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NUCLEAR REGULATORY COMMISSION

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UNITED STATES OF AMERICA

NUCLEAR REGULATORY COMMISSION

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BOILING WATER REACTOR MARK I CONTAINMENT

PERFORMANCE IMPROVEMENT PROGRAM

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PUBLIC MEETING

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Nuclear Regulatory Commission

One White Flint North

Rockville, Maryland

Thursday, January 26, 1989

The Commission met in open session, pursuant to notice, at 10:00 a.m., the Honorable LANDO W. ZECH, JR., Chairman of the Commission, presiding.

COMMISSIONERS PRESENT:

LANDO W. ZECH, JR., Chairman of the Commission

THOMAS M. ROBERTS, Member of the Commission

KENNETH M. CARR, Member of the Commission

KENNETH C. ROGERS, Member of the Commission

JAMES R. CURTISS, Member of the Commission

STAFF AND PRESENTERS SEATED AT THE COMMISSION TABLE:

SAMUEL J. CHILK, Secretary

WILLIAM C. PARLER, General Counsel

VICTOR STELLO, JR., Executive Director for Operations

TOM MURLEY, NRR

ERIC BECKJORD, RES

ASHOK THADANI, NRR

THEMIS SPEIS, RES

WILLIAM BECKNER, NRR

P R O C E E D I N G S

(10:00 a.m.)

CHAIRMAN ZECH: Good morning, ladies and gentlemen.

Today the Commission will be briefed by the NRC staff, the Offices of Research and the Office of Nuclear Reactor Regulation, concerning the results of the Boiling Water Reactor MARK I Containment Performance Improvement Program.

We last heard from the staff on this subject in public session, on July 22nd, 1988. That meeting provided a status report on staff efforts that were initiated in 1986, to improve MARK I containment performance.

At our last meeting, the Commission was told, essentially, that boiling water reactors using MARK I containments did not pose an undue risk to public health and safety, that the overall risk to the public from these plants is comparable to that posed by other plant types, and that these plants could continue to operate safely.

However, the staff told us that in the highly unlikely event of a severe core damage accident for a boiling water reactor, the MARK I containment has a higher likelihood of failure, than other containment

types. Thus, the focus of staff efforts in its review of MARK I containment performance was to provide a balance between prevention and mitigation of severe accidents for MARK I plants, by reducing the likelihood of containment failure, thereby improving accident mitigation.

At today's meeting, Mr. Stello, for each of the proposed enhancements to be discussed, I would like the staff to specifically address the effectiveness of the proposed enhancement, in improving the ability of MARK I containment to mitigate the consequences of a severe core melt accident.

It is my understanding that copies of the slides to be used in today's presentation are available at the entrance to the meeting room.

This is an information briefing today, and no formal vote is expected to be taken at this meeting today.

Do any of my fellow Commissioners have any opening comments, before we begin?

COMMISSIONER ROBERTS: Yes, and you mentioned this earlier in the week. My office got the SECY paper less than three working days ago. And this is an important issue, and I will have some oral questions today. But I assure you I will have a long list of

written questions that I want answers from the staff.

CHAIRMAN ZECH: All right.

Any other comments?

(No response)

CHAIRMAN ZECH: Mr. Stello, you may proceed.

MR. STELLO: Commissioner Roberts, that was appropriate to raise that issue, because that was the first point I was going to make. I apologize for --

COMMISSIONER ROBERTS: Sorry to upstage you.

MR. STELLO: -- the lateness of the paper. I was out of town visiting a plant last week, and asked the paper to be held, so that I had a chance to look at it, before providing it to the Commission. I did that over the weekend, and unfortunately, you got it Monday morning, which did not provide much time.

You are correct, it is a very, very important issue, one which I think the Commission will need to take a considerable amount of time dealing with. And, as I will make some points later, I don't think that there is any urgency with respect to the Commission deciding this issue in any short order.

So, I think there will be more than adequate opportunity to provide whatever information the Commission needs.

Today, the purpose of the briefing is to really concentrate and provide a briefing to the Commission on the technical issues embodied within the paper. The analysis that the staff has done to make you understand how we evolved the particular package associated with the MARK I that we did, and which of those are important, and why they are important, and how they are, in fact, tied together.

As the Chairman has already indicated, partially in the background of this issue, is certainly not a new issue -- one that we have been working on and identified over 14 years ago, in WASH 1400, and the Commission asked us several years ago to take another hard look at this issue. And we have been doing it now for quite sometime.

And what we are here today to tell you is what the results of that analysis, review and research have caused us to suggest to the Commission as a proper way to proceed to resolve this issue. And that is what we, basically, will be doing today, is providing you with that technical basis, as we evolved over the past several years.

As I said earlier, there clearly is no need for the Commission to decide this issue with any real sense of urgency. It has been with us for sometime. It

is a complex issue, for which the Commission will want to consider, I'm sure, the facts very, very carefully.

We have concluded, and have told the Commission in the past, that we are satisfied that the MARK I containment in those operating plants are safe. The recent letter the ACRS provided to the Commission, again, made the point -- they conclude they are safe, and that they don't see, as I recall, a significant difference overall in risk from the MARK I, as represented from other plants.

COMMISSIONER ROBERTS: Well, as far as the ACRS, you ought to tell the whole story, and say that-- I read directly, "We recommend that the proposed improvement plan for MARK I containments be dropped".

MR. STELLO: I am going to do that in a moment.

COMMISSIONER ROBERTS: All right.

MR. STELLO: In fact, what I do suggest that the Commission may, in fact, want to consider is a meeting with the ACRS, to understand how they came to the conclusion they came to, which is to not take any special action, but rather to integrate this particular program into the IPE. That is, basically, one of the options that the Commission really has before it in terms of how it might wish to proceed, as well as

several others I will mention in a moment.

And I think, as Commissioner Roberts has already indicated, the Commission probably will want further information from the staff regarding this issue. And we will be pleased to provide any answers to questions, or any further information that the Commission may have, but we stand behind our conclusion, that we offered the Commission previously. And the ACRS, again, reiterated, "We do not believe that there is any particular problem that suggests the need for precipitous action, or that the plants are unsafe but, rather, this is a classical issue of backfit. Here are some particular issues that we have put together and said, with respect to the MARK I, we believe that pursuant to the Commission's backfit regulation, that there are improvements in safety that are justified on the basis of backfit".

And that is what this issue is, it is clearly a policy issue, in terms of going forward with the backfit question.

Now, let me come specifically with the options that the Commission really has before it. In the paper, in itself, we identified that the way in which to proceed -- there are options of rulemaking which, in fact, we have identified as preferred by the Office of

General Counsel, and it is also the approach that the CRGR recommended, that rulemaking, if we go forward, we ought to go forward on the basis of rulemaking.

The ACRS in its letter, they suggested that the resolution of this issue ought to be integrated into the IPE program. Now, we have some views and will comment about that as part of the briefing, and that that's the way we ought to proceed with dealing with this issue.

Our paper proposes a third approach that I strongly prefer -- and I think I can speak for the staff -- it is our strong preference to use the Commission's backfit process on a plant-by-plant basis. We used the buzz word in the paper of orders. That is the culmination of backfit. But it is the whole process that I think is very, very important. It is a process that allows us to engage with each licensee, and suggest that here is a package that we ought to look at, evaluate them for each and every plant, allow the flexibility of modifying, or incorporating ideas or suggestions that may be very important with a particular plant, because of the differences in the designs of the plant, that allow one approach to be perhaps a better or more acceptable way.

So, taking that process is a process of plant-

specific backfitting, that it would allow us to engage with each licensee on how to proceed. That's what 50-109 is, in fact, all about, and allows us to proceed. And we have procedures that outline the whole process on how we would engage in that particular kind of a discussion.

CHAIRMAN ZECH: That sounds to me a little bit like the IPE program itself.

MR. STELLO: In a sense it is because it allows that give-and-take in proceeding with these issues, rather than the --

CHAIRMAN ZECH: What is the difference then between the approach that you are recommending -- I don't want to interrupt your introduction, because maybe it will be answered later -- but perhaps you could just briefly describe the difference that you see between the approach that you are recommending and the ACRS approach, which is do it in the IPE program?

MR. STELLO: Well, when we presented the integrated program for severe accidents to the Commission, we indicated that what we thought ought to happen is, in parallel with the IPE program -- and I emphasize the word "in parallel" -- we ought to deal with the containment issues.

So what we are really starting then is a

parallel approach with the IPE, rather than making it to be a burden as an integral part of it, or parallel part, but a program that, if you will, is a program that is unique with respect to the MARK I. And it goes on with -- and would be, in fact, in parallel and --

CHAIRMAN ZECH: Could you characterize it then as taking a specific part of the IPE program and bringing it forward for consideration?

MR. STELLO: It could very well involve that because some of the issues that we are involved with, in terms of how to provide more water, or dealing with the ADS valves, are issues that would be potentially part of the IPE program. So the connection is clearly there.

And that's another advantage to going case-by-case because it allows that kind of integration to take place.

CHAIRMAN ZECH: Thank you. You may proceed.

MR. STELLO: There are several parts of the program. And I am, in a moment, very quickly, going to turn to Dr. Murley, who will talk about our experiences with respect to one of them, and that's venting. I want to emphasize that a little bit because the venting is, if you will, the keystone to this issue.

And I want to emphasize that the importance of venting is not the venting of fission products, but

rather a process where venting, and the principal use of the venting, will be to, in fact, prevent fission products from being released to the fuel because you are really, basically, preventing the melt down to begin with.

And that's the predominant benefit -- and you will be hearing a great deal more about this in the technical briefing -- but that becomes the keystone, and these other elements are a necessary and supporting part of the venting process -- when you vent, you need water, you need other things, to make it successful, too.

So what we have, and what we are proposing to the Commission is, in fact, a package which has certain things that are fairly critical. And part of the program, and I must remind the Commission, has been with us for sometime, following TMI, where BWR venting was part of the original orders the Commission issued on NUREG 0737. And there is a fairly mixed performance, and generally not very good, with respect to what we have seen in the field that resulted from that particular position that the Commission took now quite some years ago.

With that introduction and trying to lay the framework of where we proceed, I will ask Dr. Murley to

begin by making some comments. And we will turn then to Eric Beckjord, for some additional points he wishes to make. And then finally get into the briefing with Themis Speis.

CHAIRMAN ZECH: Thank you very much.

Dr. Murley, you may proceed.

DR. MURLEY: Thank you, Mr. Chairman.

I should add, Mr. Ashok Thadani is with me here, and he's our technical expert in NRR who is closest to this, and he can answer the detailed questions.

To add to the background of this issue, in 1987, Mr. Stello asked us to take a fresh look at the MARK I issue. When we did that, we concluded that the MARK I issue could not be separated from the broader issue of severe accident policy, which was applicable to all plants.

So, first, then, we developed an integrated plan for closure of the severe accident issue for operating plants. And that has been presented to the Commission, and approved by the Commission.

So this plan for resolving the MARK I issue is one block then, in that overall integrated plan for severe accidents. Our re-examination found no information showing BWR MARK I reactors are risk

outliers as a class. Some MARK I plants had higher, some had lower overall risks than the average.

Similarly, we found no evidence or information suggesting that BWR MARK I plants do not meet adequate level of safety standard. Nonetheless, the defense in-depth safety philosophy compels us to look whether the accident mitigation function can be improved.

I should add that the defense in-depth philosophy is so important because it allows for the fact that you may have overlooked something, that maybe the risk estimates have overlooked something. And that is the reason we place such emphasis on defense in-depth.

The reason why the MARK I plants were looked at is that studies showed that the MARK I containment structure appeared to be vulnerable to early failure during certain core melt accidents, where the reactor pressure vessel is breached. This vulnerability is due, primarily, to the smaller size of the containment structure for MARK I.

The MARK I containment meets all regulatory requirements for design basis accident conditions. And, as you know, the core melt accidents are beyond design basis conditions.

In examining how best to augment defense in-

depth for MARK I's, one is led to the conclusion that it is not fruitful to focus solely on the containment integrity function. In the first place, for BWR MARK I's the reactor system and the containment system are very closely coupled, much more so than any other reactor type.

Secondly, there is today substantial scientific controversy on whether the MARK I liner would melt through during a core melt accident. This scientific controversy among the experts is not likely to be resolved soon, but we frequently have to make regulatory judgments in the face of technical uncertainties.

Therefore, we concluded that we should take a balanced approach to improving defense in-depth. This balanced approach involves preventing core melt accidents, in the first place, by improving the operator's capability to arrest serious accident sequences before large-scale melting begins. And venting is a key aspect of that, for example.

Another element of the balanced approach is accident management, where we improve the operator's capability, once core melting is begun, to maintain the debris inside the vessel.

And the third aspect of the balanced approach

is accident mitigation, where we improve the means for mitigating the release of radioactivity through having water sprays, and more reliable water sprays in containment.

The recommendations we are making today, we believe, meet the objective of this balanced approach. They are relatively modest cost improvements, yet we believe they yield substantial additional improvements in safety.

It is important, we believe, to view the benefits of this package as a whole, because of the synergism that exists among improved procedures, among venting, the improved reliability of the automatic depressurization system, and improved supplies of water. Still, there is one aspect that deserves special mention up front, and that is the containment venting to prevent the release of radioactivity.

As you know, I was particularly skeptical of MARK I venting a couple of years ago because I had seen how it was implemented in many cases in the field. So, we asked a number of tough questions of the industry and of ourselves and, as a result of those questions, a good deal of homework was done by the research program, and particularly our contractor at Idaho National Engineering Lab.

The BWR Owners Group did a complex, comprehensive analysis and submitted a detailed study of venting and, in addition, Boston Edison, for their PILGRIM plant, did perhaps the best study because it was a detailed plant-specific study.

From those studies emerged then consistent answers, that MARK I containment venting done properly is a big factor in reducing overall risk, primarily because of its role in preventing core damage accidents in the first place.

Boston Edison found, for the PILGRIM plant, that in over 99 percent of the time that a vent would be used, it would be releasing steam. That is, it would be clean venting and it would not be releasing any radioactivity.

We, the staff, agree with the industry on the importance of venting. Where we disagree with the industry is in our concern that the current procedures and equipment may not be adequate to assure reliable venting. And this then is a source of disagreement between us on the cost-benefit analysis, which ultimately is a disagreement on the benefits of the venting improvements that we are proposing. We think the benefits are greater. The industry does not think they are so great because they believe that venting is

already reliable and adequate.

But we base our findings on the following: While we were doing these studies of venting, I sent out inspection teams to each one of the MARK I plants, to review their emergency operating procedures. So, we did EOP inspections at all MARK I plants. And what we found then are some problems -- not at every plant -- but they were sufficiently broad that leads me to conclude that there is some uncertainty about the reliability of current procedures.

In some cases the procedures were unclear for the operators. In some cases the vent lines being relied on are much too small, they are only one-inch, or two-inch lines off the torus. In some cases the operators expressed to our inspectors, reluctance to use venting. And the reason, I believe -- and I think it would still be there -- the reason for that reluctance is that when you vent without a hard pipe to the stack, you are almost certainly going to blow out duct work in the reactor building. The steam pressure would blow it out, and that would release steam then to the reactor building, at a time when there is almost certainly going to be workers out there trying to recover the plant.

And I think -- it is very difficult, of course, to prove this one way or the other -- but my

judgment is that operators would be reluctant to do that, if they know their workers are out there trying to recover the plant.

So, based on this, that was our emphasis on the package that we are proposing today, and why venting is such a key aspect of that. And there is a disagreement with the industry. They, generally, agree on the importance of venting, but they disagree on the cost-benefit aspects of this. And I think I understand the basis for the agreement -- disagreement, and I think I kind of will stick by our views on that.

CHAIRMAN ZECH: Thank you very much.

Mr. Beckjord, you may proceed.

MR. BECKJORD: Mr. Chairman, there are three points I wanted to summarize, that come out of the research work on this. First, there are technical uncertainties concerning the MARK I containment performance, notably, the potential of containment shell melt-through from core debris in a melt down. This possibility was identified a number of years ago, and it remains an important failure mode in the NUREG 1150 study that will be completed this spring.

With regard to that point, we are convinced that the total package of recommended improvements, including the hardened vent and the water spray, will

prevent, or delay shell-liner melt-through. And that in any event, it would reduce the source term, in the event of late failure.

The second point I would like to make is that the MARK I containment performance improvement study that is detailed in the SECY 89-017, has made use of all of the available information, technical information, on this issue. The data was reviewed at the workshop in Baltimore, in February, a year ago, with researchers, with people from industry, and with the public. It was reviewed subsequently by the panel of experts that have worked on NUREG 1150. And then there has been more recent analytical and experimental information that has come to light. And this information is detailed in Enclosure 6 to the Commission paper.

Finally, I want to comment that we will continue confirmatory research on this question. The proposed research is also detailed in Enclosure 6 to this document. Specifically, I propose to initiate additional experiments, and analytical work that will resolve the question of shell failure. And I note that this program, I think, is an excellent candidate for a cooperative research effort between the NRC and industry.

That ends my comments, Mr. Chairman.

CHAIRMAN ZECH: Thank you very much.

MR. STELLO: Themis?

CHAIRMAN ZECH: Mr. Speis, you may proceed.

MR. SPEIS: Thank you, Mr. Chairman.

A number of points have been made by my predecessors, but that perhaps is why I am fourth in the pecking order, so I will proceed now.

(Laughter)

The containment performance program is intended to evaluate generic challenges and failure modes of the containment, as the result of severe accidents, as well as potential improvements to enhance containment performance.

We have programs which will deal with all containments, and that work will be finished by the end of the year but, of course, today's presentation will deal with the MARK I program itself.

And as Mr. Stello said, my presentation will focus on the technical issues associated with containment performance, and the efficacy and the effectiveness of the proposed improvements.

Vu-graph number one, please.

(Slide)

I will go through a brief outline of the presentation itself. As I said already, many things

have been said previously. I will say a few things about the background, especially what has happened in the last two years, discuss the objectives of the program itself, summarize the challenges to the MARK I containments, describe the failure modes, as a result of the loads that are generated from the severe accidents, summarize the insights that we have gained from PRAs and research, and other efforts that have gone on the last five or ten years about the BWR plants.

(Slide)

And then I get into our approach to the improvements themselves, summarize our recommendations and deal with each one of them specifically, the alternate water supply -- we are on page number two now -- the improved venting capability, the enhanced automatic depressurization system reliability and also address the emergency procedures and training; say a few things about worthwhile things going on with industry at this point in time, and then summarize the benefits of the improvements, and also summarize our evaluations-- our cost-benefit evaluations.

I should have said, Mr. Chairman, I have next to me Mr. Beckner, he is one of the authors of the Commission paper. And some of the detailed questions that might come up, he will be able to address them.

Vu-graph number three, please.

(Slide)

I will only address, as far as background goes, the last two years. Back in the Summer of '86, the staff proposed a five-element program for MARK I containment performance enhancement. The program at that time included hydrogen control measures, containment sprays, hardened venting via the suppression pool, core debris control and training and procedures.

I would like to make the point at this time that the program at that time was mitigation-oriented. That is, given a severe accident, whether those enhancements could prevent or delay containment failure, and also prevent or delay the release of radioactivity.

The program that we have fashioned at this point in time, as Dr. Murley said, is broader than this. It is a program, it is a balanced program that includes both prevention, mitigation, as well as accident management. In fact, some elements of the program go in all directions -- they help in the prevention of accidents, they help in managing the degraded core and possibly retain it in-vessel, as well, as help prevent containment failure or delay containment failure, or help reduce the source term itself.

So that's the difference between the program

at that time versus the program that we have now, even though some elements are the same. For example, we have, again, taken another look at hydrogen control. And as is described in the Commission paper, we decided that from a risk standpoint, it is not worth pursuing it because the MARK II containments -- excuse me -- the MARK I containments are inert with hydrogen -- with nitrogen and, during the inerted time period, before shutdown and after shutdown, the times are very small compared to the year that the reactor operates. So, on a per year basis, the risk improvements of doing something during that inert period is not worth pursuing.

We also discussed -- we took another look at core debris control and we decided that it wasn't worth pursuing for the number of reasons that are discussed in the paper itself. So, I will focus on the things that we think are worth pursuing, and I will discuss the effectiveness of them.

Now, the reason we didn't pursue the program back in June '86, there were very -- arguments whether the program was the right one, whether those fixes that were proposed were technically feasible. And there were many technical discussions. And we decided at that time that we had better take another look, and do some more

homework, before we come to you.

And we have done that homework in the last two years, and I think we are ready, as Mr. Stello said, to propose to you what we have in the Commission paper itself.

Back in July '87, we briefed the Commission on a plan for closure of severe accident issues, which included the issues related to the MARK I containment performance. In December '87, we gave you our first program plan for closing issues related to the MARK I containment.

In February of '88, we had the workshop to discuss technical issues relating to the MARK I containment. Mr. Beckjord summarized them.

Finally, coming to 1988, we presented to you the integration plan for closure of severe accident issues, which the Commission approved. And in July of '88, we gave you our first status of the MARK I program itself.

COMMISSIONER ROBERTS: Before you leave that slide. The second bullet, who were the two licensees?

MR. SPEIS: Vermont YANKEE and PILGRIM.

Page four, please.

(Slide)

Coming to the last slide, after we did our

work, we met with the ACRS three times -- once with the subcommittee, twice with the full committee -- and, of course, we discussed our program with the CRGR. And the CRGR went along with us. They thought that the technical part of the program was very sound. They recommended that we pursue the implementation of the program via rulemaking versus plant-specific implementation, as Mr. Stello indicated.

The ACRS, of course, as you saw in the letter, concluded that this program could be done as an integral part of the IPE.

COMMISSIONER CARR: When you did these two briefings with the ACRS only a month apart, did they send you back for some homework, or --

MR. SPEIS: They had a number of questions. They just wanted to make sure that they understood all aspects of it. One of the questions that they had was relating to the relationship between the station blackout issue and this program, the power requirements, to make sure that we don't impose power requirements twice.

And I think that was a very good question. In fact, the CRGR raised the same question.

COMMISSIONER CARR: Okay.

(Slide)

MR. SPEIS: Coming to page five -- you have seen this famous diagram before, or infamous. It shows the severe accident program itself. And it is a program that is integrated. The containment performance improvement program is one of the main elements of the integrated approach to closure of severe accidents. It complements the IPE program, and is intended to focus on resolving generic severe accident containment challenges whereas the IPE effort is focused on plant-unique vulnerabilities.

And this is one of the issues that we take with the ACRS, for example, that we think that we have come up with a number of things that are generic -- are generic and can be fine-tuned with plant-specific examinations but, after ten years of work, we believe that, indeed, truly, these things are generic and can be implemented now, without waiting for the completion of the IPE.

DR. MURLEY: Themis, could I interject here-- this answers, I think, the questions the Chairman had up front, that's probably worth emphasizing. When this plan was thought out and put together, it was always contemplated that there were some generic issues that could move in parallel with the IPE.

The IPEs were aimed at finding plant-specific vulnerabilities and fixing those. But where we thought

we knew enough about some issues that could be approached generically, like MARK I, it was contemplated that we would move ahead and do that. And so there was always this thought of moving in parallel, and not waiting for the IPE to be complete.

MR. SPEIS: Slide number six, please.

(Slide)

Briefly, the primary objective of the program is to determine what actions, if any, should be taken to reduce the vulnerability of containments to severe accident challenges. Initially, we are focusing on MARK I. And as I already said, other containment types are to be addressed.

On Vu-graph number seven, please.

(Slide)

As Tom said, the MARK I containment could be challenged by a large scale core melt, principally due to its smaller size. On the next Vu-graph I will amplify on that.

We have identified several early containment failure modes for MARK I's and, again, I will discuss them shortly. But I must emphasize that, as both Mr. Stello and the other speakers already have said, the MARK I plants are not risk outliers as a class. We have a more detailed discussion of that on Enclosure I to the

Commission paper.

COMMISSIONER ROBERTS: You can't say that too much.

MR. SPEIS: Excuse me?

COMMISSIONER ROBERTS: Nothing.

MR. SPEIS: And uncertainties, of course, remain in estimating containment failure, especially via the drywell shell melt-through.

On the next picture --

(Slide)

-- I don't know if it can be shown up here, but it is a picture of the MARK I containment. There are 24 MARK I -- BWR MARK I containments at 17 different sites. They are inverted light bulb design. All BWR MARK I's except Brunswick I and II, have steel lined reinforced concrete containments. The primary containment is the steel lined itself.

COMMISSIONER ROBERTS: What does Brunswick have?

MR. SPEIS: Excuse me?

COMMISSIONER ROBERTS: What does Brunswick have?

MR. SPEIS: Concrete.

The steel liner, again, is the primary containment boundary itself. The thickness varies along

the circumference from .7 to 2.5 inches. The volume of the MARK I is very small compared to the other containments, it is 200,000 -- 300,000 cubic feet versus, for example, large dry containments varying anywhere from 2-3 million cubic feet.

It is designed for 55 to 60 pounds per square inch, even though on our best estimate it can take pressures which is much higher than that, maybe can go up to more than 100 pounds per square inch.

You can see the drywell. The dimensions-- from the center of the light bulb to the liner itself, it is only 6.8 meters. So it is a very small distance. And the failure mode that has been discussed is when the molten core penetrates the vessel, and gets to the drywell, it can -- this pedestal which supports the reactor vessel has a door, and the molten core supposedly can raise and get to the liner. This failure mode is more predominant if the conditions in the drywell are dry.

And, in fact, I think the earlier number that was calculated in the Draft 1150, the top -- the high number was under dry conditions.

A lot of work has been done in the last two years, and there is consensus now that if there is water in the drywell, which is one of the elements in our

proposed package, the liner, even though there is still no consensus about what is the quantity of the probability of failure, there is consensus that even if it doesn't fail, the liner -- the failure would be delayed substantially. And that delay is a very important part in reducing the source term itself.

For example, with the venting system, where you take credit of the suppression pool, water is an important part because you need water to protect the liner because you don't want to by-pass the suppression pool. And if you fail the liner, you by-pass the suppression pool.

Now, if you delay the failure of the liner for four hours, you take advantage of the suppression pool, and you can reduce the source term by an order of magnitude. So, that's why Tom and the other speakers already have said that the package is a synergistic one, where the package itself, the benefits are very effective -- more effective than the sum of the parts of the package.

So, getting to the next Vu-graph number, number nine --

(Slide)

One of the things that we have been doing the last five years, and more -- in a very concentrated way,

the last two years, and also an integral part of the 1150, is to understand the failure modes of containments, given a severe accident. The failure modes and their timing, and the relative probability of those failure modes. It is very important because, otherwise, you don't -- if you don't understand how something fails, then you don't know what to do to fix it.

So, what I have here, I have listed all the failure modes that have been -- on pages 9 and 10, I have listed the failure modes that have been identified, and the relative importance. And I have put in terms of risk importance, where I have "yes", we think that those failure modes are more important than where we say "no".

For example, the first one that talks about overpressurization, this is overpressurization that can lead to core damage. This is overpressurization that can fail the containment from loss of long-term decay heat removal. If you have venting, effective venting, this is the failure mode that can be prevented, or at least substantially reduce its likelihood.

So, again, this is an important part of the package, to prevent this failure mode which can lead to core damage.

The other ones I have listed, number five and

six, these are failure modes that take place following the breach of the reactor vessel and the massive molten core getting into the cavity and interacting with the concrete and producing non-condensable gases which pressurize the containment.

Again, overpressurization can be prevented, or substantially delayed by venting. So venting will, again, help in the prevention of accidents, as well as in preventing the failure of the containment from this particular overpressurization mode.

Getting into page 10 --

(Slide)

I have listed at number eight, for example, the containment shell, the melt-through, which some of us already have spoken about. This issue has been discussed and argued. And as I said, more work is being done in this area, but we have done enough work that we think that the things that we are proposing will go a long way in alleviating some of the concerns that have been raised about this specific failure mode.

(Slide)

On page 11 of the packet, of the Vu-graphs, I have summarized the insights, all of the insights that we have gained from the PRAs that have been performed, from the research, from the engineering analyses, from

experiments, from tests, and so on and so forth. In fact, for MARK I containments, there have been 12 PRAs, six of them done by NRC, six of them by industry. And the staff has access to eight of them. And I understand that we are getting -- we are getting access to the Brunswick one right now. I understand that three more PRAs for MARK I's are being performed at this point in time by FERMI, Hope Creek and Millstone.

Now, from all this we see that the dominant accident initiators, due to internal events, for MARK I's are due to station blackout -- I am on page 11 now -- to ATWS events, and loss of decay heat removal. And we are talking about long-term loss of decay heat removal where, again, you can fail the containment, before core melt. And, again, this is the one that we want to prevent by making sure that the events that are there are very effective and they work properly.

We have seen also from these PRAs that there is wide variation in accident likelihood, close to two orders of magnitude. I have summarized the risk significant containment failure modes from the previous tables. They are the over-pressurization, both before core melt, as well as after core melt, and the containment shell melt-through issue.

Again, from the other indexes that we have

seen from these PRAs, MARK I plants are not risk outliers as a class, but having seen this picture now, we think that based on these insights, further reductions in severe accident risk using a balanced approach involving accident prevention, management and mitigation is possible. And we think and believe that our proposed improvements accomplish this.

COMMISSIONER CARR: Before you leave that one --

MR. SPEIS: Yes, sir.

COMMISSIONER CARR: On the dominant accident initiators, we presumably fixed the first two, or we are fixing them, right? On our blackout and our ATWS?

MR. SPEIS: Yes, we are going a long way in reducing the likelihood of --

COMMISSIONER CARR: They are being taken care of separately from this, we hope.

MR. SPEIS: Yes, there is still residual risk, you know.

COMMISSIONER CARR: Okay.

MR. SPEIS: On page 12 --

(Slide)

Now having summarized the challenges to MARK I containment, and the importance of the failure modes, and which ones are more important, and which ones are

less important, then we have put our program together and, on page 12, the program, as has been said many times already, is a balanced one. It comprises severe accident prevention, which means to reduce the likelihood of an accident occurring; accident management, what things can be done to control the course of an accident, and return the plant into a stable state; and, of course, accident mitigation, to reduce the challenge to the containment and the magnitude of the source term, or the radioactive release to the environment.

I would like now to summarize the staff recommendations.

(Slide)

Number one, accelerate staff actions to implement station blackout rule -- and by that I mean the staff's review of actions leading to the implementation; require alternate water supply for drywell spray and vessel injection with pumping capability independent of normal and emergency AC -- I will discuss each of them separately, shortly -- require hardened venting capability from the wetwell, and should be able to withstand the severe accident pressures. Also, it should include isolation valves which should be remotely operable and independent of normal and

emergency AC.

Require enhanced automatic depressurization system reliability -- and here we are talking of additional power and/or nitrogen supply and also, would like to take a look at the cable reliability.

And, also, require implementation of improved emergency procedure guidelines. And we are talking about REV 4 of the BWR owners group.

These improvements, although not representing large changes to the plan, form an integrated set which, when fully implemented, will substantially enhance defense in-depth, including improvement of containment performance.

I will -- as I said already, I will briefly describe each recommendation separately, so you can see what is involved.

On page 14 --

(Slide)

Getting to the alternate water supply. An important proposed improvement involves the employment of a back-up, or alternate supply of water and a pumping capability, independent of normal and emergency AC power. We are talking about water here could be delivered either into the reactor vessel via the low pressure residual heat removal system, or through

existing drywall sprays via use of appropriate valving arrangements.

I understand a number of plants have done something of that sort already by utilizing existing water supplies and equipment, by using diesel fire pump connections, and so on and so forth.

Ashok can elaborate on this farther if there are questions. Ashok Thadani.

The alternate source of water for injection into reactor vessel reduces the likelihood of core melt, and provides, also, additional in-vessel accident management capability.

Also, the same water which can be used in the containment via the drywell sprays, provide significant mitigation capability to cool the containment environment and also to cool the core debris and, as I already have said, the containment liner itself can, hopefully, prevent or even delay failure and scrub the airborne fission products.

Now, our review of some BWR MARK I facilities indicates that most plants have one or more diesel-driven pumps which could be used to provide an alternate source of water.

Getting to page 16 --

(Slide)

-- the improved venting capability. Dr. Murley elaborated extensively on this. Venting of the containment is currently included in BWR emergency operating procedures. The present vent path, external to existing containment penetrations typically consists of a duct work system which has a low design pressure, and venting at the high pressure severe accident conditions could fail -- would fail the duct work and release the containment atmosphere into the reactor building, and potentially contaminate or damage equipment that could be needed for accident recovery.

Therefore, that is one of the big reasons that we recommend that the use of hard vent of adequate size, of course, to replace the present metal duct to withstand severe accident pressures.

We are talking also here about the vent isolation valves to be remotely operable from the control room, with power supply independent of normal and emergency AC powers.

Implementation of adequate venting procedures can reduce the likelihood of core melt from loss of long-term decay heat removal. And our calculators indicated this has a benefit of about a factor of five and ten. And I would like to stress -- Tom already mentioned that when we talk about venting the

containment, here we are talking about venting almost pure steam. So you are doing this to prevent core melt.

The way it works, you want to make sure that you don't lose the containment suddenly, in a catastrophic way, because if you do that, you can lose net positive suction to the pumps which provide cooling water to the reactor. Here I am talking about the ECCS pumps, for example.

Of course, venting via the suppression pool will scrub non-noble gas fission products prior to release. I should have added on this Vu-graph that, as I have said already, venting also has been estimated to reduce the likelihood of delayed overpressure failure from the interaction of corium and concrete in the basemat.

Getting to the next part of the enhancement packet --

CHAIRMAN ZECH: Before you get off the venting subject -- have you completed your survey of the MARK I containment plants, to -- so you know which ones already do have hardened vents, and which don't?

MR. SPEIS: Tom, do you want to -- Ashok?

MR. THADANI: Yes, sir, we have conducted survey and a small number of plants do have hardened vent, on the order of four or five plants. There is

still some question in terms of the size of the vent. We believe, generally, they are sufficiently large enough to take care of this TW sequence that has been discussed, but the rest of the plants, we don't think have hardened vent paths.

CHAIRMAN ZECH: Okay, so you are going to place this survey and its results into part of your analysis, for really an individual plant type review, to see which plants, perhaps, would need hardened vents, if it is decided to make that modification, is that correct?

MR. SPEIS: Yes, sir.

MR. THADANI: Yes, sir. In fact, if I may add to that, as Mr. Stello indicated earlier, a large number of plants also have alternate means of injecting water. That is part of the proposal. And that's why the approach of plant-specific backfit seems rational, reasonable, it would permit those kinds of considerations to be built in, up front.

CHAIRMAN ZECH: All right. Thank you.

Let's proceed.

DR. MURLEY: One point, Mr. Chairman, I might add, that from the looks that we've made, we are fairly certain that only one plant, that's PILGRIM, has done all of the things that we are proposing here.

MR. THADANI: All of them, that's correct, yes.

CHAIRMAN ZECH: All right, but have you completed your survey, you say, or you are still looking into the survey?

MR. THADANI: We have completed our survey in terms of the information on venting, the hardware, as well as the procedures, implementation procedures and so on. But we do not have total survey results in some other areas, such as alternate injection path and being able to use the sprays and --

CHAIRMAN ZECH: All right, thank you.

Let's proceed.

MR. SPEIS: Getting to page 16 --

(Slide)

-- enhanced automatic depressurization system reliability. The ADS consists of relief valves which can be manually operated to depressurize the reactor cooling system. Now, actuation of the ADS valves requires DC power but, for an extended station blackout, after station batteries have been depleted, or for other reasons, if batteries have been depleted, the ADS would not be available and the reactor would repressurize. So, that's the reason we want to make sure that we have looked at things that can be done to increase the

reliability of the ADS.

The benefits would be it will make sure that we are always able to depressurize and the low pressure water sources then can be utilized to cool the core. Also, by assuring that the primary -- that the vessel is under low pressure, we reduce the likelihood of high pressure melt ejection in event of pressure vessel failure.

Again, the synergism comes here where the water sources can be reliably utilized, if you -- since they are under low pressure conditions, if you are sure that your system is under low pressure.

MR. THADANI: Themis?

MR. SPEIS: Yes?

MR. THADANI: Could I make a comment?

MR. SPEIS: Please?

MR. THADANI: As you recall, one of the options for resolving station blackout was to propose an alternate AC power source. And the Commission, as well as the staff, agreed that was the preferred approach to resolving the station blackout concern.

If licensees were, in fact, to choose such an option to resolve station blackout, it was important to give them this information up front, so that they could utilize the same power source, to be able to operate

these valves, as well. And for that reason, I think, it is good to get this information out fairly early, so they can coordinate those functions.

CHAIRMAN ZECH: All right.

MR. STELLO: If I may, I would like to emphasize the kinds of additional benefits you get from this sort of an approach. You recall that during the Brown's Ferry fire, this was, in fact, the way to cope with keeping the core cool, was they finally found a mechanism to keep the valves open, and then were able to use the low pressure pumps that were part of the feedwater system, to keep the core cool.

So there are additional safety benefits that derive from these kinds of approaches, as part of this package. I am not suggesting that that is the basis for doing it, but there are clearly other benefits that are inherent.

CHAIRMAN ZECH: All right. Thank you.

Let's proceed.

MR. SPEIS: On page 17 --

(Slide)

-- I will say a few things about the emergency procedures and training. A major element in MARK I containment performance improvement program, in both emergency procedures and training, I would -- the EPG's,

of course, as we all know, provide a general logic for taking certain actions and precautions, based upon available information concerning the status of the plant.

For example, venting is called upon in the BWR EPG's REV 4 for containment pressure control and for hydrogen control.

We have recently approved -- NRR has approved Revision 4 to the BWR owners' EPG's. We think they provide significant improvement over the earlier versions. They extend beyond the design basis event, as I already said, by going to venting hydrogen control, and a few other things. And they include many actions which are appropriate for severe accident management.

Of course the EPG's, as I said, they are general guidance, and they have to be reflected in plant-specific emergency operating procedures and the operator training to be effective. The implementation is presently voluntary, and we are talking about here proposing to make it mandatory.

I have finished with the five items. I would like to say a few things about industry efforts. And then I will summarize the benefits of the improvements in the one last Vu-graph.

(Slide)

I am on page 18. I mentioned the first item already, the approval of Revision 4 to the emergency procedure guidelines.

Vermont YANKEE is planning changes during the '89 refueling outage, which includes use of diesel fire pump for decay heat removal; diesel-driven air compressor to the safety relief valves; modification of their emergency operating procedures, and upgrade of their simulator.

As Dr. Murley already has said, PILGRIM has developed a safety enhancement program which includes the items listed here, which already are all the things we talk about in our package --

COMMISSIONER ROBERTS: That's the whole laundry list?

MR. SPEIS: Yes, sir. Yes, sir.

Now, I would like to mention NUMARC because we met with NUMARC on January 12, in an open meeting. I would like to start by saying that back in 1966-- excuse me -- 1986, following the staff's proposed five-element program for MARK I improvements, the BWR owners group informed the staff that they planned to initiate a study to evaluate these improvements.

At that time the staff expected to receive the owners' report and use it as input to its evaluations

and conclusions. The staff also informed the Commission of this effort by the owners' group when they briefed the Commission in July '87, on a plan for closure of severe accident issues.

This report was never provided to the staff. But on January 12, NUMARC, which now represents the industry on this issue, requested to brief us on the findings of this report. So this meeting took place.

The NUMARC presentation dealt mostly with their cost-benefit evaluations of our 1986 five-element program. I think I mentioned this already, but I would like to stress it again that our program at that time was almost exclusively mitigation-oriented. That is, it was focused on consequence reduction, assuming a severe accident had taken already place.

Now, NUMARC concluded in their presentation to us on January 12, that the five-element program that they evaluated was not -- was not -- cost-effective. We asked them a number of questions and we had a discussion for an hour but, based on our discussions with them only, since we have not seen all the bases and the assumptions of their calculations, we can make the following points:

The cost estimates used in the owners' report seems to be in the same range as ours. I will discuss

the cost-benefit analysis that we have done, I will tell you about our cost estimates.

But the risk reduction estimates seem to be based on using one plant as a base with a low core melt probability. In fact, they told us they used the Peach Bottom Plant, Ashok?

MR. THADANI: Yes.

MR. SPEIS: -- versus our cost-benefit, which we have used a range of probabilities based on the total population of MARK I plants.

Also, they seem to have focused their analysis of risk reduction in terms of mitigation only versus the staff's focus on both prevention and mitigation. Also, we believe they have given significantly more credit for the success of core venting procedures for prevention, which we would not have given any credit which, of course, we make that assumption in our regulatory analysis.

Also, it is possible that they have used a lower source term than we have, but we do not know for sure. So, these are some estimates based on the discussions we had. They told us that they will make this report available to us. So we would like to see this report and understand it better, and the basis of their conclusions that the cost-benefits of the five

enhancements that they evaluated are not beneficial.

I would like now to summarize the benefits of improvements, and then say a few things about our cost-benefit calculations.

(Slide)

I am on page 19, I have two more Vu-graphs to go. We think that the proposed improvements, which include the four things -- the hardened vent, the reactor pressure vessel depressurization, the alternate water supply, and the implementation of the procedures -- lead to lower core melt probabilities, reduce the potential for containment failure, and reduce the fission product releases.

The major benefit is reduction in core melt frequency of about a factor of five to ten. I think that's very important.

And a large portion of that reduction is due to improved venting by, of course, assuming that venting is effective and can be implemented. And, of course, this is done by allowing the removal of long-term decay heat from the containment. And, of course, the likelihood of that sequence is reduced substantially.

But accident mitigation is also significant. In addition to reducing the likelihood of this long-term decay heat removal sequence, venting reduces the

potential for containment failure, resulting from slow overpressurization. Venting also via suppression pool provides fission product scrubbing. We have a number of calculations indicate a substantial reduction in the non-noble gases. Also, I mentioned already that -- now, the last item which is also important, which is an integral part of the package, is the water and drywell may cool the debris, delay liner failure and scrub the fission product releases.

In fact, the last two are -- kind of go together, because if you are able to utilize the suppression pool for even four hours, by the help of the water to cool the liner and delay failure, that gives you another factor of ten in source term release.

So with that, again, I want to stress the synergistic benefits of the package which when you look at them in totality, we think, are more important quantitatively than the sum of the parts.

Now, I have one more Vu-graph.

(Slide)

I would like to summarize our cost-benefit results. Cost-benefit involves two parts of the equation, the cost and the benefits. The costs are in terms of the dollars that one has to expend to implement the fixes, and the benefits are in terms of the risk

reduction. And that includes both probability and consequences.

In terms of the cost estimates that we have made, in our regulatory analysis discussed in the Commission paper, we have used two estimates. One of them -- we have done some estimates using our people in the Commission itself, there is a special branch that helps with providing cost estimates. And they gave us figures ranging from $1.6 to $3. million per package.

Also, we have gone to the plant that has done all of these things, and our earlier estimate was that they spent $7.3 million for the package. I understand now that a more thorough evaluation has been made as to that number -- do you want to say something?

MR. BECKNER: We expect it is probably $1 to $1.5 million less than that figure we had in the Commission paper.

COMMISSIONER ROBERTS: But as I understand it, you used that as the high estimate.

MR. SPEIS: Yes, we used the $7.3. We used the $7.3 as the high estimate, but we have scrutinized that estimate, and I understand that number is not 7.3 it could be as low as 5 or 6.

MR. BECKNER: As low as 5 or 6 million.

MR. SPEIS: Five or 6 million.

CHAIRMAN ZECH: You are talking for the whole package?

MR. SPEIS: For the whole package, yes, sir.

CHAIRMAN ZECH: Summarize for me again then, what are the industry estimates and what are your estimates?

MR. SPEIS: Okay. The industry -- our understanding of what PILGRIM spent for the things that are in our package, was up to a few weeks ago, $7.3 million. But, Tom, do you want to say something? Your people have looked at that more carefully, and they think that number is less than that now.

DR. MURLEY: Yes. Just briefly, as you know, their enhanced safety program is a very complex program and broad. And overall, it was $30 million. So, we had to separate out from that those aspects that would bear on this issue.

And we think that the 7.3 million in our initial estimate probably included some analysis and some costs of an added diesel generator, that might not be applicable. So, if anything, it is probably somewhat lower than the 7 million.

MR. SPEIS: But in our analysis, we have used a range varying from 2 million to 7.3 million, okay. So, we have used an average of our low number, 1.6 to

3.1, as well as the high range.

CHAIRMAN ZECH: Thank you.

Proceed.

MR. SPEIS: The other part of the equation is the risk reduction. Now, for purposes of this analysis we have assumed that the core melt probability for the population of the MARK I plants ranges from 10 minus 4 to 10 minus 5. This is based on our evaluation of all MARK I plant PRAs. And our estimate of the contribution of the TW sequence to the total core melt probability, including consideration of the low pressure rated duct work, as part of the containment vent path which, of course, we didn't give much credit.

And, also, we have estimated the contribution -- all the benefits of the station blackout rule.

So, based on those two numbers then, the range of core melt probability, 10 minus 5 and 10 minus 4, and the high and low industry cost, we have the numbers here. And you have to compare these numbers to the thousand man-rem per $1 million, which is kind of the criteria.

So, if I want to summarize, if I get to the low core melt probability 10 minus 5, and the low industry cost, then the ratio is close to two above the guideline. But if we were to use the high industry cost,

then the ratio is a factor of two below the guideline.

If I get to the high core melt probability number of 10 minus 4, and if I use the low industry cost, then the benefit is substantial, it is 29.6 in comparison to the thousand number. And if I use the high industry cost for that high core melt probability, then the cost-benefit is also substantial, it is 4.5.

Now, details of this are discussed in the regulatory analysis, which is provided in the Commission paper.

So, with that, Mr. Chairman, I am through with my presentation.

CHAIRMAN ZECH: Thank you very much.

MR. STELLO: Mr. Chairman, that concludes what we have to say. I would summarize again, the Commission has several approaches, as to how to proceed. We stand by the recommendation that we made to the Commission. And we think the proper approach to use, and the one we would like to go with, is to do it on a case-by-case plant-specific backfitting process, following the Commission's regulation 50-109.

CHAIRMAN ZECH: All right, thank you very much.

Questions, my fellow Commissioners? Commissioner Roberts?

COMMISSIONER ROBERTS: I have a number of questions, but I will reduce them to writing. And I would appreciate your response.

Let me make a comment. We've just recently been briefed on the IPE. We just this week heard about the accident management program. We've got the station blackout rule in place. It looks to me, Vic, the staff is using a shotgun, but not a single slug like you would use hunting deer. But this is bird shot.

And when we've got all these parallel things going out that relate, and inter-relate.

MR. STELLO: And that is what --

COMMISSIONER ROBERTS: And I see all sorts of conflicts between the station blackout rule and this particular issue. You clearly say, "To improve venting and the depressurization system requires more power".

MR. STELLO: But this is one of the reasons we would like to get this out and on with, in part --

COMMISSIONER ROBERTS: Why can't all of these things be addressed in the IPE?

MR. STELLO: Well, you remember when we came to the Commission with the integrated severe accident management plan, we identified these particular paths that we thought were appropriate to follow, and went through how we intended to proceed. With the IPE being

focused on specific plant vulnerabilities, we've tied and coupled how you would integrate severe accident management. We identified the issues that were generic issues that the Commission asked us to look at, vis-a-vis containment. And have those, in fact, be integral with, and tied to the IPE.

And the chart that we have in the Commission package attempts to show you how to tie those two things together.

If you try to put them all in there, I think you are just going to burden that process, and detract from its original purpose, which is plant-specific vulnerabilities.

But I think it is important -- and you are right -- to get as many of these things on the table as we can, if --

COMMISSIONER ROBERTS: I don't take issue with that.

MR. STELLO: If the example that we've talked about, that was mentioned, if in proceeding with station blackout, they do elect to put in another power supply system, that clearly makes

COMMISSIONER ROBERTS: That's all.

MR. STELLO: -- part of this problem very quickly, and it would -- that's another reason we are

plant-specific backfitting. I think some plants may elect to do that, others may not, which is, again, another reason for wanting to take that approach.

COMMISSIONER ROBERTS: That's all I have.

CHAIRMAN ZECH: Thank you.

Commissioner Carr?

COMMISSIONER CARR: I only have a small detail question. On page 8 of the paper, at the bottom of the page, it talks about this station blackout and electrical power issue. And on the top of page 9 it says that "it is coordinated with the requirements of the SBO rule in order not to cause an undue proliferation of power supplies, which could be counter-productive to safety."

How about explaining to me why that is counterproductive to safety, to proliferate power supplies?

MR. THADANI: The intention here was to get this information out front, such that the industry, the licensees, could make a proper selection of the size of the alternate power source, not only to take that into account, as well as to focus in and implement similar requirements that they would have to implement for station blackout rule.

And it was from that perspective, it was

believed it was important that we encourage the industry to look at this issue, in conjunction with their requirements that they develop, to meet the station blackout rule.

That was really the focus.

COMMISSIONER CARR: I don't have any argument with that. I just got a little concerned why two power supplies is more unsafe than one, or --

MR. THADANI: No, no, it was --

MR. BECKJORD: I think it has to do with the specific design of the switch gear, not with the fact that there was another power supply. If the switch gear could cause a problem, I think that is what you are talking about.

COMMISSIONER CARR: Well, in line with that, I notice that -- if I remember the SBO rule, it requires -- perhaps would require additional AC power supplies. And I notice in your enhanced ADS reliability it says additional DC power sources.

MR. THADANI: The intention -- one could clearly utilize an AC power source to charge one of the batteries. That could be an approach one could utilize.

COMMISSIONER CARR: Well, but you have lost the batteries. And that's why we need this additional power supply, I thought.

MR. THADANI: One of the things one could, in fact, do here, is not to get to the stage of losing the batteries. You lose AC power. Batteries have capacity, they can go on for several hours, and then be able to utilize one of the existing DC sources. Charging one of the batteries, perhaps, would be an option.

COMMISSIONER CARR: Okay.

CHAIRMAN ZECH: Thank you.

Commissioner Rogers?

COMMISSIONER ROGERS: Well, there was just one thing I thought I would like to understand just a little bit better, on page 10 of your presentation, not the SECY. Basemat melt-through interaction, you are listing as of no risk importance.

What is the basis on which you come to that conclusion? And what is the relationship of the research that has been going on in Germany on this matter, and our thinking here on MARK I designs?

MR. SPEIS: Well, in this context, Commissioner Rogers, we are talking about a failure mode that takes a long time. You know, you are talking about penetrating the concrete. And, also, if that is the only path to the atmosphere, you know, you have the filtering effect. So in terms of consequences to the

public, it is very small in comparison to the other failure modes.

Now, we have followed very closely the work in Germany, in terms of the corium/concrete interaction, you know, the large-scale experiments. And we have used, in fact, those experiments to check some of our codes. And we have a very close cooperation between them -- but in this context, it is --

COMMISSIONER ROGERS: But didn't they come to some conclusion that you needed something like 10 meters of basemat to be safe?

MR. SPEIS: Gee, I don't recall that. I don't --

VOICE: I don't think so.

MR. STELLO: We can get the answer.

MR. SPEIS: Yes, we can get the answer.

COMMISSIONER ROGERS: I have nothing else.

CHAIRMAN ZECH: Commissioner Curtiss?

COMMISSIONER CURTISS: Just a couple of quick questions. On the proposal to go out with an order, if all the licensees requested hearing on the order, would that tip the balance, in your view, towards doing this deregulation?

MR. STELLO: No.

COMMISSIONER CURTISS: And is that based upon

an assumption of how long a hearing would take, or is there a point beyond which it makes sense to do it, in view of the response that you get from the industry?

MR. STELLO: I think that the benefits to be derived with the case-by-case evaluation of coming up with the best solutions, by having the ability to deal with this issue, and discuss with the licensee the particular things that are the best way to solve the problem on those plants outweigh the potential problem I would see with a hearing.

I would be perfectly content to deal with that, at the risk of having the benefit of the face-to-face, sit down, discuss and arrive at the best answers on that.

COMMISSIONER CURTISS: Just sort of a technical question on the order itself. One of the requirements here that you ask the licensees to address is how you prevent inadvertent actuation of the venting system. How do you do that? What does the staff envision to address that issue?

MR. STELLO: Well, there are a classical number of ways that you can probably assure you don't get inadvertent actuation, you can put covers over the switches, locks and keys, and that kind of a thing.

COMMISSIONER CARR: Rupture disk --

MR. STELLO: Rupture disk.

COMMISSIONER CURTISS: They are the kinds of things that PILGRIM has done with their system?

MR. STELLO: I don't know, what did they use, rupture disk?

MR. THADANI: PILGRIM used rupture disk. That certainly is one way. There might be other options.

COMMISSIONER CURTISS: A quick question on the cost estimates. Do we have any experience from what other countries have done on the venting issue and, if so, any direct knowledge about the cost?

MR. STELLO: We are the leading edge on this issue.

COMMISSIONER CURTISS: One last question --

COMMISSIONER CARR: Except for filter venting, right?

MR. STELLO: Oh, except for the big dries that are using -- on the big dries they have incorporated filter vents, but to the best of my knowledge, no other foreign countries have taken this approach with the BWR's, except Dubarsebek (phonetic) which built in a huge additional building, which is a completely different approach.

COMMISSIONER CURTISS: One final question. Do you have a feel yet for when we will get the NUMARC

report, and when you will have a chance to look at it, and give us an assessment on the differences of the assumptions?

DR. MURLEY: We have the NUMARC, actually, it is a set of briefing slides. We have that. And I don't know, if we have made it available, but we will certainly do that.

MR. STELLO: We will find out. We haven't been given a date, we will get it and give it to you.

COMMISSIONER CURTISS: I had a number of notes here about questions that we appeared to have -- that led to the assumptions in our analysis on the range of plants used, and the lower source terms that they may have used. And I guess I would like to see --

MR. STELLO: Okay, we will get the report-- we will try to get it, and if we get the report, we will get it right to you.

COMMISSIONER CURTISS: Thank you. That's all.

MR. SPEIS: I speculated on summary, based on discussions we had for an hour, and sometimes it is not fair to speculate. We would like to see the report.

MR. STELLO: We will try to get the report and get it to you.

COMMISSIONER CURTISS: Thank you. That's all I have.

CHAIRMAN ZECH: Thank you.

It seems to me that, if I understand what your approach is, that imposing a plant-specific requirement on the basis of what I understand is a generic analysis -- I just -- I just question the appropriateness of that kind of an approach. And it seems to me that you have to analyze the requirements on a very specific plant-specific basis.

And so I -- will you give us the rationale you have used for the generic type of approach you have taken?

MR. STELLO: Well, we presented the generic, but when we go to plant-specific, the analysis will be plant-specific. The cost-benefit analysis, as you recall, that is required pursuant to the Commission's regulations.

CHAIRMAN ZECH: That would seem --

MR. STELLO: That would be a plant-specific cost-benefit analysis.

CHAIRMAN ZECH: Well, it seems to me that you are really going into the IPE-type approach.

MR. STELLO: I would think it is close to that, but I -- not in the context of the ACRS --

COMMISSIONER CARR: Well, it looks to me like he has pulled this to the front of the IPE, you know,

going out and say, "Do this now". Keep on with the IPE.

CHAIRMAN ZECH: These things are pulled out of the IPE program, but I guess my concern is that -- just to make sure I understand you, you are emphasizing it on a plant-specific basis.

MR. STELLO: Yes, sir.

CHAIRMAN ZECH: Even though you are analyzing it generically, is that correct?

MR. STELLO: We've analyzed generically --

CHAIRMAN ZECH: And then you go look at it plant-specific, is that correct?

MR. STELLO: That's correct. Yes.

CHAIRMAN ZECH: All right.

Well, I guess my comment would be concerning the whole approach that is being taken, is that it is awfully important that we end up making the right decision on this. As I have said before, we are trying to improve safety, and I think you have emphasized that these plants are safe now, they are operating safely.

So it is appropriate that we consider the -- improving safety, that we involve ourselves in the backfit program, and in the cost-benefit analysis. So, we are trying to improve safety, that's what we are about, is that correct?

MR. STELLO: Yes, sir.

CHAIRMAN ZECH: And, therefore, it seems to me that if we are doing that, we need to take the time to make sure we are making the right decision. And I think it would be appropriate for the Commission to hear from the advisory committee on reactor safeguards, if my colleagues would agree with me.

COMMISSIONER ROBERTS: I would agree with that.

CHAIRMAN ZECH: I will arrange to set up a meeting, a public meeting, with the advisory committee on reactor safeguards at some early date.

Also, I guess I would only conclude by thanking the staff for the efforts that they have undertaken. I think this is a very, very important program. We are making decisions that the intent is to improve safety, and not detract from safety. That is, I think, the essence of what is taking the staff considerable time, to make sure that we are going to do that.

And I fully approve your approach to do this analysis on a plant-specific basis. So, we will involve the utilities themselves, and the staff, on a careful analysis, before we have to make a decision on any of these items that you have made, but I think it is a very responsible action to take. I hope we will take the

time we need to do it correctly.

And that doesn't mean that we should not continue the analysis and the effort that you have put forth, but in my judgment it means the most important thing is to make sure we take the time we need. And when we make the decision, that we are confident that we are improving safety, and not detracting from safety.

Those are, I think, at least from my standpoint, a very important part of the consideration that we are bringing to this effort.

Are there any other comments from my fellow Commissioners?

Yes, Commissioner Carr?

COMMISSIONER CARR: I don't see anything in here that looks like it would require a plant shutdown, other than normal refueling, to do -- I mean, they can do all of the work and then hook it up, whenever they are shutdown for other reasons?

MR. STELLO: That's our judgment.

COMMISSIONER CARR: So there is no reason that we have to shut them down, to do this --

MR. STELLO: Oh, no, by all means. In fact, that would definitely sway the cost-benefit to go in the other direction.

COMMISSIONER ROBERTS: Isn't that debateable?

MR. STELLO: No, I don't think so.

COMMISSIONER ROBERTS: No question about it. It can be done --

MR. STELLO: I will give you my judgment --

COMMISSIONER CARR: It looks to me like it could.

MR. STELLO: I believe that all of the plants could accommodate the modifications during a normal refueling outage, that time frame. Because a lot of this can be done during operation.

CHAIRMAN ZECH: Any other comments?

(No response)

CHAIRMAN ZECH: Thank you very much for an excellent presentation.

We stand adjourned.

(Whereupon, at 11:30 a.m., the meeting was adjourned)

CERTIFICATE OF TRANSCRIBER

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

TITLE OF MEETING: BRIEFING ON FINAL REPORT ON BWR MARK I CONTAINMENT ISSUES
PLACE OF MEETING: ROCKVILLE, MARYLAND

DATE OF MEETING: JANUARY 26, 1989

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

Phyllis Young

Reporter's name: _____
(if other than transcriber)

COMMISSION BRIEFING

BWR MARK I CONTAINMENT PERFORMANCE IMPROVEMENT PROGRAM

THEMIS P. SPEIS, RES
THOMAS E. MURLEY, NRR
JANUARY 26, 1989

BRIEFING OUTLINE

- BACKGROUND
- SEVERE ACCIDENT PROGRAM
- CONTAINMENT PERFORMANCE IMPROVEMENTS PROGRAM OBJECTIVES
- CHALLENGES TO MARK I CONTAINMENTS
- MARK I CONTAINMENT FAILURE MODES
- PRA INSIGHTS FOR BWR'S
- STAFF'S APPROACH TO MARK I IMPROVEMENTS

BRIEFING OUTLINE
CONTINUED

- SUMMARY OF STAFF RECOMMENDATIONS
  - ALTERNATE WATER SUPPLY
  - IMPROVED VENTING CAPABILITY
  - ENHANCED ADS RELIABILITY
  - EMERGENCY PROCEDURES AND TRAINING
- INDUSTRY EFFORTS
- BENEFIT OF IMPROVEMENTS
- COST-BENEFIT RESULTS

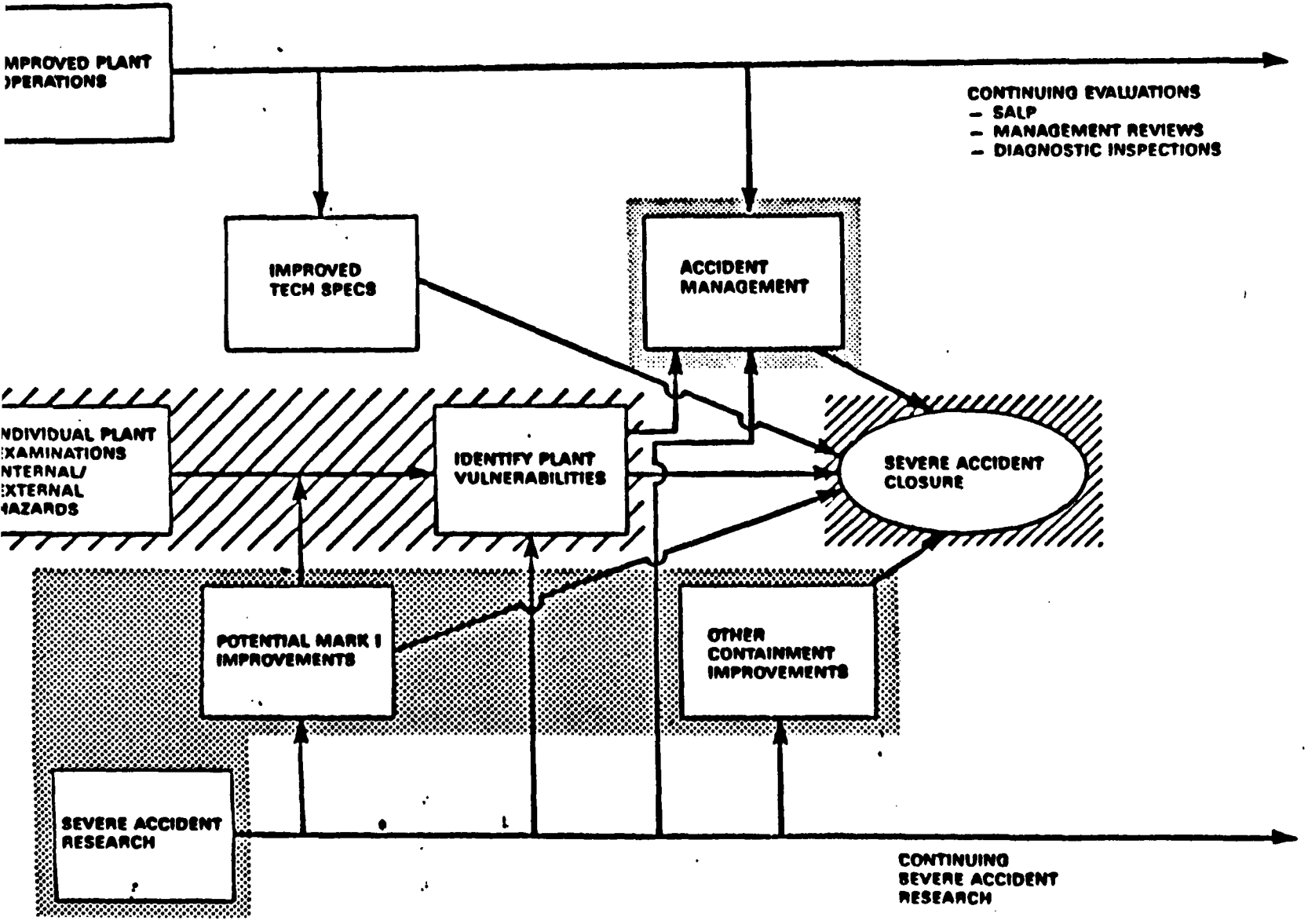
BACKGROUND

- JUNE 1986, STAFF PROPOSED 5 ELEMENT PROGRAM FOR MARK I CONTAINMENT PERFORMANCE ENHANCEMENT
- JUNE-JULY 1987, TWO LICENSEES INFORMED THE STAFF OF THEIR INTENTION TO INVESTIGATE CONTAINMENT AND SAFETY ENHANCEMENT
- JULY 1987, STAFF BRIEFED COMMISSION ON A PLAN FOR CLOSURE OF SEVERE ACCIDENT ISSUES
- DECEMBER 1987, "MARK I CONTAINMENT PERFORMANCE PROGRAM PLAN" (SECY-87-297)
- FEBRUARY 24-26, 1988, WORKSHOP ON MARK I ISSUES
- MAY 1988, "INTEGRATION PLAN FOR CLOSURE OF SEVERE ACCIDENT ISSUES" (SECY-88-147)
- JULY 1988, "STATUS OF MARK I CONTAINMENT PERFORMANCE EVALUATION" (SECY-88-206)

BACKGROUND
CONTINUED

- DECEMBER 6, 1988, ACRS SUBCOMMITTEE ON CONTAINMENT SYSTEMS
- DECEMBER 14, 1988, CRGR REVIEW
- DECEMBER 15, 1988, ACRS FULL COMMITTEE REVIEW
- JANUARY 11, 1989, CRGR REVIEW
- JANUARY 13, 1989, ACRS FULL COMMITTEE REVIEW

FIGURE 1
SEVERE ACCIDENT PROGRAM - SCHEMATIC



CONTAINMENT PERFORMANCE IMPROVEMENT PROGRAM

- OBJECTIVE:

  DETERMINE WHAT ACTIONS, IF ANY, SHOULD BE TAKEN TO REDUCE VULNERABILITY OF CONTAINMENTS TO SEVERE ACCIDENT CHALLENGES

- STAFF EFFORTS FOCUSED INITIALLY ON MARK I'S

- OTHER CONTAINMENT TYPES TO BE ADDRESSED, AS WELL

BWR MARK I
CONTAINMENT CHALLENGES

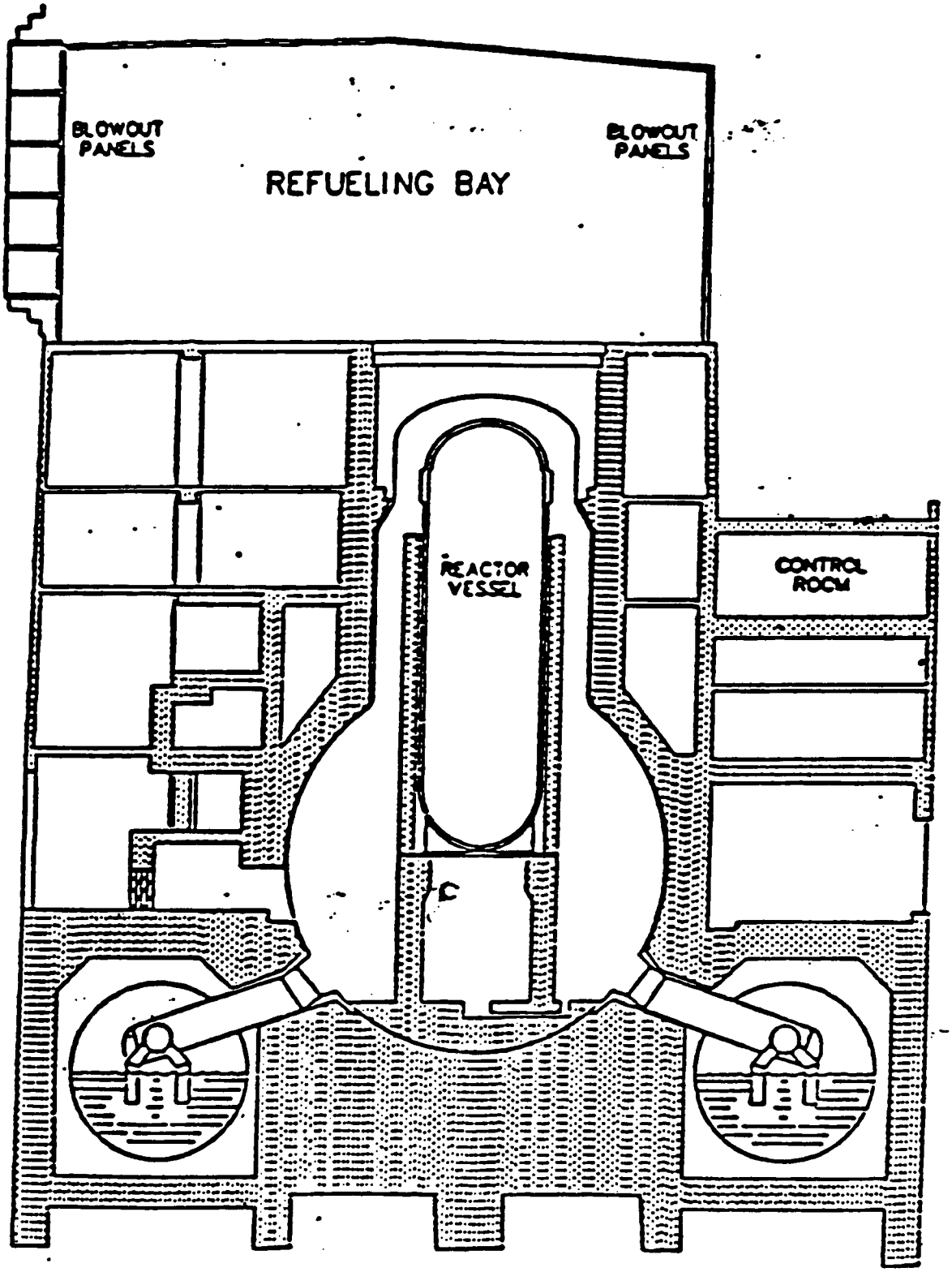
- CONTAINMENT COULD BE CHALLENGED BY LARGE SCALE CORE MELT, PRINCIPALLY DUE TO SMALLER SIZE
- SEVERAL EARLY CONTAINMENT FAILURE MODES IDENTIFIED

BUT, MUST EMPHASIZE THAT

- BWR MARK I PLANTS ARE NOT RISK OUTLIERS AS A CLASS, AND
- UNCERTAINTIES REMAIN IN ESTIMATING CONTAINMENT FAILURE, ESPECIALLY VIA DRYWELL SHELL (LINER) MELT-THROUGH

LOCATION OF THE MK I PRIMARY CONTAINMENT WITHIN THE SECONDARY CONTAINMENT (REACTOR BUILDING)

ORNL-DWG 82-5181 ETD



FAILURE MODES IN MARK I CONTAINMENTS

FAILURE MODE		RISK IMPORTANCE
1. OVERPRESSURIZATION: LEADING TO CORE DAMAGE (I.E., CONTAINMENT FAILURE BEFORE CORE MELTING)	OVERPRESSURIZATION	YES+
2. STEAM EXPLOSION:	MISSILE	NO
3. FAILURE TO ISOLATE•		NO
4. HYDROGEN BURN/DETONATION		NO
5. OVERPRESSURIZATION: INTERACTION PLUS STEAM)	(CORIUM/CONCRETE	YES
6. OVERTEMPERATURE: INTERACTION)	(CORIUM/CONCRETE	YES

• MITIGATION FEATURES ARE INEFFECTIVE AGAINST THESE FAILURES THEIR PROBABILITY CAN BE REDUCED BY PROCEDURAL/ DESIGN CHANGES.

+ IN THE ABSENCE OF WETWELL VENTING.

FAILURE MODES IN MARK I CONTAINMENTS cont'd

FAILURE MODE	RISK IMPORTANCE
7. BASEMAT MELT-THROUGH: (CORIUM/CONCRETE INTERACTION)	NO
8. CONTAINMENT SHELL (STEEL LINER) MELT-THROUGH	VARI••
9. INTERFACING LOCA: (CONTAINMENT BYPASS)•	NO

- • MITIGATION FEATURES ARE INEFFECTIVE AGAINST THESE FAILURES THEIR PROBABILITY CAN BE REDUCED BY PROCEDURAL/ DESIGN CHANGES.
- •• DEPENDS ON VESSEL FAILURE MODE, CORIUM'S ABILITY TO FLOW TO AND MELT THROUGH THE LINER, ESPECIALLY IN THE PRESENCE OF WATER.

PRA/ENGINEERING ANALYSIS INSIGHTS FOR BWR'S

- DOMINANT ACCIDENT INITIATORS (INTERNAL) ARE:
  - STATION BLACKOUT (SBO)
  - ATWS
  - LOSS OF DECAY HEAT REMOVAL (TW)♦ (CONTAINMENT FAILURE BEFORE CORE MELT)
- WIDE VARIATION IN ACCIDENT LIKELIHOOD
- RISK SIGNIFICANT CONTAINMENT FAILURE MODES
  - OVERPRESSURIZATION
  - CONTAINMENT SHELL (STEEL LINER) MELT-THROUGH
- BWR MARK I PLANTS ARE NOT RISK OUTLIERS AS A CLASS
- FURTHER REDUCTIONS IN SEVERE ACCIDENT RISK VIA BALANCED APPROACH INVOLVING ACCIDENT PREVENTION, MANAGEMENT, MITIGATION POSSIBLE; PROPOSED IMPROVEMENTS ACCOMPLISH THIS

♦ IN THE ABSENCE OF WETWELL VENTING

STAFF APPROACH

BALANCED APPROACH
TO
REDUCE OVERALL RISK

ACCIDENT PREVENTION
REDUCE THE LIKELIHOOD OF AN ACCIDENT OCCURRING

ACCIDENT MANAGEMENT
CONTROL THE COURSE OF AN ACCIDENT AND RETURN PLANT TO STABLE STATE

ACCIDENT MITIGATION
REDUCE THE CHALLENGE TO CONTAINMENT AND THE MAGNITUDE OF RADIOACTIVE RELEASES TO ENVIRONMENT

SUMMARY OF STAFF RECOMMENDATIONS FOR MARK I

- ACCELERATE STAFF ACTIONS TO IMPLEMENT STATION BLACKOUT RULE
- REQUIRE ALTERNATE WATER SUPPLY FOR DRYWELL SPRAY/VESSEL INJECTION WITH PUMPING CAPABILITY INDEPENDENT OF NORMAL AND EMERGENCY AC.
- REQUIRE HARDENED VENTING CAPABILITY FROM WETWELL (ABLE TO WITHSTAND SEVERE ACCIDENT PRESSURES).
  ISOLATION VALVES TO BE REMOTELY OPERABLE INDEPENDENT OF NORMAL AND EMERGENCY AC.
- REQUIRE ENHANCED ADS RELIABILITY. ADDITIONAL POWER AND/OR NITROGEN SUPPLY AND CABLE RELIABILITY.
- REQUIRE IMPLEMENTATION OF IMPROVED EPG'S (REV. 4 OF BWROG).

ALTERNATE WATER SUPPLY

- ALTERNATE SUPPLY OF WATER PLUS PUMPING CAPABILITY INDEPENDENT OF NORMAL AND EMERGENCY AC POWER
- WATER DELIVERY AVAILABLE EITHER INTO REACTOR VESSEL (VIA RHR SYSTEM) OR TO DRYWELL SPRAYS
- ALTERNATE SOURCE OF WATER FOR INJECTION INTO REACTOR VESSEL REDUCES LIKELIHOOD OF CORE MELT AND PROVIDES ADDITIONAL IN-VESSEL ACCIDENT MANAGEMENT CAPABILITY
- WATER FOR DRYWELL SPRAY PROVIDES SIGNIFICANT MITIGATION CAPABILITY TO COOL CORE DEBRIS, COOL CONTAINMENT LINER, AND SCRUB AIRBORNE FISSION PRODUCTS

IMPROVED VENTING CAPABILITY

- VENTING CURRENTLY INCLUDED IN BWR EMERGENCY OPERATING PROCEDURES
- HARD PIPE VENT WOULD REPLACE PRESENT SHEET METAL DUCT TO WITHSTAND SEVERE ACCIDENT PRESSURES
- VENT ISOLATION VALVES TO BE REMOTELY OPERABLE FROM CONTROL ROOM
- IMPLEMENTATION OF ADEQUATE VENTING PROCEDURES CAN REDUCE LIKELIHOOD OF CORE MELT FROM LOSS OF LONG-TERM DECAY HEAT REMOVAL (FACTOR OF FIVE TO TEN)
- VENTING VIA SUPPRESSION POOL WILL SCRUB NON NOBLE GAS FISSION PRODUCTS PRIOR TO RELEASE

ENHANCED ADS RELIABILITY

- TO INCREASE RELIABILITY, ADDITIONAL DC POWER SOURCE NEEDED
  - MAY NEED ADDITIONAL NITROGEN SUPPLY
  - NEED TO REVIEW CABLE PERFORMANCE
- BENEFITS
  - WITH ENHANCED ADS RELIABILITY, AN ADDITIONAL SOURCE OF LOW PRESSURE WATER INJECTION BECOMES AVAILABLE FOR CORE COOLING
  - LOW REACTOR PRESSURE REDUCES LIKELIHOOD OF HIGH PRESSURE MELT EJECTION IN EVENT OF PRESSURE VESSEL FAILURE

EMERGENCY PROCEDURES AND TRAINING

- MAJOR ELEMENT IN MARK I CONTAINMENT PERFORMANCE IMPROVEMENT PROGRAM.
- STAFF RECENTLY APPROVED REV. 4 OF BWROG EPG'S. SIGNIFICANT IMPROVEMENT OVER EARLIER VERSIONS. NEW EPG'S EXTEND WELL BEYOND DESIGN BASIS EVENTS, INCLUDE MANY ACTIONS APPROPRIATE FOR SEVERE ACCIDENT MANAGEMENT.
- IMPROVEMENT IN EPG'S HAS TO BE REFLECTED IN PLANT SPECIFIC EOP'S AND IN OPERATOR TRAINING. IMPLEMENTATION PRESENTLY VOLUNTARY. PROPOSE TO MAKE MANDATORY.

INDUSTRY EFFORTS

- NRC STAFF RECENTLY APPROVED REVISION 4 TO THE EPG'S, PROPOSED BY BWROG. THESE INCLUDE VENTING OF CONTAINMENT.
- VERMONT YANKEE PLANNING CHANGES DURING 1989 REFUELING OUTAGE, INCLUDING:
  - USE OF DIESEL FIRE PUMP FOR DECAY HEAT REMOVAL
  - DIESEL DRIVEN AIR COMPRESSOR TO SRV'S
  - MODIFICATION OF EOP'S
  - UPGRADE OF SIMULATOR
- PILGRIM HAS DEVELOPED A SAFETY ENHANCEMENT PROGRAM WHICH INCLUDES:
  - HARD PIPE VENT FROM TORUS TO STACK
  - THIRD ONSITE DIESEL GENERATOR
  - BACKUP NITROGEN SUPPLY FOR ADS AND MAINTAINING CONTAINMENT INERTED
  - USE OF FIRE PROTECTION DIESEL PUMPS FOR DECAY HEAT REMOVAL

BENEFIT OF IMPROVEMENTS

- PROPOSED IMPROVEMENTS LEAD TO LOWER CORE MELT PROBABILITIES, REDUCE POTENTIAL FOR CONTAINMENT FAILURE AND REDUCE FISSION PRODUCT RELEASES
- MAJOR BENEFIT IS REDUCTION IN CORE MELT FREQUENCY OF ABOUT A FACTOR OF FIVE TO TEN
- LARGE PORTION OF CORE MELT REDUCTION DUE TO IMPROVED VENTING
- ACCIDENT MITIGATION ALSO SIGNIFICANT
  - VENTING REDUCES POTENTIAL FOR CONTAINMENT FAILURE RESULTING FROM SLOW OVERPRESSURE
  - VENTING VIA SUPPRESSION POOL PROVIDES FISSION PRODUCT SCRUBBING
  - WATER IN DRYWELL MAY COOL DEBRIS, DELAY LINER FAILURE AND SCRUB FISSION PRODUCT RELEASES

COST-BENEFIT RESULTS
(MAN-REM AVERTED PER MILLION DOLLARS)

LOW CORE MELT PROBABILITY PLANT (TW•10-5)	
LOW INDUSTRY COSTS•	1,970
HIGH INDUSTRY COSTS••	500
HIGH CORE MELT PROBABILITY PLANT (TW•10-4)	
LOW INDUSTRY COSTS•	29,600
HIGH INDUSTRY COSTS•••	4,570

• LOW INDUSTRY COST IS ESTIMATED TO BE $48 MILLION
•• HIGH INDUSTRY COST IS ESTIMATED TO BE $176 MILLION
••• INCLUDES AVERTED ON-SITE COST OF CLEANUP, REPAIR AND REPLACEMENT POWER