft.
Mass	1,448,000 lb.
Energy	26×10^6 Btu

Reactor System Volume	12,000 ft^3
Reactor Vessel Volume	4650 ft^3

The refill tanks have sufficient heat sink capacity to quench the steam carryover during the entire process of RCS refill. The volume of water in the refill system is sufficient to refill the reactor vessel more than five times. Flow from the deluge tanks maintains coolant flow throught the core for about four hours in a design basis LOCA.

5. Pipe Cracks

The PCS anticipates pipe breaks; pipes leak before breaks occur. Early detection of an incipient leak enables timely corrective action. Catastrophic events resulting in the release of radioactivity to the environment, and costly prolonged outages are thus avoided.

In the PCS the reactor coolant pressure boundary (RCPB) and the secondary system pressure boundary are within primary reactor containment. The main steam isolation valves and the check valves in the feedwater lines are immediately adjacent to the primary containment. Thus all potential leaks in the reactor coolant system and in the secondary system are contained.

An incipient leak is readily detected within an hour's time by an increase in radioactivity, humidity, conductivity, temperature or pressure. Leakage into the primary containment carries over as vapor into the vacuum system. The rate of leakage can be monitored by the condensation of the vapor in a cold trap. Electrode probes in drain lines enable a rapid location of a leakage point. Thus incipient leaks are detected, monitored and located with the reactor in operation; the urgency of plant shutdown can be evaluated.

With the vacuum system shutdown, a 1 gpm leak increases the pressure in the 250,000 ft^3 containment free volume by 2 psi in about 3 hours; a 10 gpm leak produces the same pressure increase in about 18 minutes. With the vacuum system in operation an incipient leak is detected more rapidly and readily.

Continued operation of essential equipment is assured during a developing leak in the RCPB or in the secondary system. This essential equipment is not subject to excessive humidity, temperature, pressure, radioactivity or the spray of caustic solution.

This essential equipment is removed from the primary containment. The reactor coolant pump motors are housed in compartments locally-cooled under a controlled atmosphere. The control rod drive mechanisms as well as the pressurizer are housed in separate compartments; thus their vital mechanical and electrical components are well protected. Essential reactor auxiliary systems are not within the primary containment free volume. Instrumentation and controls are removed from the primary containment; extension wells span the relatively short

TABLE 1
STEAM JET INJECTOR ECONOMY
50F INTAKE WATER

Steam Pressure	Back Pressure	Flow Percent		Economy
PSIA	PSIA	Steam	Water	lb-H_2O/lb-Steam
1000	1000	44.67	55.33	1.24
900	900	43.19	56.81	1.32
800	800	41.64	58.36	1.40
700	700	40.02	59.98	1.50
600	600	38.27	61.73	1.61
500	500	36.36	63.64	1.75
400	400	34.21	65.79	1.92
300	300	31.72	68.28	2.15
200	200	28.58	71.42	2.50
100	100	23.98	76.02	3.17
50	50	20.07	79.93	3.98
25	25	16.66	83.34	5.00
14.7	14.7	14.31	85.69	5.99
10	10	12.72	87.28	6.86

Reference: Croft, T., Duffin, D.S., Steam Power Plant Auxilairies and Accessories, New York; McGraw - Hill, 1946.

THE PASSIVE CONTAINMENT SYSTEM
NUCLEDYNE ENGINEERING CORPORATION

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10. "Passive Containment System for Nuclear Power Plants", NEC-5, NucleDyne Engineering Corporation, 1977.

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Technical sessions

At the 1978 APC, O. B. Falls, of Nucledyne Engineering Corporation, outlined that firm's passive containment system, in which virtually all of the space not occupied by components and piping would be filled in with concrete. Falls returned this year with a somewhat evolved version of the system, the PCS-II. Addressing the inevitable, Falls said that if an accident such as the one at TMI-2 were to occur in a PCS-II LWR, there would have been no core damage and no release of radiation to the environment. Falls said that the design prevents Class 9 accidents, and that secondary system releases would be completely contained.

Despite its professed advantages, the system faces a long battle for regulatory acceptance. Updating the progress since 1978, Falls said that the NRC declined to evaluate the system, allegedly because it would require too much work by its staff. The DOE is interested, however, and has assigned a team outside its own staff to study PCS pipebreak response. Falls said that TMI might spur looks at concepts like the PCS, and added, "The fact that it came along late is not necessarily an excuse not to take a look at it."

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