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NUCLEAR REGULATORY COMMISSION

In the matter of:

ADVISORY COMMITTEE ON REACTOR SAFEGUARDS

304th General Meeting

(Public Session)

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UNITED STATES OF AMERICA

NUCLEAR REGULATORY COMMISSION

ADVISORY COMMITTEE ON REACTOR SAFEGUARDS

304th GENERAL MEETING

- - -

OPEN SESSION

- - -

Thursday, August 8, 1985

Room 1046

1717 H Street, N.W.

Washington, D.C.

The Advisory Committee on Reactor Safeguards met in Open Session, pursuant to notice, at 8:35 a.m., David Ward [Chairman of the Committee] presiding.

ACRS MEMBERS PRESENT:

D. Ward	H. Lewis
J. Ebersole	D. Moeller
W. Kerr	M. Carbon
H. Etherington	G. Reed
C. Wylie	F. Remick
C. Mark	C. Siess
P. Shewmon	R. Axtmann

ACRS STAFF MEMBERS PRESENT:

Raymond Fraley	Norman Schwartz
Richard Majors	

SPEAKERS:

B. Bernero	D. Scaletti
C. Thomas	G. Sherwood
D. Hankins	D. Foreman
T. Pratt	J. Yeazell
N. Anderson	H. Booher
T.Y. Chang	F. Schroeder
G. Bagchi	Mr. Hernan
J. Thomas	G. Cwalina
J. Jankovich	D. Brinkman
D. Persinko	

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P R O C E E D I N G S

MR. WARD: We will go ahead now with Agenda Item No. 2, GESSAR-II report, and Mr. Ebersole.

MR. EBERSOLE: Thank you.

GESSAR-II Subcommittee met yesterday, in the absence of David Okrent, and I'm sure you all know how impossible it is to replace him; however, I am giving it a try.

We had a lengthy discussion right on up through today. I refer you to Tab 2. The various topics we took up, mainly we were following up Supplement 4 of the SER, and I am just going to briefly mention some of the topics there that we did.

The first topic we will, in fact, take up for the first time today is discussion by the Staff, by Mr. Bernero, about core melt frequency, et cetera, and the guidelines or the performance criteria for the review of the new standard plant, with some expression of what are the Staff goals.

We went into the SSER No. 4 and looked at the outstanding issues, and again, I noted that when issues are resolved, they disappear, and I think that is unfortunate. So we pumped up a few and amplified them, and I intend today to take the liberty of expanding the fourth topic, which is security considerations, which is going to be very brief because there are not many, and include within that some

portion of the Staff consideration of G.E.'s offer for numerous potential design improvements, of which a few have been adopted and are firm now in the design, and the extensions of the concepts that are being offered, such as seismic capability of the UPPS system.

We have here -- perhaps one of the more important topics is a detailed discussion of hydrogen and the scrubbing efficiency of the pool and the hot and cold condition. You can see on page 2 of the agenda yesterday we took up the matter of detonation in some detail, if one wants to pick further discussion on that.

Mainly, however, I think that the more interesting aspects of this stage of the GESSAR-II design is looking at the potential design improvements, which of these have been adopted -- there are very few -- have been adopted out of a great list that was prepared by G.E., and I would like to suggest some discussion of the cost basis on which they were and were not adopted.

These were considered solely on the basis of reduction of the dose guideline of $1000 per man rem and did not include consideration of on-site averted cost, which might have made some of these alterations and improvements more attractive had that been done.

My understanding is this is in a Never-Never Land state of resolution now, and I think we ought to take it up

before we really lock up GESSAR-II to see whether we can justify extensions in characteristics of some of the offered features or perhaps some others which were not considered because of these costs.

As you all know, it is very difficult to get a design improvement identified against simply the criterion of the $1000 per man rem.

With that, unless there are other contributions from other members of the subcommittee, which was Carson Mark and Mr. Etherington and Charlie Wylie, I am going to turn this over first to the Staff.

MR. KERR: Mr. Ebersole, I could get the impression from your comments on cost-benefit analysis that you have the impression that this committee has a firm position on that, it seems to me.

MR. EBERSOLE: No.

MR. KERR: It seems to me that might not be the case.

MR. EBERSOLE: No. I think it is a floating matter, but I would just point out I am sure certain improvements were not adopted because of the limitations of this $1000 per man rem basis.

I turn it over to the Staff.

MR. BERNERO: I would like to take advantage of my infrequent appearances down here to get up at the podium.

For the record, I would like to say I am Bob Bernero, Director of the Division of Systems Integration in the Nuclear Reactor Regulation Office, and I am happy to say that in a short time, I will be the Director Boiling Water Reactor Licensing, so I have a dual interest in the GESSAR-II evaluation since I expect I will be living with it for a good period of time, as well as having participated in some substantial measure in the conduct of the review.

It was said by the Chairman just before you started as part of the housekeeping announcements that the Commission is releasing the Severe Accident Policy Statement. I think it is fortuitous but interesting that it is today it will appear in the Federal Register.

For your information, you may stumble for a moment, not recognizing it when it appears. It is actually a dual notice. At the last minute it had to be changed editorially so that one notice withdraws the October 1980 degraded core rulemaking or severe accident rulemaking, and legally that is one thing; and then the other thing published back to back with it is the severe accident policy statement, with which you are familiar from very long review.

Now, that policy statement, as you know, emphasizes attention to future plants such as GESSAR-II but also covers existing plants, and in essence, the policy statement has the Commission saying, from what we know today, the level of

technology and safety associated with light-water reactors is safe enough, with conditions, and those conditions are quite significant, and we are discussing some of them on this one future plant, GESSAR-II, today.

The conditions for the existing plants are also well known to you because that is the focus, to great measure, of what we are doing with IDCOR, where we are looking at the population of 120 or so existing plants and saying by what means can we systematically and efficiently and effectively evaluate severe accident risk in those plants so that we can discover and suppress outliers.

We generally speak of outliers as those accident vulnerabilities, severe accident vulnerabilities that stand out from an acceptable background level that would be higher than desirable, or perhaps even higher than tolerable.

That process was done in one case, certainly, at Indian Point, exhaustively over a period of many years, with hearing, and that was far from perfect and certainly a very expensive and ponderous way to do it. We are looking for a much more efficient way.

For future plants, the severe accident policy statement is much more explicit, and we have been trying to do the General Electric GESSAR-II review in parallel with the development and promulgation of that policy statement, and it basically lays out criteria by which you first and foremost

take the existing regulations in their latest form, look carefully at the plant and get that behind you, satisfy yourself that this future plant is going to satisfy the regulations in all respects; then you take in serial order the unresolved safety issues, generic safety issues and the like, and I always regret that the severe accident policy statement is, if anything, glib in saying to resolve them, to address them and resolve them.

That is a very difficult thing to do. It is a far different thing to address and resolve station blackout on the GESSAR-II than it is to resolve or address and resolve A-29 on safeguards. We are intellectually limited on some of them, and it is a rather difficult thing to speak dispositively, to say, oh, yes, we have addressed that and resolved it.

But nevertheless, it is incumbent on us to look at these plants in order to do that, to take the information base we have, to address the plants to the extent that we can and have that as part of our overall safety judgment in saying this future plant is acceptable for future licensing, for referenceability in FDA as we speak of it now, or even if we go in that direction, if G.E. chooses, in the not-too-distant future to even certify this design by rulemaking through the Commission, 10 CFR 50, Appendix O, which has been on the books for ten years now.

Now, the last condition and the one that raises a

great deal of controversy and difficulty in the future plant review is the use of the PRA, which is, as it should be, a systematic way to display what we understand about the safety of this plant, the vulnerability of this plant, and determine what is worth doing. What refinements of design, what addenda, what alterations are appropriate, are justifiable in light of the severe accident risk of this plant and the overall cost or cost-benefit of such change.

Now, we have here with GESSAR-II the first real example of this in the regulatory process, and it differs from the usual review in a very significant way, and I invite your attention on this difficult part of it, which is not does this plant satisfy the regulations or not, is this plant sufficient, does this meet GDC X, Y or Z. No, the issue here is have we gone far enough? Are we satisfied that we have turned over all the stones?

Now, the Commission has not given us the benefit of a formally-adopted safety goal or set of criteria by which to judge this is safe enough. And as I like to tell people, even if the Angel Gabriel comes down from heaven with such a safety goal or set of criteria on a plaque, I don't know how to evaluate against them because we don't have the certainty to say this is exactly the core melt frequency or this is exactly the severe accident risk off site of this plant.

There is just far too much unknown in this. But it

is a useful backdrop. It is a useful description of acceptable risk, just as the PRA work, the source term work, the severe accident consequence work is a useful description of the vulnerability of this plant and the effect on that vulnerability that one feature or another might have.

So as we go in, it is not terribly important that the Commission has not officially adopted a safety goal. There is certainly a range of debate enshrined by many years now -- in fact, one of your members devoted a year or so of his life to the safety goal. The range of debate gives a clear idea of the philosophy of acceptable safety and the best available quantitative descriptions of that level of acceptable safety, and we come into this forum, along with the applicant for this FDA, this license, and we come into this forum with the available tools, the state of the art we have on severe accident risk analysis, and we can say how does this match this backdrop, this description of acceptable risk?

In general, if you refer to the Safety Evaluation Supplement No. 4, which is the most useful compendium of the outcome, you [illegible] see that, not surprisingly, the General Electric portrayal of risk and the Staff portrayal of risk are not the same. General Electric chooses core melt frequency values and accident release values that are different from the Staff. The Staff is roughly one order of magnitude higher in the core melt frequency. And in what people call source terms

in the severe accident releases, we are more like two orders of magnitude higher than the G.E. portrayal.

That is not surprising and it is not disabling because if you look at it -- and in fact, it is delineated in here in that fashion -- the Staff is saying, for instance, in the source term arena, we choose to use what we would characterize as a higher range of outcome. You know how much uncertainty there is. It is a matter of active debate on the severe core damage phenomenology, core melt phenomena, core-concrete interactions, all of those things.

We choose to err on the side of caution, perhaps, using, roughly speaking, two orders of magnitude higher releases than G.E. does. Reinforcing that, we choose one order of magnitude higher core melt frequencies. Thus, when we do a cost-benefit analysis, we will more likely justify a change. We will more likely conclude that a certain thing is worthwhile, worth doing. We will draw that line in the sand at what is an acceptable GESSAR-II, and a stricter position than G.E. would, than they propose.

Now, what that says is since we are in great measure erring on the side of caution, that our uncertainty is somewhat skewed then, that it may be that with later information, we will learn not that we should have done more, but we would learn that perhaps some of what we have done is superfluous.

But with that in mind, and recognizing that we don't have exact answers, the Staff went ahead and made its judgments, and you will see or have seen in the Safety Evaluation Report Supplement No. 4 that we have chosen -- and General Electric, I believe, has acknowledged -- further additions to the design philosophy and the design approach of GESSAR-II, the ultimate plant protection system and certain features associated with hydrogen control and DC power that we think significantly enhance the safety of the plant, and therefore are justified, and they become part of the FDA.

Now I would like to add, going back to the range of debate for the safety goals, a very important point. This is not with respect to the arguable levels of safety. We are not hanging around a coremelt frequency of 10 to the -4 per year. We are not hanging around a .1 of 1 percent increase in background risk for people who live near a plant that would be built like this.

No. In fact, we are haggling in a very difficult arena, in coremelt frequency, by our estimate, where we are already down in the range of 10 to the -5 per year, plus or minus. In GE's estimate, it's another decade lower than that. And in the source terms, we are well below the range of debate.

So with respect to acceptability, criteria for acceptability, this is not a close call. Where it is a close

call is in cost/benefit analysis. And the cost/benefit analysis in this report, in this action, is indeed based on the dollars per person-rem.

And just earlier, it was mentioned by the Acting Subcommittee Chairman that, why or should the Staff use averted economic loss? It is well-known that you can more readily justify a design improvement or a design change using averted economic loss -- the severe core damage and coremelt cost being immediately of the order of, you know, a few billion dollars or more -- that you could justify it more likely with averted economic loss than you can with averted offsite public health risk.

We know that. We have had substantial signals from our own Commission that they are not pursuing the idea of the averted economic loss, and as you know, the Staff has recommended it. The ACRS has recommended it in a number of ways.

No. What we are doing is, we are basing the cost/benefit analysis on the averted public health risk, and we are nonetheless satisfied that we are achieving a very high level of safety. We are achieving reasonable justification of design refinements for this technology, for this kind of reactor, that are good, that are worth building, that are justifiable in the fullest sense of the word.

We don't feel cheated because we can't use an

averted economic loss measure. And if I would say there is a lingering concern, that lingering concern is not that the hardware design could be justified to be something different. No, that lingering concern is the one that we would have anyway, no matter which criterion we use, and that is that this comes true when that plant is built. There are no fission products in this blue book. But when we build or someone builds this plant, to make all of this PRA come true is the lingering question and is the one we would want that, in the actual construction and in the operation, we realize the apparent benefits of this design.

So with that, I would like to open to your questions. The criteria, the lack of a safety goal, are not a problem, because this does not come out to be such a close call.

MR. LEWIS: Bob, just as a quick obiter dictum -- or you made an obiter dictum -- that the ACRS had recommended including averted economic cost?

MR. BERNERO: I shouldn't go too far. In a number of -- if you go back to NUREG-0739, the original -- which really wasn't an ACRS report, there has been a lot of debate. I should have said that more accurately, that some members of ACRS have.

MR. LEWIS: And some have recommended against it.

MR. BERNERO: Yes, and some have recommended against

it.

MR. LEWIS: I just wanted to clarify the record on that point.

MR. BERNERO: And I think in their unique way, the Commission made it abundantly clear which way they are leaning in the final editing of the Severe Accident Policy Statement.

MR. LEWIS: But don't lay it on ACRS.

MR. BERNERO: No, no. No, the Commission did that.

MR. KERR: Bob, you made a comment about the way in which the Staff arrives at numbers for risk and said something about erring on the conservative side or erring on the high side.

It was my impression that the Gospel according to the Staff was that PRAs are supposed to best estimates. Does that mean that when you get to the cost/benefit stage, that you do another PRA that's a conservative one?

MR. BERNERO: Well, no. I think -- oh, any number of -- there are some Staff members here who worked with me or for me in the past years -- I have used an expression over and over again for a long time -- and I think it characterizes what happens in PRA-land correctly and properly -- and that is, you are trying, to the best of your ability, to make a realistic estimate, but you always approach realism from the pessimistic side of the field.

And we just had an example a little over a month ago

-- no, not quite a month ago -- the Davis-Besse incident -- and you know the controversy about feed-and-bleed and how many aux feedpumps should you have and what kind of HPI -- and the success/failure state criteria for Davis-Besse in all of the analyses to date were that that plant can't feed-and-bleed.

In retrospect, throwing a lot of thermohydraulic bucks into it and people, it looks like that plant can feed-and-bleed, fairly marginally, at least for a long time, but its success state is not what the PRA portrayed it.

I'm not uncomfortable with that. We want to be as realistic as we can, but as WASH-1400 did iodine or as we have done with feed-and-bleed capability on Davis-Besse, where you don't have a solid basis to make a realistic estimate, you should be very careful to know where pessimism lies and choose to lean that way.

MR. KERR: Well, it seems to me that in almost any situation that you encounter, there are uncertainties. So what you seem to be saying is that if the uncertainty gets big enough, you then become conservative, and I don't know how big is big enough, and I expect nobody else does either.

So it would be fair to say that PRAs generally are conservative.

MR. BERNERO: Especially if the Staff is sponsoring or doing them.

MR. EBERSOLE: Bob, there's a little bit of a hole,

I think, in that rationale, about feeding-and-bleeding at Davis-Besse or, for that matter, most other PWRs. Although we have long culled it out, the circuitry and equipment that makes it possible to feed-and-bleed is energized circuitry, comparatively high-voltage, 250 or 125. That circuitry is open and exposed to a hostile environment after a period of feed-and-bleed, and presumably will die in the cold or dead state, at which point the valves close and you can't open them.

MR. BERNERO: That's a possibility. But there have been cases -- February 28, 1980, the Davis-Besse -- when they had a loss of the NNI bus -- you know, essentially it was a reproduction of the Rancho Seco lightbulb incident -- and the operator didn't really know what was happening at Rancho Seco. He turned it on, and he fed-and-bled 50,000 gallons worth of coolant.

MR. EBERSOLE: What was the containment environment?

MR. BERNERO: Well, it is primary coolant. It is not that hot. And I consider that a much lesser challenge than failure.

Now in Davis-Besse, the implementation of the procedure was somewhat delayed. There is a question, as you may know from NUREG-1154, that the operator's definition of "immediately do something" was subject to question.

MR. EBERSOLE: Well, at least in theory, you can't

live very long with the PORVs unless you do something to upgrade them.

MR. BERNERO: Yes.

MR. KERR: May I continue, please?

MR. LEWIS: Well, if I could pursue the conservatism for a moment, if you're not coming back to that --

MR. KERR: I was going to another subject.

MR. LEWIS: Okay. Let me just pursue conservatism.

Just for the record, there are those who feel very strongly that an approach to realism from the conservative direction, as you so quaintly put it, is logically flawed, and it can easily lead to non-conservative results. And in your early comments, you made statements like, "Maybe later we will learn that we were too conservative, and we did things that we didn't need to do."

Those things that you didn't need to do, there is no way to prove that they didn't make the plant less safe rather than more safe.

So at least some of us believe that when you have a large uncertainty, you should do your level best not to approach from the conservative direction, but aim squarely at the middle and acknowledge your uncertainty, and that that's the only way in which you can end up with a result which you can characterize in terms of a mean and an uncertainty around it.

That's for the record.

MR. BERNERO: May I add to that?

Again, invoking the Davis-Besse as an example of what I think you are driving at, in the Davis-Besse plant, you may know that there is a startup feedpump that sort of has the character of an extra auxiliary feedwater supply. But unfortunately, it was discovered not long ago that it's in the same room as one of the safety-grade auxiliary feedwater pumps and had some piping that was not appropriately designed to withstand high-energy line rupture, et cetera.

And in the gavotte that went to "What do you do about this," it ended up that the Licensee proposed, "I will close some valves, and I will padlock the valves, and I will rack out some breakers, and I will do a total of about five rather bizarre things to assure that there will be no high energy in the line, and therefore no high-energy rupture." And that actually appears to have made the plant distinctly less safe, because here when that pump was valuable as a water supply in a very real, in a very ordinary sort of incident to begin with, it took extraordinary measures by the plant staff to go down there and get that pump on line, you know, a series of keys and all sorts of things.

That is a classic example of how erring on the side of conservatism may not be so -- that situation of saying, "I will defend against high-energy line rupture.

But nonetheless, you are faced with the dilemma, whenever you do a PRA -- and I like to go back to that vintage example of, how do you treat the iodine, in WASH-1400 and -- what was it? -- Appendix 4 or Appendix 6 -- that said, "It looks like it ought to be the iodine salt, cesium iodide, but there's just not enough data." Well, we have to treat it one way or the other, and we'll just treat it as the more volatile, elemental radioiodine, and as you well know, there was a partition coefficient associated with elemental radioiodine that was quite generous, and there was even controversy at that time, because that didn't gibe with the Reg Guide, but you have to make such a choice, and you have to carry that choice through your cost/benefit analysis, and it will pervade that analysis and give you that pessimistic side of the field skew that I speak of to a realistic estimate.

It takes care -- it can be counterproductive; it can make the plant less safe. And that's a major uncertainty.

But the central aim -- and then stand back and say, "That's what I have, and there's an uncertainty" -- still leaves you with the need to make a decision, the need to have some fiduciary mark, $1000 per something, to decide whether or not you will turn to these people and say, "I want AC-independent tiki torches for hydrogen ignition. I want the UPPS. I want whatever I want."

You have to make that decision, and when you do, you

will consciously or subconsciously choose to reflect your bias, and what I have instructed people for years and continue to instruct them is, be careful, be knowledgeable, be as realistic as you can, but approach realism from the pessimistic side.

MR. LEWIS: This is the wrong place for an extended debate on that point, but I think you are really quite wrong on it. But I'm sorry, Bill.

MR. KERR: You know, after observing how easily you convinced Mr. Bernero of your viewpoint, I think I will forego further comment.

MR. LEWIS: I really do apologize.

MR. MARK: Cost/benefit, $1000 totally out of the air per man-rem. Nobody knows if it's worth a nickel. It goes into the numerator or the denominator, whether you do benefit/cost or cost/benefit. The estimate of those things is as hairy a step as one can possibly -- probably never seen before. Until one became more than 21, one never would have believed such hairy arguments as go into the estimates of a man-rem or some release.

In the case of the GE, I think the situation is really a tremendously swampy, soft basis for any kind of argument. Four-fifths of the total risk comes from seismic. The risk from internal is really very modest indeed.

Some large fraction of the seismic risk comes from

some assumptions about relay chatter, which aren't based on any look at any actual relays, but are based on some relays that somebody once said chattered like this.

It would be entirely possible to go and say, "Look, make sure that in this plant you use relays which are immune to or largely defended against chatter." Then you would change the whole estimate of seismic risk. You would change the denominator of the cost/benefit equation. You already can't get things down to $1000 for some of the modifications which are thought of. There might be good reasons, but I don't think this is a good reason.

You can't get very close -- well, you can get fairly close to $1000, but on the basis which you simply know could be improved, should be improved, perhaps shouldn't be used at all.

So I think the situation here is not an awfully encouraging one from the point of view of having a numerical basis for decisions, as derived from PRA, as PRAs are done, and can or even can be done, and that one ought to accustom oneself a little more to saying, "We're going to rely on judgment, since that's what we do anyway, and in our opinion, it would be good to have the containment inerted."

I don't believe that, but, I mean, you could just say that. It isn't going to come up in a cost/benefit formula. It isn't worth it at all on that basis, even with

inflated risk numbers, and I think we should perhaps somewhat regroup, rethink, and decide that we're going to assert policy, that we're going to make the best judgment we can, we'll debate it, but we won't debate it on that basis.

MR. EBERSOLE: Carson, could you extrapolate that to include security?

MR. MARK: Oh, in fact, in security, of course, there is absolutely no underpinning for a cost/benefit analysis of any kind. And if there was yesterday, there is a new one today, with the bombing last night and so on.

One shouldn't even be attracted to go that stupid route.

MR. BERNERO: I would like to speak to that because I think what you are voicing here is the most significant aspect of this review as compared to other reviews. The point I was trying to make before, that ordinarily when we speak of the acceptable safety of a power plant, prospective design or an actually constructed one, we are speaking of satisfaction of regulations, satisfaction of regulatory requirements that are so carefully crafted that all of this mushiness that you speak of, all of this ill-defined quantitative deliberation is buried back in some regulatory activity that came out in all the splendor that we have in the regulations now. That a single failure criterion, as qualified by the word and the practice of regulation is a sufficient test of reliability.

And what we have, then, is in the conventional review, we have masked these difficult problems to a very great extent. We have dealt with them generically. We have, perhaps as in the case of the ATWS rule, gone through some of this very tortured cost-benefit analysis and then backed away from it and said you will have that feature in that plant; a very prescriptive, simple regulation that derives from that information but -- I make this argument and I must make it very strongly -- the decision is not made by the cost-benefit analysis. The cost-benefit analysis can only display in some consistent fashion what you know and what you don't know in order that judgment can be focused on the places where it has to be exercised and exercised with as much information as you're going to have.

MR. MARK: But of course, that presumes that the cost-benefit analysis is done as well as one knows how and not approached from the left or the right in any conscious way.

MR. WARD: Dr. Kerr?

MR. KERR: Mr. Bernero, I think I agree with your discussion of the way in which regulations are used until one begins dealing with the severe accidents. As I understand the policy statement, -- and although I have looked at it carefully over the months I'm still not sure I do -- one deals with the severe accident issue at least for new plants on a basis which depends rather heavily on PRA and on cost-benefit

analysis. There, they are not regulations to guide one, so far as I know.

And it is to that, I believe, that Mr. Mark was speaking and not to existing plants. And I don't know how one is going to make those decisions, but at least the Severe Accident Policy Statement would lead one to believe that the PRA and other analyses of that kind would be dependent upon significantly. At least that's my interpretation of the statement.

MR. BERNERO: I agree with that. In fact, the reason I invoked the single failure criterion out of the current regulations was that is a severe accident question. Core melt frequency is a contest, or an evaluation, that goes past the single failure criterion. That is a sophomoric evaluation. It happens to give you a basically reliable system to begin with, but then it requires the more careful scrutiny of multiple failures, common cause failures, in order to determine is the occurrence rate or the arrival rate of severe accidents for this design going to be acceptable or not.

And admittedly, we are trying to be as realistic as possible but I think the committee has to recognize that you sooner or later will, in some aspect or another, confront issues where you just don't know where realism is. It's a range of debate; a range where you don't have sufficient test

data or sufficient analysis. And it's only in those regimes that I say you have to be very careful in your judgment on that specific to choose how pessimistic you are or what you use in that particular parameter.

But what we're trying to do here with this cost-benefit analysis is to consistently and fairly approach realism as carefully as we can, and then consistently apply that "realistic" cost-benefit analysis to measure possibilities for refining this design and its subsequent implementation.

Now, I have to turn to Staff on the relay chatter. Did Staff, somehow, somewhere actually do the cost-benefit of qualified relays? I just don't remember anything on that subject. So that I would have to take that up -- if that were a separate issue --

MR. WARD: Did you get an answer?

MR. BERNERO: I am getting negative nods.

MR. WARD: Well, we can't see those.

MR. SCALETTI: No, we did not.

MR. WARD: Thank you.

MR. BERNERO: The Staff did not. So if you go in this SER Supplement No. 4 -- I forget the table number but there is a table of the stuff that GE first started to look at. Table 15.4. And then the Staff, after they reviewed it, kind of combed the field another way in sharper analysis of

the principal competitors of modification. But I just don't think we did look at the chatter-qualified relays, or whatever you might call them.

MR. WARD: Dr. Remick has a question.

MR. REMICK: Bob, would you help me? Is the GESSAR II a modification of an existing FDA, or is it a review of a new FDA?

MR. BERNERO: Well, I will defer to any correction from Cecil Thomas. The existing FDA's are backward referenceable. And what you have here is a substantially modified design over the original GESSAR, and the issue -- and the phrase used for the issue in the Severe Accident Policy Statement was forward referenceable FDA -- use in future cases. And that's where you get the big threshold of you have to follow the Severe Accident Policy Statement, the CPML rule and all that kind of stuff. So it's really a different FDA; substantially different.

MR. REMICK: So you are approaching it from that standpoint.

MR. BERNERO: Yes. I am dealing with it as a new FDA. It builds on that previous history.

MR. REMICK: I have another question. You have referred to rulemaking for the design certificate in Appendix O. For sometime I have been making the claim that I am not sure anybody knows what that rulemaking would be. Do you know

if I am wrong? I haven't found anybody that has told me I am wrong yet, but I keep asking or making that statement, that I don't think anybody has thought out what that means.

MR. BERNERO: Well, I would second your comment because we have never done that. And we have had discussions in Staff that if we ever sit down to do it, we really have to go through the protocols rather carefully, because it hasn't been done. Would the Commission sign SER's, you know, what would be done? It's a rule prerogative in principle but there is no precedent, no practice, to which we can look. And internal discussions in the Staff, and I believe to some extent in OGC, have kind of explored this.

Perhaps GE would be the first applicant to go for that. And I think part of their decision would be what is it; you know, what sort of resources would it take.

MR. REMICK: That's exactly my point. I don't know how anybody can make that decision without knowing what ballgame they're get*ing into.

MR. BERNERO: That's really one of the reasons that the forward referenceable FDA is an alternative in the policy statement that was added, because it was really kind of a Pandora's Box, this rulemaking by Appendix O, including the NRC people. It wasn't too clear what that would take, how long it would take, you know, the hearing mechanisms and all of that to be established.

MR. WARD: Okay. Jesse?

MR. EBERSOLE: No more questions? Let me ask General Electric, do you have any observations on any of this? On any of the discussion?

MR. SHERWOOD: I am Glenn Sherwood of GE. I could give you a little background on attitude of the GE engineers to cost-benefit analysis. That is maybe appropriate. And I think -- to be perfectly candid with you, I think they really disdain cost-benefit analysis.

Our engineers in the Nuclear Division are under the same scrutiny as other GE engineers in our Airplane group and our Steam Turbine, and therefore, they take great pride in their work. But as they have done for decades, they essentially do their engineering by engineering judgment.

And we think, for example, that the GESSAR plant has probably the lowest core melt frequency of all the current generation of plant, if not the lowest, and probably the best off-site risk of all of the current plants.

So at least within General Electric, we rely on good engineering judgment, just as we have for decades. We do cost-benefit analysis when we're forced to do it, but we really don't put much stock in it.

MR. EBERSOLE: Thank you.

MR. LEWIS: When you do it, do you do it conservatively?

MR. SHERWOOD: Oh, of course.

[Laughter.]

MR. EBERSOLE: Any other questions?

[No response.]

Thank you, Bob. The second topic on the agenda is a discussion of hydrogen and related matters like scrubbing efficiency and the suppression pool and so forth. I believe that is General Electric's topic.

MR. SHERWOOD: That will be Dr. Debbie Hankins.

[Slide.]

MS. HANKINS: I am Debbie Hankins. I don't know if we had a miscommunication on this agenda item, Jesse, from what you just said, but we had limited it just to the discussion of the hydrogen issues. We weren't going to go into the source term.

MR. EBERSOLE: That's correct. I really didn't mean source term. Just what you have up there.

MS. HANKINS: Okay. Thank you.

The agenda asked for specific topics, so I have tried to address those in the order in which they were listed. The first one was on the rate and amount of hydrogen.

The generation rates that we see for the full core melt scenarios -- and I will remind you that in a GESSAR PRA we analyzed full core melt scenarios as opposed to the degraded core scenarios, that for example, the hydrogen

control owners group is analyzing.

For those scenarios, the generation rate varied in time during the sequence and for various sequences, from about .4 to 1.6 pound mass per second. Those are about the range that HCOG is analyzing in their experimental work.

The total in-vessel hydrogen produced, again, varied by sequence from about 1300 to 2300 pound mass. There's only enough oxygen in the 238 MARK III containment to support the combustion of about 2480 pound mass of hydrogen, and that's equivalent to about 67 percent of the active clad as opposed to the hydrogen control rule which states you must analyze --

MR. MARK: Could you help me? That 2480, that's the total air space -- wetwell or drywell?

MS. HANKINS: Wet.

MR. MARK: How is it broken down, roughly?

MS. HANKINS: I think it is 1.1 times 10 to the 6 cubic feet in the wetwell, and what is it, about .4 times 10 to the sixth for the drywell.

MR. MARK: So a quarter of it is in the drywell and three-quarters in the wetwell.

MS. HANKINS: Yes. Maybe even more than that; a higher percentage in the wetwell.

This is assuming one burns down to 5 percent oxygen, and it's enough to support the combustion of 67 percent metal-water reaction. The requirements of the CPML

rule are that you must have a system capable of handling 100 percent metal-water reaction in the active clad.

Again, we had some discussion yesterday about whether one would go down to 5 percent oxygen or if one would have complete combustion. Theoretically, you could have complete combustion; however, the way we envisioned these accident scenarios is that the hydrogen would be bubbling up through the pool and you would actually have multiple ignitions. So eventually, once you got the oxygen concentration down to 5 percent, you could not have -- or continue to have ignitions. So that's why we say it is 67 percent equivalent.

In terms of hydrogen detonations, when we did the original PRA we assumed there was about a 26 percent chance of a global hydrogen detonation which would cause simultaneous failure of the drywell and the wetwell. Our understanding of detonations, and in particular global detonations, today is that in fact, they will not occur. And as such, the original PRA results are conservative compared to the analysis, if we were to perform it now in 1985 as opposed to 1982.

That understanding comes from testimony that was given a the Perry hearings by Dr. Bernard Lewis who is a recognized world expert on combustion phenomena. He says that in the MARK III geometry you simply cannot have the proper conditions to have a detonation. We have some disagreement

with the Staff in that we say that the only way to fail the drywell through hydrogen phenomena is by a global hydrogen detonation. The Staff assumed a certain fraction of the time one could have a local detonation that was capable of failing the drywell. We do not agree with those results; we think there is insufficient energy to fail the drywell for a local detonation.

Because of their assumption on local detonations failing the drywell, the Staff is showing a high seismic risk, which can then be reduced by about a factor of 2 with the implementation of igniters which would burn the hydrogen in low concentration and preclude the possibility of detonations. Again, we disagree with that analysis so we would not show the same type of risk reduction for igniters.

We do agree with the SER in the sense that there is no risk reduction for hydrogen for internal events.

[Slide.]

What we are talking about is this was the original PRA without us. Again, this is the BNL staff assessment of risk. The GE numbers are substantially lower.

Today, since GE has committed to the implementation of the UPPS design, we would say the GESSAR design is really here. And if one takes the design and adds then igniters with the back-up power supply, the risk reduction essentially is zero.

The large risk reduction shown here for seismic events again is related to that assumption of LOCA detonations failing the drywell and we believe that when a realistic analysis, even approached from the pessimistic side, is performed, that these numbers will not show that kind of a risk reduction for seismic events with igniters.

[Slide.]

Despite our disagreements, GE has committed to provide a hydrogen control system that is consistent with the outcome of the HCOG program and the NRC review of that experimental and analytical program.

The NRC is requiring an SER for it, that we provide a diverse power supply for the igniters, and this is to supply power to the igniters for the case of station blackout, just the dominant core melt event.

We find no technical justification for that back-up power supply. However, GE will comply with the SER, we will provide that back-up power supply.

In addition, relative to hydrogen, we have also provided the UPPS system. Once again, despite our commitments, our position is that hydrogen control is unnecessary, that it provides no risk reduction, in that the risk is already low. We find no justification in particular on a cost-benefit analysis for additional hydrogen control in the GESSAR plant.

But, again, we will comply with the requirement.

[Slide.]

One of the other issues that is on the agenda related to hydrogen --

MR. MOELLER: Excuse me. On your cost-benefit which did not support it, how close was it? Or, you know, was it miles away from --

MS. HANKINS: Yes, orders of magnitude.

MR. MOELLER: Thank you.

MS. HANKINS: Oh, I think if you just look at the internal events, using the Staff BNL analysis, they are showing no risk reduction. If you show no risk reduction and divide it into the cost, it's a pretty high number.

MR. MOELLER: Thank you.

MR. REMICK: Could we have a copy of that slide at the table?

MS. HANKINS: It is in SER 4. It was one of the handouts yesterday.

One of the questions, because hydrogen phenomena in a BWR, or because of the suppression pool, can be different than what one sees in, for example, large dry containment or even an ice condenser, and that as the steam and hydrogen is delivered to the pool and it starts to bubble up through the pool, the steam is stripped out, and what is released from the surface of the pool is essentially pure hydrogen.

And that hydrogen then comes upon an ignition source such as an igniter, and can burn in what we would call diffusion flames. And the question arose, what would be the impact of those flames on increasing the probability of pool bypass by either failing a sealer or a penetration in the drywell?

The drywell equipment hatch in the GESSAR design has a five-foot concrete shield plug between the wetwell air space and the seals itself.

So we don't feel that there is any potential for flames impacting those seals.

Likewise, with the personnel air lock, it also has a cement shield plug.

The electrical penetrations which are five foot long are potted with a Portland cement mixture. There was a concern with the MARK-I containment that if you had high drywell temperatures, the compound that is used for potting of the electrical penetrations is an epoxy type substance that, given high temperatures, becomes more fluid. And then with a pressure differential, there could be substantial leakage through those penetrations.

The design of the penetrations for GESSAR are substantially different, and the Portland cement material can go to very high temperatures without losing its integrity.

So we don't feel that standing flames, either from

the standpoint of the equipment hatch ai lock seals or the electrical penetrations, would have any effect on the integrity of the drywell.

I have just one chart, and that will complete my presentation, if it would be all right with you, and that was a question on the ablation of the RPV pedestal. If we could do that, then we wouldn't have to have GE and the Staff --

MR. EBERSOLE: Yes, that's the next item on the agenda. You flew right into it, didn't you?

MS. HANKINS: The question arose at the last committee meeting --

[Slide.]

-- we were discussing whether temperature effects could have any impact on the drywell structure and this molten core in the pedestal region. Could the thermal gradient cause stresses in the drywell structure and cause loss of integrity.

That question was answered in the negative, in that we did not have any concern from the thermal stress, but another question arose, and that is what about the ablation of the pedestal region, and could it in fact -- the ablation result in the loss of the RPV and loss of drywell structure and potentially containment integrity?

We went back to San Jose and looked at this issue.

One thing we would like to know is that the pedestal design that was analyzed and that Jack Rosenthal presented at

the last committee meeting was a pure concrete pedestal. It was very similar to the design, for example, that they have in Grand Gulf.

The GESSAR pedestal is a steel-concrete composite. It is two concentric steel rings. Each are one and a half inch thickness. They are connected with steel shear ties, and the concrete is filled in between. But the primary structural support comes from the steel, not from the concrete.

So we did an analysis starting with conditions that were on Rosenthal's chart, and we said okay, let us assume that the first 1.4 meters of concrete have been ablated and, as such, the inner steel ring would also be assumed to be gone.

We assumed that the only support is provided by the outer steel shell which would then be at a radial distance of 1.8 meters.

And further, let's assume that that steel shell is at high temperature.

Look at the loads, the weight of the RPV, the shield wall and other equipment and the weight of the pedestal itself. We looked at what that would mean in terms of the load per unit area of that outer steel shell, and found it was about 3.4 ksi was the load the outer ring of the pedestal would have to carry.

The yield strength of stewel at 1100 degrees

Fahrenheit is about 21 ksi. There is a tremendous difference between 3 and 21. And because of that, we felt that there was a very substantial margin and that the pedestal will in fact carry the loads.

As such, we see no loss of the pedestal, the drywell or the containment as a result of this ablation challenge.

MR. EBERSOLE: May I ask a question? I gather that all of the structural material between the two shells was standard concrete as well as the foot down below it. The GE design looks strangely almost already as a sort of a pot which might contain the molten core and some steel from the vessel.

I would guess that it might have been of minor cost additions to do something or to put something besides just plain concrete in those areas. Did you-all look at that?

MS. HANKINS: You mean in terms of like a core ladle?

MR. EBERSOLE: Whatever.

MS. HANKINS: We did look at that very early on in '80 or '81 when we were doing some assessments on core-catchers. And what we found was putting a material down there that would decrease the penetration rate would drive the heat in the upward direction, and we were more concerned about having drywell failure due to the heat in the upward direction than just allowing it to go into the concrete.

MR. EBERSOLE: I see. You really have an absorptive

concept.

MS. HANKINS: Right.

MR. EBERSOLE: Then that would either tend to go the other way, that would make it even more absorptive than plain concrete. Did you do that?

MS. HANKINS: Well, we didn't want it penetrating the basemat.

MR. EBERSOLE: Okay.

MS. HANKINS: So there has to be a happy medium there.

MR. EBERSOLE: Right. So this is it, plain concrete. Thank you.

MS. HANKINS: That's all.

MR. EBERSOLE: Any questions?

MR. REED: I thought I saw something on one of those slides that said "committed to UPPS." Is that something new, that commitment?

MR. EBERSOLE: We are going to take that up later.

MR. REED: Oh. Okay. I just wanted to come to a better understanding.

MS. HANKINS: We were reminded by the Staff in yesterday's presentation that in addition to committing to the igniters, the back-up power supply, that GE is also committed to UPPS as part of the resolution of hydrogen control. And so that is why I added it to the chart.

MR. EBERSOLE: Debbie, I think the committee might be interested in your objections to the ignition system, including your grounds that it costs a great deal, in that it carries the burden of the spray system, which is the major part of the cost. As I recall, it was about 1 million for the igniters and about 9 for the sprays.

I don't think the committee -- at least my guess is, they don't understand why the igniter system carries the burden of this, of the sprays.

Could you clarify that?

MS. HANKINS: Well, let me clarify that the system that we have committed to, which is consistent with HCOG, is just the igniter system with the back-up power supply, which is about $1.2 million.

When we did our original assessment of hydrogen control for the cost-benefit analysis, we at that time included a heat removal system. In other words, a way of powering the containment sprays independent of the present RHR system. And we did that based on the assumption that that would be needed in order to preclude loss of containment integrity for full core meltdown scenarios.

I think BNL and the Staff have done some analyses that say the containment may or may not survive without sprays operating during the hydrogen release.

Again, that independent containment cooling system

upped the cost from about $9 million to a total of about $10 million, and that was using the cost-benefit.

But again, even if you did the cost-benefit with the $1.2 million, you are still orders of magnitude away from the cost-benefit ratio of 1.

MR. EBERSOLE: And the configuration now does have these sprays or not?

MS. HANKINS: No.

MR. EBERSOLE: Any questions?

[No response.]

Well, thank you very much.

I am going to ask the Staff to comment on this topic.

Do you have anything to say?

MR. MOELLER: In the Staff's comments, it would help me to understand better -- I gather on backfits, you do cost-benefit, but on what you might call a forward fit or a new design, you don't have to justify cost-benefit.

MR. BERNERO: No, you do cost-benefit analysis on both. It's just what goes into the equation differs. Clearl if you are backfitting to an existing plant, replacement power cost is going to be a very significant thing for anything, you know, for downtime. Rip-out costs. Backfitting the pedestal, for instance, would be terribly expensive.

But in a future plant you do the cost-benefit

analysis, recognizing that you are dealing with lines on paper and engineering costs, looking forward, rather than ripping out and backfitting.

But you do the cost-benefit analysis and have to exercise the same precaution in both cases. You can't get an exact equation, you can't get an exact answer that just gives you a numerical decision process. It just can't be done.

MR. MOELLER: Well, in the presentation we just heard, though, if there is no benefit of the igniters, how do you require them?

MR. THOMAS: I believe the difference is the numbers that are assumed or the numbers that result from the calculations, I believe the Staff's numbers do show an incremental benefit, and GE's numbers do not. That is the main difference.

One point of clarification: At least I was slightly confused -- I believe the GESSAR design --

MR. KERR: Excuse me. I thought Dr. Hankins said that BNL's numbers showed no benefit. Did I misunderstand? Oh, for internal events. Okay.

So it's the seismic -- thank you.

MR. THOMAS: The other point of clarification, just to make sure, I believe, that GESSAR design does include containment sprays, but not the separate dedicated sprays that you mentioned; is that right, Debbie?

MS. HANKINS: Yes.

MR. THOMAS: They do contain containment sprays, but they are not separate from the RHR system, as Debbie described.

MR. KERR: Well, what would a spray system be dedicated to, if it weren't dedicated to containment heat removal? I mean you referred to the second one as a dedicated spray system. The other one is undedicated, I take it.

MR. THOMAS: Perhaps GE could elaborate on that, since -- since they brought up the subject.

MR. KERR: Well, you are the person who used the term. What did you mean by dedicated?

MR. THOMAS: Totally independent of the normal RHR system.

MR. KERR: Are you talking about two independent systems?

MR. THOMAS: For the purposes of cooling for severe accidents and hydrogen burns and so on.

MR. EBERSOLE: There is a sort of a curious relationship, Bill, about the potential for bypass of the drywell that makes these sprays important or unimportant.

This design -- it's sort of difficult to get a bypass for this design, but some plants you can -- you have a higher probability of bypass.

I understand that those have sprays in part

dedicated to accomplish a function after bypass of the drywell; am I correct? I hear that is more or less the critical consideration, is the potential for bypass or not bypass, or no bypass, rather.

This design has just about precluded bypass.

MS. HANKINS: The sizing of the containment sprays is based on an assumed bypass from the drywell to the wetwell air space, assumes steam bypass under LOCA conditions. That bypass we realistically don't believe exists, but for licensing purposes, design basis purposes, it is included. Where we would use the sprays would be for, you know, cases where you need additional containment heat removal.

MR. EBERSOLE: If you should get substantial bypass with some of the old designs, like the loss of a downcomer from PRV or something like that, you will only escape by spray condensation because you are going to lose suppression condensation.

MS. HANKINS: Most of those bypass mechanisms are included in the MARK III design.

MR. EBERSOLE: Right.

Any further comments by the Staff on either this or the ablation problem of the vessel support?

MR. SCALETTI: We have a presentation by Dr. Pratt from BNL.

MR. PRATT: My name is Trevor Pratt. I am with Brookhaven.

[Slide.]

Before I launch into the discussion of hydrogen, perhaps I could clarify the point that Debbie was making with regard to internal events and the change in risk associated with the hydrogen control.

This is a copy of Table 15.9, which is in Supplement 4 to the SER. What Debbie was talking about, if you look at the base case with UPPS -- and this, they would argue, is GESSAR now -- you have 33 person rem with UPPS, which is a reduction of quite a significant amount without UPPS. The use of igniters would take you down from 33 to 31, which is not zero but it is not very much.

If you assume perfect hydrogen control, you would go down to 23. Now, let me explain these calculations because the headings here may be a little bit confusing.

We have to make an assumption. We were extrapolating a deliberate ignition system into a regime which it was not designed for. That is full core meltdown events. We weren't sure how that machine would work in that environment. So this calculation, which we have labeled "igniters," assumes that you will lose the containment building shortly after vessel failure because of uncertainties associated with the core debris coming out of the vessel and

so on, but maintain drywell integrity.

This calculation, with perfect hydrogen control, assumes that you maintain containment integrity and drywell integrity until you fail many hours later into the accident sequence as a result of buildup of partial pressure of gases due to core-concrete interactions.

There is an argument, of course, and if you look at some of the hydrogen generation rates during the full core meltdown event, that indeed you could maintain containment integrity during that period of time, and if the UPPS was operating successfully, perhaps that could also help you. So again, to say that this would be the only benefit -- it's a range, if you like, of possible benefits from the system, and certainly this is true that if you inerted the containment building with perfect hydrogen control, that is what you would get, but you might also get there by the installation of the device, as well.

I don't know whether that helps clarify the point, but that is what really we were talking about.

I have two presentations for you, and we can go through as much detail as you would like. The detailed discussion on hydrogen is not quite as detailed as it was for the subcommittee, and I have taken out quite a few of the Vu-graphs, and again, we have all of the backup slides, so if you do want to go into detail, we can certainly do that.

What I would first like to do, though, is to point out that there are two differences in the way we have done the assessments, and some of the items that were identified for discussion fall into two categories. When we dealt with GESSAR-II PRA review -- and Debbie has already alluded to this -- we were looking at full core meltdown events.

The initial submittal did not include any provision for hydrogen control. There was a very high probability of containment building failure in the PRA and signficant probability of early loss of drywell integrity, so we weren't really looking at what were acceptable hydrogen generation rates, how much hydrogen should be oxidized. Debbie pointed out you don't need to oxide a great deal of the cladding before you run into trouble.

So there we were looking at full core meltdown events and not dealing with the specific topics that were on the agenda, and again, the containment event trees that went into Supplement 2 of the SER dealt with full core meltdown events and not these degraded core events that we were discussing with HCOG.

So the impact of hydrogen control was really only addressed in Supplement 4 to the SER.

[Slide.]

My second slide goes through some of the interactions that have been going on between the NRC and

HCOG. Here we are dealing with degraded core events. The aim is to maintain containment integrity. Therefore, we are interested very crucially in the amount of hydrogen produced and the rates of hydrogen production so that we could, in fact, design the system and ensure that the system works.

And the issues that were brought up by the ACRS related to optimum ignition sources, type of power supply, limitations of the sources and the effect of standing flames, really impacted this particular assessment. And again, I have a Vu-graph that will touch on the status of our interfaces with HCOG.

But the potential for hydrogen detonation, which is one of the items that you brought up, was related specifically to our assessment of GESSAR in the absence of hydrogen control.

[Slide.]

What I did with the subcommittee yesterday, and I think it worked well and we will try to do the same thing today, is I put up this Vu-graph, which really outlines the various steps that we in the Staff took to determine the potential for damage to the structures as a result of detonations.

We have gone through some of these Vu-graphs already with the ACRS a couple of months ago. It was a rather hurried presentation. So we can go into more detail if there are any

questions.

I don't propose, in view of the time, to go through every one of the Vu-graphs that are in your handout. Basically, we looked at hydrogen generation, and as I say, there were not terribly large differences between our assessment of hydrogen generation and those given by G.E. We were both using the MARCH Code and gave our usual generation rates.

Again, looking at distribution, both of us looked at the potential for local distributions to occur in the containment building --

MR. KERR: As I remember, the MARCH Code will tell you how much hydrogen you generate if you tell it how much to tell you.

MR. PRATT: That is certainly true. You know, I have been through this with you many times.

MR. KERR: I just wanted to make sure it was still consistent.

MR. PRATT: Most of the control that you have, though, is really in the core slumping phase of things. During the initial core degradation --

MR. KERR: I am reminded because within the week, I have heard an exposition on what is called tweeking the MARCH Code.

MR. PRATT: You are referring to last week's

presentation, yes. I was there, too. So again, as you point out, you can get wide ranges in hydrogen generation rates and total amounts of hydrogen released. And just a point that was brought up earlier in terms of the way we tried to go with our assessment, when we quantified our containment event trees, we did go with a central estimate on what the event tree should look like and that is coming from our assessment in MARCH in its reasonable form.

You can go to extremes in MARCH and get more severe consequences and more optimistic assessments and, again, get less impact, so we did have a high containment event tree and a medium and a low, and when we looked at our cost-benefit analysis, we were looking at our best estimate containment event tree. We really only looked at the high range when we were looking at our source term uncertainty study.

And there again, just so that we are not confused, our high range on the source term was not as extreme, for example, as you have heard from QUEST, where they went very extreme and had an extremely wide range of uncertainty.

I have Vu-graphs that I gave to the subcommittee yesterday which will show you very clearly that the upper range of our source term estimates was very close, and in certain cases were not as high as some of the mechanistic calculations that you would get from the suite of codes coming from ASPO.

So it was an attempt to make a very realistic assessment of what the range might be. We did not go to the extremes that, for example, QUEST went to, and I think that is a very important point.

MR. MARK: A question. You have headed this slide "Hydrogen Detonations."

MR. PRATT: Yes.

MR. MARK: Does that imply that you really have no concern over hydrogen deflagration?

MR. PRATT: Oh, not at all, no. This is purely because the agenda item pointed out was for detonations, and what I wanted to do is to note on this Vu-graph the various elements that went into that assessment so that if there were questions on a particular area, we could then go to the more detailed Vu-graphs and discuss that.

So no. In fact, at the end I have a couple of Vu-graphs that Jack Rosenthal, I think, gave to you at the last meeting that gives you the general effect of detonations versus deflagrations and how risk changed around doing that; but most of the time you would expect deflagrations, and it is only very rarely that we get the detonations.

MR. MOELLER: What does DDT stand for?

MR. PRATT: This is the transition of deflagration to detonation, transition, and it's once you start a deflagration, how that would accelerate and go sonic and

become a shock wave. So again, as I say, the hydrogen generation rate was based on parametric studies with the MARCH.

For distribution, we used an in-house computer code to look at hydrogen distribution and checked that against HECTOR, which was developed at Sandia as part of a research program for NRC.

By looking at the distribution as a function of time, you could find out over the timeframe of interest when you might get detonation, when you may get detonable mixtures. And just to address a point that Debbie made earlier, we feel that local detonations will cause damage. There were -- I wouldn't really call them local detonations. The distribution that we looked at -- and I have a typical one here in your handout --

[Slide.]

This shows the distribution across the various volumes that we set up. At the high range, we are talking about a 20 percent mixture of hydrogen, and at the lower range, about a 15 percent. So again, propagation of the shock wave from the enriched area into the lower enrichment, I wouldn't think would affect the shock wave movement.

Therefore, I really wouldn't call this a local detonation because it was traveling from the rich region into the weak region and failing at this point. The assumption was

that the reduction in concentration did not slow down or affect the shock wave.

MR. MARK: Well, it will cut the pressure by a considerable factor.

MR. PRATT: Moving into this region?

MR. MARK: Yes. The detonation, if it propagates at 15 percent, is certainly not the same thing as propagating at 30 or 20.

MR. PRATT: At 20 percent, the difference is significant between this? In the calculation that we performed --

MR. MARK: Something like the factor in the energy source.

MR. PRATT: Well, as I mentioned when we met last time, the calculation that was performed by CSQ at Sandia was based on an 18 percent uniform across the containment building, so there may be -- what you are saying is for this region there may be a slight -- well, there could be a significant increase in the pressure pulse.

MR. MARK: Well, it will -- I'm not sure just how. Maybe Lewis can tell us. The energy in the burning front is going to be much affected by the concentration of hydrogen, essentially linearly, and that will reflect in the pressure and the pressure history. That is really quite a bit beside the point. You might get the propagation you speak of.

MR. PRATT: Yes. Well anyway, just so you know the the calculation that was performed, as we mentioned yesterday, we did two calculations. One, of course, was the CSQ calculation that was performed at Sandia, which was based on a uniform 18 percent concentration, and the other one was to look at the shock wave as a simple Chapman/Dugay calculation, and they were sufficient to fail the structures, we felt. By conversion of the next step --

[Slide.]

MR. MARK: On that slide, your conclusion is that the hydrogen distribution, except for a rather transitory period, is effectively uniform. There is a period of -- I don't know what that scale is. How long is it out of equilibrium?

MR. PRATT: Well --

MR. MARK: For about ten minutes.

MR. PRATT: Yes, that's right. But be careful. This we kind of chopped off here. This would be the in-vessel hydrogen production, and then you would expect after vessel failure that this would start to build up again as a result of core-concrete interactions.

I have separate slides -- I didn't bring them with me -- that show the effect of the additional hydrogen generation at later times.

MR. MARK: Look, it will raise the level, but it

will still not disturb the uniformity.

MR. PRATT: Right. And I think when you look at the containment event tree for the later times, you will find that there is much less distribution in the phenomena because of that very fact. What we find is that during the early stages, there is possibility of deflagrations and so on, whereas later on, because of the later times and the fact that it is not distributed as well, you do see a difference in the containment event trees, that's right.

[Slide.]

So again, after we move on from the detonation, we then looked at the potential for detonations to occur, and the assumption that we made, as I mentioned, is that if it was above 18 percent to 20 percent, we would get detonation. We looked at the magnitude of the shock loading. I didn't mention that we used two assessments, one the Chapman/Dugay and the other one the CSQ load, and then we converted those dynamic loads through an equation that G.E. used, which looks at the materials that the shock wave was seeing, and converted the equivalent shock loading into an equivalent dynamic static loading.

Let me say that again. Converted the equivalent dynamic shock loading into an equivalent static load, and compared that static load against the estimates of the capability of the structures. We did have some discussions

yesterday with the subcommittee on the appropriateness of that in particular.

So again, if there any particular quetions that anybody would like to go into on any of these items, otherwise I don't plan on going through all of the Vu-graphs, in the interest of time.

MR. WARD: I guess there are none.

MR. PRATT: Okay. Let me just move on, then, to the last couple of Vu-graphs, which illustrate the --

[Slide.]

This will give you a very brief status of the interface that is going on between the NRC Staff and the Hydrogen Control Owners Group. The Staff position regarding accepability of hydrogen release histories is defined in the letter from Bob Bernero to Hobbs dated June 24, 1985, and I think the issues that the NRC were bringing up related to hydrogen release rates and the amount of hydrogen oxidized were relevant to this particular consideration.

And basically we have arrived at three cases that the HCOG people should look at in terms of encompassing a range of degraded core sequences that they should model in their quarter-scale test program.

The first case assumes that you would have restoration of basically CRD flow, about 150 gallons per minute started at about 3000 seconds after scram, look at

the hydrogen release rates and generation rates for this particular sequence as being typical of a degraded core event.

Another limiting --

MR. KERR: Excuse me. One does that looking with MARCH?

MR. PRATT: Well, we have looked at it with MARCH, the Staff and the consultants. The Hydrogen Control Owners Group have their own computer code, which is a core heatup code, and a good deal of time and money is being spent on ironing out differences between the version of MARCH that we have -- bearing in mind the version of MARCH that we used here was different from the version of MARCH that we used in our GESSAR review. We went into this a little bit at the last meeting. GESSAR was based on --

MR. KERR: No, I just asked because this implies that MARCH can tell you what the condition of the core is at 50 minutes after scram, sufficiently well for one to know the hydrogen production produced by 150 gallons per minute flow. And I admire -- well --

MR. PRATT: I hear what you are saying. As I said before, this is an early stage of core damage, and a good deal of the interface that went on between ourselves and HCOG related to the condition of the core, questions of when you would put off the oxidation as a result of core damage, bypass of damaged reasons and so on.

So there was a good deal of code comparison in the calculations. The version of MARCH that we are using here is MARCH II, and it does involve a modeling of the channel boxes, which we didn't have in the earlier version of MARCH. You know, in the old days, we used to have to lump that into the fuel to try to get the right amount of zircalloy and so on. So none of that was in there.

We were explicitly modeling these things. There were differences. They had nodes within the fuel and we did not and so on.

But the predicted differences during the early stage when you're looking at degradation, you are really limited by steam, and it's really not a terribly hard calculation to perform; you have X amount of steam and you know what you're going to get out. Really, where the problem arises is when you try to restore the water. In this particular case it's so fast you really don't care. I mean, the reflood process is very fast. You can get a very sharp spike of hydrogen generation and it's all over.

Here, it's just about balancing it. And things that MARCH does -- for example, it's a systems code so there's a feedback of pressure. And just the changing of the enthalpy of the steam, or of the water, in the bottom head can give you an additional steam source in MARCH, whereas the HCOG code, which is just looking at the channel, fixed boundary

conditions, that specifies the flow rate doesn't see that.

So there is a lot of subtlety that went into the reflood process, an additional hydrogen steam sources and so on. So while we have quoted these three cases, there are modifications to the code that will be input to the code to get it closer to what we would feel comfortable with, so that we are all talking about the same types of generation rates.

But you are right, there is a good deal of uncertainty here. And in Case C it's really an attempt to say okay, we have to reach the 75 percent metal-water reaction which is in the rule, so we have got to just tack on an artificial tail to reach that at the end. But the types of flow rates you get in here do vary, and of course, you will terminate the accident sequence long before you get to this point by these two cases [indicating].

MR. MARK: What, in pounds per minute or seconds, what does Case A lead to in hydrogen generation rate?

MR. PRATT: Oh, I wish I had brought you the graphs. We have literally hundreds. I will have to send them to you. It falls short of the 75 percent metal-water reaction, and it reaches a peak of about --

MR. MARK: Well, in some of them you have 20 pounds per minute, or things like that, of hydrogen appearance. Is that consistent with what is up here?

MR. PRATT: If I recall, -- and again, I'm thinking

back to a lot of the sensitivity studies that I saw Dr. Yang do, who is in my group at Brookhaven, but I think the maximum we saw about here was at the peak about 80 pounds per minute. 80 pounds per minute peak for a very short time, and then it came down.

MR. MARK: Okay, that's good enough. That means half the water is getting used or converted.

MR. PRATT: In certain cases, that's right.

MR. EBERSOLE: Has anyone looked at the probability of this interesting window through which there flows a chance of all this hydrogen generation? Because you get get just the right amount of water but not enough to cool the core. It seems like that is a fairly narrow window, if you get just the right amount of water to do all this, but you don't get more than that and thus accomplish cooling, or none at all. Isn't that a pretty improbable state of affairs?

MR. PRATT: Improbable, did you say?

MR. EBERSOLE: Improbable.

MR. PRATT: Yes. I think that's true. I think the way this has been handled, though, is more from a deterministic approach.

MR. EBERSOLE: That you have exactly the right amount to do the wrong thing.

MR. PRATT: Right.

MR. EBERSOLE: And what are the odds that that can

occur?

MR. PRATT: I wouldn't dare guess.

MR. EBERSOLE: Mr. Bernero is gone. Oh, well, he wouldn't have it either.

MR. PRATT: I think there is a difference between this approach and what we are doing in the PRA's in the sense that, you know, this is an attempt to try to scope the types of hydrogen generation rates that one might get, however one does it, and to try to do it to the best of our ability. We are not purposely building into any of this assessment anything that is physically unreasonable. But again, the probability of this occurring, as you say, could be pretty low.

MR. EBERSOLE: What you're doing is driving the conditions towards optimization of hydrogen production.

MR. PRATT: Yes, this is miserable. You know, this is terrible, and it's terrible to analyze. That's exactly right. And we spent a tremendous amount of time really tracking down, you know, really the guts of the computer codes to come up with the difference that we're coming up with here.

MR. MOELLER: In Case C, how long would it take to reach 75 percent metal-water?

MR. PRATT: I'm not sure. I can't answer that, I'm sorry.

MR. MOELLER: You couldn't ballpark it for me?

MR. MARK: Well, you get 7000 pounds of hydrogen if you take 75 percent of zirconium, so it would take several thousand seconds --

MR. MOELLER: Times 10.

MR. MARK: Which is to say some number of hours.

MR. PRATT: Yes. I just did a little calculation here. The numbers that I seem to remember, I would think it would take at least 1000 seconds. At least. Additional. Because the numbers that I seem to remember from this calculation were in the region of about 1400 pounds of hydrogen, and you're trying to get to about 27 or 26. So it's about 1000 seconds, which is maybe a half an hour or so.

MR. MARK: Ten thousand seconds is three hours.

MR. PRATT: Okay. The three other points here -- and these address some of the concerns of the ACRS -- this test program is really designed to look at the adequacy of the deliberate ignition. There was a question asked yesterday about whether or not they were going to look at distribution, and I spoke with the people at Containment Systems Branch at NRC. The aim of the program is to try to look at it as built initially.

There is some talk that they may not switch on all of the deliberate ignition devices but keep some of them out of the circuit to see what the effect might be. But that would be the only attempt to look at it, as I understand it.

I think that was a question you brought up yesterday.

And again, they are really not looking at optimum ignition sources; they are really taking the source that will be installed in the plant and testing the as-is situation.

MR. EBERSOLE: Well, it's not possible to have too much ignition or too much distribution; it's just an economic or practical matter.

[Slide.]

MR. PRATT: The final point which we wanted to touch on was the effect of wetwell hydrogen flames, and I think we're pretty well in agreement with GE in this regard. There was an assessment performed by Appendix A to the Containment Performance Working Group report; that is NUREG-1037. The report is out for distribution and for comment at present.

The heat fluxes were provided to the containment performance working group by the containment loads working group, and they are defined in NUREG-1079, and there is I believe a copy for comment of NUREG-1079 out now.

And the calculations reported in Appendix A indicate that the seal temperatures will increase but they were still below the estimated failure point. There is an additional point that I have in here which really deals with full core meltdown events and not the standing flames that we see in the degraded core events, which would imply that at later times, because of high drywell temperatures during core-concrete

interactions, that one could exceed the failure limit of the seals at later times as a result of those high temperatures and then introduce pool bypass at that time.

If there are no more questions, the second presentation that I have deals with really the thermal degradation of the support of the vessel. And again, I will abbreviate this presentation relative to the presentation I gave to the subcommittee yesterday.

The three items of importance related to ablation of the support, and Debbie has already mentioned that the calculations that the committee were given by Jack Rosenthal were based basically on a concrete support structure. And she has now shown that the support would be transmitted to the steel. And in fact, if the outer steel supports the vessel, there may not be a problem.

What I would like to do is skip over the viewgraphs that were given to you by Jack Rosenthal that looked at the ablation front of the temperatures, and show you what the significance of the loss of containment integrity would be in terms of the impact on risk, and that might give you some perspective as to what this effect would do. And then there was a final item that you wanted to talk about relating to the effect of containment venting, and I have one viewgraph which summarizes that effect.

So I will skip over the drawings you have of the

various structures and move to this particular slide.

[Slide.]

The table that I showed you earlier at the start of my presentation, Table 15.9 of Supplement 4 to the SER, can be used because it itemizes the contribution to risk of the various failure modes. You can use that to estimate the impact of early loss of containment integrity, for example, as a result of movement of the vessel. An early loss of containment integrity plus loss of drywell integrity. And simply, if you lose containment integrity, the late containment failure mode calculations, such as the L2 and L3 -- the L refers to late containment failure -- would become I2 and I3; that's an intermediate failure.

If you lose also, in addition to that, drywell integrity then the situations in which you had 3's, which imply suppression pool scrubbing of all of the fission products would move from a 3 to a 2. So by simply looking at that table, we can go to the bottom line results.

If you lost containment integrity for all of the sequences as a result of this phenomena early on, shortly after vessel failure, the increase in risk -- and this is without UPPS installed -- would be a very modest increase. If you lose containment integrity plus a loss of drywell wall, your person rem estimates would go up by less than a factor of 2.

So again, this is to give you some feeling for if you go to the very conservative assumptions that you would lose drywell integrity and containment integrity as a result of slippage of the vessel early on, this is the effect you would get. I think the calculation as presented by GE would indicate that this event would not occur earlier on and would occur much later in the accident sequence. So this gives you an upper bound as to how things might change.

[Slide.]

There was a question or an issue related to containment venting, and this is a viewgraph basically that I've put together and doesn't necessarily represent the staff position, but I think it does summarize the thinking that's going on.

"Clean" venting of the containment building would be designed to really address the Class 2 accident sequences plus, too, it refers to those accidents that lose containment heat removal. And by attempting to vent, you prevent core damage. And also, the ATWS sequences for the same reason.

You can effectively get an estimate of the impact of this by looking at that table. But Class 2 sequences, by looking at that table, you'll see are significantly reduced anyway by the venting capabilities already built into the UPPS system. And the only thing, in our looking at the cost-benefit work that we did at Brookhaven, we didn't take a

great deal of credit for mitigating ATWS sequences as a result of the venting. I think this is something that personally, you would prefer to try to manage the ATWS sequence rather than going to a venting procedure to help you there, simply because you're dumping such a large amount of energy into --

MR. EBERSOLE: May I make an observation at this point for the full committee? The venting concept of the UPPS is just that; it's a concept, and it's an assembly of loose parts, I would call it, not yet integrated and organized into a modular package. And it's General Electric's proposal and the Staff's proposal to leave it this way until the first application or the first buyer appears, and at that time to have a general set of guidelines and criteria against which they will construct this.

I have a little problem with this because it seems to me that it is not a part of a well-developed standardized package; it's a little bit like the early allowance of the industry to let whoever wanted to to design the aux feedwater systems. And I would rather -- and this is just a personal viewpoint -- see this as a pre-identified and well organized picture, both in the context of operating it -- what you're talking about now -- as well as in design configuration including such independent housing as it may have.

At the moment, it's a number of pieces which are

scattered about including piping which traverses the containment building possibly into the aux building and I would call it sprawled. And thus, it has no integral character. This precludes it being used at this time for consideration, among other things, of security. And in short, it's just a concept.

I think the committee should at least study whether they want to leave it as a loose, sprawled concept or have it pulled together at least a little bit tighter. That's all I have to say. Carry on.

MR. PRATT: That is the end of my presentation.

MR. EBERSOLE: Well, in that case, let's have a little recess of 10 minutes until 10:30.

MR. WARD: And when we come back we will be in closed session.

[Whereupon, at 10:20 a.m., a short recess was taken, the subcommittee to reconvene in Closed Session.]

AFTERNOON SESSION

1:50 p.m.

MR. WARD: Our next topic is Item 3, the seismic qualification of equipment in operating plants.

We appreciate the Staff and representatives from the industry coming in a few minutes early to accommodate us.

Mr. Wylie?

MR. WYLIE: Okay. The Subcommittee on the Qualification Program for Safety-Related Equipment held a meeting on Tuesday, August 6th. In addition to myself, those in attendance were ACRS members Ebersole, Reed, Siess and Ward, and ACRS consultant Lipinski, and the Staff Engineer, Tony Cappucci.

The objective of the meeting was to review and discuss the NRC Staff Resolution of Unresolved Safety Issue A-46, Seismic Qualifications of Equipment in Operating Plants.

The subcommittee had the benefit of presentations by the NRC Staff, Mr. Newt Anderson and T. Y. Chang representing the Staff, and the Seismic Qualification Utility Group, Jim Thomas for Duke Power and Peter Yanev of EQE, and Mr. Dick Shaftstall of KMC.

The NRC Staff presented a status report regarding the resolution of USI A-46 and its implementation, and SQUG presented their activities regarding their program, the

results to date and their implementation plan.

In addition, Mr. Peter Yanev of EQE presented a detailed report of the most recent investigation by SQUG of the March 3rd, 1985 Chilean earthquake, which provided additional evidence that the type of equipment used in power plants survive large earthquakes very well. He presented about 50 slides out of 5000 that they collected in their investigation.

I won't go into a lot of detail, since Mr. Thomas is here today to cover that portion of the presentation. But in general, it showed that the power plants, industrial plants, oil refineries in general did very well, and the equipment survived very well.

The subcommittee decided at the end of the meeting to request the NRC Staff and SQUG to present to the full committee a somewhat condensed version of their presentation in the two hours allotted this afternoon. The presentation regarding the Chilean earthquake will be somewhat abbreviated today, but SQUG has offered to present a full report to the ACRS at a later date if the full committee so desires.

In considering the proposed resolution of USI A-46, one should keep in mind that the scope of A-46 is somewhat limited, and perhaps a comment regarding its scope will be of value.

The scope of A-46 requires the verification of the

seismic adequacy of equipment required ot bring the plant to a safe shutdown condition and maintain the plant in a safe shutdown condition following an SSE. The scope is limited to active mechanical and electrical components, and the scope is further limited by excluding those issues and items which are addressed elsewhere by other USIs, generic letters and IE bulletins.

For example, systems interactions are being addressed by USI A-17. Decay heat removal requirements are being addressed by USI A-45. Masonry wall adequacy is covered by IE Bulletin 80-11. And the accident mitigation systems are not included in the scope of A-46.

As a matter of background, in July of 1983 the ACRS was briefed by SQUG on their program and approved a letter from ACRS Executive Director to the EDO, which encouraged continued work along the lines presented by SQUG.

During the 289th meeting, May 10 through 12, 1984, the ACRS was briefed on the status of USI A-46 and subsequently wrote a letter to the Commission on May 16, 1984 endorsing the approach being taken by the Staff based on the SQUG efforts with comments.

The NRC Staff has prepared its revised resolution package, which consists of NUREG 1030, Seismic Qualification of Equipment in Operating Nuclear Plants, Draft Report for Comment, which is the supporting technical basis for the

resolution of A-46.

It has prepared the regulatory analysis for A-46, which covers the analysis, the plan, the implementation procedure.

A draft letter has also been sent -- has been prepared, which will be sent to licensees following resolution of public comments.

CRGR has reviewed the package and approved sending NUREG 1030 and the regulatory analysis out for public comment.

The package has been sent to EDO to be sent out for public comment.

No action is required on the part of the ACRS. However, the ACRS may wish to consider writing the letter at the conclusion of today's presentation, in light of the earlier letter which the ACRS wrote.

So with that, unless -- first of all, let me ask the subcommittee members if anyone has any additional comments or statements they would like to make.

(No response)

If not, I will call on --

MR. MOELLER: A quick question, Charlie.

You are saying this then covers systems which may be covered in other USIs, but this only applies to the seismic resistance of those systems, is that correct?

MR. WYLIE: That's correct, seismic qualifications of the systems.

Let me make myself clear. The equipment and considerations which are being addressed in the other USIs are not included in A-46.

MR. MOELLER: Well, you were saying like there is another USI to cover safe shutdown heat removal.

MR. WYLIE: That's correct.

MR. MOELLER: Okay. But this USI covers electrical and mechanical -- the seismic capabilities of the electrical and mechanical equipment used?

MR. WYLIE: That's right. Used to obtain safe shutdown.

MR. MOELLER: Okay. I'm clear.

MR. EBERSOLE: Charlie, I would like to make an observation.

The robustness of this equipment which enables it to survive these earthquakes, these other shocks, has been acquired and obtained by longstanding developing practice, probably based on the notion that a lot of this equipment is going to be thrown around on trucks and bounced on the ground and whatever, at which time it will see greater g values and shocks than it ever will in an earthquake.

I can't put my finger on any existing control document that says this will continue. In short, a vendor

manufacturer might say, "Oh, I am going to pack my device in cotton, so I can make it flimsy and it will survive the challenge that I thought it was going to have to survive against much more rigorous circumstances."

This is a nebulous nature. Whether we can count on a persisting character of robustness in this equipment -- it seems to me there has got to be some sort of controls which have perpetual significance.

MR. WYLIE: I think to some extent what you say has some validity to it, in that you do have to ship equipment and it has to hold together when you ship it. But, it also has to perform once it has been delivered. For example, motors have to be strong enough to deliver their --

MR. EBERSOLE: I'm thinking about relays.

MR. WYLIE: Relays. Again, there are all kinds of relays. I think that is one of the considerations. Relay chatter is one of the considerations.

MR. SIESS: Jesse, it seems that your concern is related to future.

MR. EBERSOLE: Yes.

MR. SIESS: Those are all covered under the existing criteria. This has to do only with the qualification of equipment that is already in operating plants, the 72 of them.

MR. EBERSOLE: You have got to replace these things as they wear out.

MR. SIESS: Yes. But the replacement presumably will come under the same criteria as new plants.

MR. EBERSOLE: I didn't know that.

MR. SIESS: I'm not sure.

MR. ANDERSON: I don't believe that is correct as you stated it. I think our proposed position with regard to replacement parts is that the utility would have the option of either using the A-46 developed data base, or qualifying it to current criteria.

MR. SIESS: Okay. Now, what would apply to, say, Vogtle, the plant Vogtle, which presumably has equipment qualified under the existing criteria, right?

MR. ANDERSON: Yes.

MR. SIESS: Their replacement equipment would not have to be qualified under the existing criteria?

MR. ANDERSON: I would have to look to see if Vogtle is on our list. I don't believe that it is.

MR. SIESS: Let's take a plant that is not on your list. That is what I am talking about.

MR. ANDERSON: I think Vogtle is a good example. There isn't any consideration in our proposed resolution that plants that do not now fall within the scope of A-46 would be allowed to use this in the future.

However, as we noted to the subcommittee Tuesday, the IEEE 344 Committee is proposing a provision which would

include the use of seismic experience data much in the same fashion that we are doing.

MR. SIESS: So they intend to go to a relaxation.

MR. ANDERSON: Yes, sir.

MR. SIESS: Then, I think Jesse has got a legitimate argument.

MR. WYLIE: Except if it is proven by experience that the equipment is adequate and placed in the data base, then you could use it.

MR. SIESS: You could use that model.

MR. WYLIE: You could use that model.

MR. EBERSOLE: Sure, if you hold to that model.

MR. SIESS: It seemed to me the SQUG type approach resolution of A-46 makes a great deal of sense for equipment that is in operating plants now, equipment for which qualification under the existing criteria would be somewhere between difficult and impossible.

I don't see that similar justification for replacement equipment which can be hauled out to labs somewhere and tested, or for relays which will undergo quite a research program, and maybe will be qualified on some other basis.

But, it seems to me the rationale for experience base on existing plants, and the rationale for using experience base on future plants is somewhat different. And,

I had not thought of it entirely in that light.

MR. ANDERSON: I would like to add that we did meet with the vendors on much of this equipment.

We talked with the NEMA people with regard to cabinet sizes and design practices.

Although in some areas the standards are not that well established, the design practice is established. As a matter of fact, does not appear to be a softening or a cheapening of the manufactured materials that is coming out.

We can't guarantee this in the future, but I think that we did establish that it has not happened to date.

MR. WYLIE: Mr. Thomas had a comment.

MR. THOMAS: In that area, what the SQUG program is doing in the implementation plan, is trying to come up with some pretty specific criteria for things that need to be checked, looked at in equipment, to verify that it truly is rugged.

These walkdowns play a big part in that. What we have really learned is that there are a lot of things that you can look at and by using judgment, probably make in most cases, as good a judgment as to the seismic ruggedness of the equipment as a test is going to give you.

As far as the new equipment, I agree, it is out of the scope of A-46. But some of the criteria and some of the things we have learned, I would say probably are in many cases

as good as a seismic test if you use those as a screening criteria when you look at the equipment and check it out, check the way it is made, its ruggedness, look at cutout sizes, truly verify that you haven't introduced any kind of sensitive area.

The relay issue is one thing that is difficult to do.

MR. SIESS: Let's take it one at a time.

Taking what you have said, for example, wouldn't 344 have some of those criteria in it? So, if you simply said, "That is your standard. Meet 344," people would have to look at those things and establish their ruggedness.

Or, is it just something between the licensee and the manufacturer.

MR. THOMAS: The incorporation of the experience data approach to 344 is just beginning. I think what you are saying is a logical way to proceed to where the standard does give you some of that type guidance in regard to what you would be expected to do in regard to applying experience data to a newly manufactured piece of equipment.

MR. SIESS: So, specification or committing to 344 would provide a fair level of assurance that significant change in weaklings wouldn't get by?

MR. THOMAS: Assuming 344 gets developed as we hope it will.

MR. SIESS: If it doesn't, of course, we could always have a Reg Guide that supplements it. That is not an unheard of practice.

MR. WYLIE: Any other comments or questions?

[No response.]

Why don't we call on the Staff to go ahead. Mr. T.Y. Chang is going to present the Staff's presentation.

[Slide.]

MR. CHANG: My name is T.Y. Chang. I am the task manager of USI A-46.

Today I would like to present to you the status of A-46.

The first Vu-graph is an overview of today's talk. I will summarize the A-46 program, then talk about proposed resolutions, scope and basis and implementation requirements. Then Jim Thomas of the SQUG Steering Committee will present a talk on the ongoing SQUG EPRI activities.

Among their activities, anchorage guidelines is one thing being currently developed by the EPRI, and also they are in the process of collecting test data from previous qualifications.

Relay review procedure is another thing they are looking into, and they are going to propose something on the line of the generic implementation. It is called SQUG generic

implementation plan.

[Slide.]

Since the beginning of the commercial nuclear power plant program, design methods and qualification philosophy of equipment have been changing continuously, so it is a logical question to ask whether equipment in those existing plants, when they are called upon to perform their safety functions, will they be able to do so or not if an earthquake comes?

One possible choice to answer that question is to impose the current licensing criteria on all the equipment in the existing plants, but upon a closer look, it is apparent us by using the current licensing methods and criteria that is not practical because the current requirement calls for testing those equipments on the shake table in the lab.

First of all, you may not be able to obtain a piece similar to the ones in the plant, the sort of vintage that we are talking about. Secondly, you have to worry about the down time once you take the equipment out of the plant. So we are looking for an alternative to the current licensing criteria, which is both effective and also cost effective.

MR. MOELLER: Excuse me. I don't follow what you are saying. You are saying you are debating whether to apply the current criteria to the equipment at the plants. I thought you had to do it whether you wanted to or not.

MR. CHANG: We are talking about operating plants

now, not licensing plants.

MR. MOELLER: You are talking about backfitting?

MR. CHANG: Yes. A-46 is concerned only with operating plants. I neglected to mention that.

MR. MOELLER: What you are saying, then, is you are debating or the discussion relates to whether you should take criteria that have been developed recently and back apply that to operating plants?

MR. CHANG: Yes. That comes as a logical choice when you look at it because we have that current licensing criteria and methods in place for the licensing plant.

MR. MOELLER: For new plants.

MR. CHANG: For new plants, right.

MR. MOELLER: When were these licensee criteria developed?

MR. CHANG: The document, the technical requirement actually is described in Standard 344, 1975.

MR. MOELLER: So anything that was finished prior to 1975 --

MR. CHANG: The requirement for this document actually is for those plants. The CP application, if it is docketed after October 1972, then they have to comply with this document.

MR. MOELLER: All right.

MR. CHANG: So the objective of A-46 is to look for

alternative methods in lieu of using the current criteria to assess the seismic adequacy of equipment.

MR. MOELLER: Help me again, now. If a plant does not now have an operating license -- you know, say one is under construction -- do you require that all of these critical components be put on a shake table and tested?

MR. CHANG: Yes. They have to comply with the current licensing criteria.

MR. MOELLER: Which includes --

MR. CHANG: Which includes -- well, testing equipment on a shake table is the recommended method in the actual 344 document.

MR. MOELLER: If it can be done.

MR. CHANG: They have other alternatives, such as analysis, but for equipment, the functionality cannot be assured by structural integrity, then they have to test it.

MR. EBERSOLE: Point of clarification. He said all. What really happens is one out of 500 might. Then they invoke the standard construction on electrical apparatus in particular, right, type tests.

MR. CHANG: Type tests, right.

MR. EBERSOLE: Highly dependent on consistency in manufacture, assembly, maintenance, et cetera.

MR. CHANG: You don't actually have to test each piece of equipment. A-46 was designated as USI in December

1980.

MR. EBERSOLE: As a matter of fact, couldn't these earthquake experience records constitute type tests of sorts, the actual equipment of a given model, type and so forth has survived a given g value in the laboratory influence?

MR. CHANG: This is what they are proposing in the actual document now, trying to use the seismic experience as an acceptable way in lieu of doing the actual qualifications.

MR. MOELLER: When you do shake table tests, and I realize we are not necessarily talking about that, what acceleration forces do you use?

MR. CHANG: This has to be site specific. It depends on the site.

MR. MOELLER: Let's say it is site specific. Do you use the SSE or the OBE or what?

MR. CHANG: They have to do a number of OBE tests on top of the SSE.

MR. MOELLER: Okay.

MR. CHANG: During the process, of course, they have to consider the amplification of the seismic input through that building.

[Slide.]

MR. ETHERINGTON: Are they putting an actual earthquake spectrum into the test procedure?

MR. CHANG: Yes. For each site in the location of

the elevation, they have to generate the required response spectra.

MR. ETHERINGTON: At one time they were using what they called sign beat testing.

MR. CHANG: That was the old method 344, 1971 method.

MR. ETHERINGTON: Has that been abandoned?

MR. CHANG: In certain cases if you can justify it that can still be used, but in the current version of 344, the recommended method is to use a random test.

MR. ETHERINGTON: That is much better, of course.

MR. CHANG: That is much better, yes.

Upon looking at several potenti-l alternatives, we concluded that the only viable and practical way other than using the current criteria and method is to use the seismic experience data approach. The feasibility of this approach was established by two independent studies. One is done by Lawrence Livermore Labs. The other one was initiated by a utility group, SQUG, Seismic Qualification Utility Group.

They started to look at earthquakes in California. The question coming to their mind is, firstly, is there enough information they can gather from those earthquakes? And the second question, obviously, is is there any similarity between equipment in those nonnuclear plants and equipment in the nuclear plants?

To answer those questions, they looked at two California earthquakes. One is 1971, San Fernando earthquake. It is a magnitude 6.5 earthquake. The other one they looked at is 1979 Imperial Valley earthquake, magnitude 6.6.

They looked at a number of nonnuclear plants in that area, and they looked at six nuclear plants and compared the equipment in both categories, and it turned out to be that they are quite similar regardless that it is in a nuclear plant. A piece of pump is a piece of pump, basically. There is no major difference. And for motor control centers, things like that, there is no difference whatsoever.

The only obvious difference is that for nuclear plants, you require a piece of paper to prove that.

In their pilot program they looked at eight classes of equipment, both in the category of a mechanical equipment and electrical equipment. Those eight classes were chosen in such a way that they will be representative of equipment in the plants, and also they constitute a big percentage of all the equipment in the plant.

The eight types of equipment chosen are motor control centers, low voltage switchgear, metal clad switchgear, unit station transformer, motor operator valves, air operated valves, horizontal and vertical pumps.

MR. MOELLER: What was the criterion used to select

those particular eight items?

MR. CHANG: As I mentioned earlier, they think this constitutes a pretty representative cross-section of both mechanical and electrical equipment in the plants.

MR. MOELLER: Would it represent 90 percent of the risks?

MR. CHANG: They did not consider this from the point of risk.

MR. MOELLER: Maybe I should have said do they represent 90 percent of those components most likely to be subject to a seismic failure?

MR. CHANG: Not from the seismic failure point of view. It constitutes a big chunk of all the equipment in the nonnuclear plants and nuclear plants. They probably represent 80 percent of all the equipment someone would like to look at.

MR. MOELLER: I would have thought there would have been a basis for the selection. In other words, these were the components most likely to fail or the components in greatest use or something?

MR. CHANG: Keep in mind this is a pilot program. They are starting from scratch. They just want to get some idea as to how the equipment qualification question can be answered by comparing nuclear to nonnuclear plants from earthquake experience point of view.

MR. THOMAS: I would like to add a little to that. What you just said happens to be correct. We tried to pick the equipment that was most utilized in the systems and also the ones that would -- just backing up and taking a big look -might be most susceptible to seismic-type forces.

So just as an example, you are going to see hundreds of valves, hundreds of motor operators in plants. You are probably only going to see one inverter. So we picked valves, motor operators for valves. You look at them. So what they said, they are the ones we felt were a group that we could kind of hone in on that was truly representative of very large amount of the equipment.

MR. CHANG: Again, I think that is from a numerical point of view that that represents a big percentage of the equipment in a plant. When you talk about earthquake loading, every piece of equipment will see earthquake loading in a plant. In their pilot program, the data were collected from the two earthquakes I mentioned, the San Fernando and the Imperial Valley earthquakes, but later, in 1983, Coalinga earthquake happened, so they managed to incorporate the Coalinga data into their pilot program as well.

In 1984, Morgan Hill and the recent Chilean earthquake. They went there and tried to collect information from those earthquakes in order to expand the data base from the pilot program.

I think I should mention here the Chilean earthquake is a big league earthquake, magnitude 7.8. Jim is going to talk about that. He is going to show you some slides. From the building and structural point of view, there is a lot of damage seen there. However, the performance of equipment is very remarkable. You can see from those slides.

A panel, SSRAP, Senior Seismic Review Advisory Panel, was formed in June 1983. This panel was jointly selected by SQUG and NRC. The function of the panel is to provide expert opinion and advice as to how to use the seismic experience data, how this should be utilized in our review.

There are five members on the panel. They are all acknowledged experts in this area, and two members are from engineering consulting companies. One is from a university, one is from a test lab and one is from a national lab.

Since the formation in June 1983, they started to look into the SQUG pilot program. They actually asked SQUG to go back and recollate the data in a more systematic fashion that they can readily utilize, and at the end of 1983, they formulated a tentative guideline as to how the experience data should be utilized to assess the equipment seismic adequacy.

That report was revised twice, and the final version was out January 1985, this year. In that report, the rules as to how those experience data should be utilized were laid out, and in that report, so-called bounding spectra, that spectra

represents what they think a conservative estimation can be from those earthquakes that should be utilized in our review.

Those are the spectra that the equipment actually have seen during the earthquake. So in a sense, this is sort of like test spectra in the seismic qualification, but this is a much conservative approach. They reduce the actual size spectra by a certain factor just to make it more conservative.

The NRC Staff participated in all the SQUG and SSRAP meetings and closely monitored their progress, and the present proposition from the Staff is based mainly on the seismic experience approach.

I might add that when we talk about seismic experience approach, we are not limiting ourselves to only the earthquake experience, but we are covering the test data experience as well. This is the effort that EPRI is currently doing and working on.

[Slide.]

Those are either types of equipment I mentioned earlier that are being looked at in the pilot program. Roughly, there are 3000 pieces of equipment included in their pilot program.

When we talk about the number of equipment there, the devices, for instance, relay switches and things like that in the electrical cabinets are not counted as one piece of equipment. We only count the electrical cabinet as one piece

of equipment. So if you go down to the device level, actually it's much more than 3000 pieces.

[Slide.]

These are the conclusions of review by the SSRAP on the SQUG pilot program. First of all, they think the equipment installed in nuclear power plants is generally similar to and at least as rugged as that installed in conventional power plants. And when this equipment is properly anchored and with some reservations, those reservations are described in the report. They call it caveats or exclusions. I will go into those things a little bit more later on.

When those eight classes of equipment are properly anchored, then they concluded that those equipment have an inherent seismic ruggedness and have demonstrated capability to withstand substantial seismic motion without structural damage. This substantial seismic motion they were referring to is actually the earthquake input they have seen at those two earthquake sites in California.

MR. KERR: What am I supposed to learn from that second statement?

MR. CHANG: From this statement what we're saying is yes, there may be some concerns about equipment. Actually, it's in the area of anchorage. Once you assume the anchorage is adequate, then the equipment is really pretty rugged as far

as seismic loading is concerned.

MR. EBERSOLE: Isn't it just the end result of having to package it for handling prior to installation?

MR. CHANG: That could be a result of that.

MR. KERR: Does that tell me that anything more needs to be done, or that something needs to be done?

MR. CHANG: That tells us that at least we have to look at the anchorage, because this may be an area that will cause some problems. Because during their review of the data base plants -- and we got that input from the ACP program also -- if you don't have anchorage or if the anchorage is not adequate, then the equipment is likely to be shifted during earthquakes, or it can even overturn and cause some damage to the equipment.

MR. KERR: I'm surprised it took a study to reach that conclusion.

MR. CHANG: This is actually what you see from their experience.

MR. KERR: Thank you.

MR. MOELLER: I guess, though, one could question your first bullet equally. I would that equipment installed in nuclear power plants is as rugged as that installed in conventional power plants. Why wouldn't it even be better if it has a better pedigree in terms of QA and so forth?

MR. CHANG: Well, I think that's why they say at

least as rugged. Their feeling is probably that equipment in nuclear power plants should be more rugged.

MR. ANDERSON: That's a necessary conclusion to go to the point where you're going to use the seismic experience in the plants, to the nuclear plants. We think it's much more rugged. We're trying to establish that similarity.

MR. MOELLER: Okay. In that light, I fully understand.

MR. AXTMANN: What does the phrase "with some reservations" mean, in the second bullet?

MR. CHANG: Those are the caveats and exclusions, because the number of equipment in those plants cannot cover all the equipment in nuclear power plants.

For instance, when you talk about motor-operated valves, if there are valves only up to -- the motor-operated is only that much apart from the valve body, say six feet. Now, if you have a piece of valve seven feet from the body in a nuclear plant, apparently that piece of equipment cannot be evaluated by using the seismic experience data base approach. So those are the things they spelled out as the caveats and exclusions to the use of the experience data.

Other things such as they would think a cutout from an electrical cabinet cannot be bigger than six inches by 12 inches, and things like that. Some of them are based on their engineering judgment; some are based on the extent of

equipment they can collect in those experience data base plants.

MR. AXTMANN: Thank you.

MR. CHANG: The number 3 conclusion from this study is that functionality after the strong shaking has ended has also been demonstrated. But the absence of relay chatter during strong shaking has not been demonstrated.

What they are saying is there is evidence to show that devices like relays after an earthquake when they are called upon to function, they can always function. But whether they function or not during an earthquake because of the fact that those earthquakes happened early and that kind of information is lost. So that question cannot be established -- the operability of the equipment during an earthquake.

MR. MOELLER: Excuse me. How big is a relay? Why can't it be tested on a table?

MR. CHANG: It can, and that is being done for the licensed plants; they are all being tested on tables.

MR. MOELLER: But have these tests shown whether it chatters during the shaking? I guess I just don't understand the statement. If it's small enough to test on a table I would think you would have tested it.

MR. CHANG: Yes, indeed. During the test for new licensing plants they observed chattering.

MR. MOELLER: So they did observe chattering.

MR. CHANG: Yes.

MR. MOELLER: So we can presume then that there's chattering in the old relays, also.

MR. CHANG: It depends on the function. Okay? In certain cases the relay chatter may not be a matter of concern. But in other cases, depending on the function of the relay in the system --

MR. ANDERSON: Excuse me. I think one thing you've got to remember is that these conclusions are the conclusions of this panel following their look at the pilot program, and this reflects their conclusion with regard to what they learned from the seismic experience data. It's not necessarily the conclusions of our program; just what they said.

MR. CHANG: Those conclusions are strictly from an evaluation of the seismic experience data on the eight classes of equipment.

MR. MOELLER: Right. And there's nothing, no instrument, in these plants that underwent the earthquake. There's no instrument that would have recorded whether the relay chatter --

MR. CHANG: Yes, there's no indication whether they chatter or not during earthquake. So from this conclusion we can see that equipment basically is rugged from the seismic

point of view.

However, there are at least two areas of concern. One is anchorage; the other is the functionality of equipment and devices such as relays.

[Slide.]

Now for those eight classes of equipment, we have the guidelines pretty much laid out how they should be used and the caveats and the exclusion rule spelled out in the SSRAP report.

Now how about equipment other than the eight classes? Well, I have to say during their collection of seismic data from those plants, they did not restrict their effort to only the eight classes. They looked at, from the damage point of view, they tried to look for damage to all kind of equipment during the survey. Well, those eight classes are the ones that are being looked into in more detail and the data are being presented in a systematic way.

However, the ruggedness of equipment other than the eight classes is actually being looked at and assured from the survey as well. So our recommendation for equipment other than the eight classes is that yes, we believe that they are rugged from this survey. So we don't require any additional collection of seismic experience data for the other classes of equipment. However, we will require the utility to document their basis for seismic adequacy for their remaining classes

of equipment. This can be provided by either verification that the equipment exists in the data base plant; in other words, they have to prove a similar piece of equipment is really in existence as in those plants surveyed in the California earthquake. So they actually underwent that type of loading.

The alternative is by comparing it with the test data. This is currently being collected by EPRI. What EPRI is doing now is they are trying to collect test data information from test labs, from vendors, from AE's, from various different sources. They're trying to come up with some sort of conservative envelope for the test spectra and they call that GERS, generic equipment ruggedness spectra. So in essence, spectra is similar to the bounding spectra that SSRAP is proposing.

However, the GERS come out to be higher than the bounding spectra because normally the way you test, the test input will be higher than the actual earthquake input you saw at the California sites.

[Slide.]

In conclusion, after all these studies we have concluded -- SQUG and SSRAP, they all agree, we all agree on these three points. The only three concerns on the seismic adequacy of equipment in the operating plants are the following. The first one is the equipment anchorages. We'd

better take a look at anchorage to make sure they're adequate.

The second concern is the relay operability for those relays that are required to function during 30 seconds or so strong motion earthquake. You had better prove that it's going to function.

The third one is outliers. When we say outliers we mean those things I mentioned earlier, the caveats and these exclusions. We'd better have those rules spelled out clearly.

[slide.]

With the background I discussed earlier, the following is the proposed resolutions. Well, let's divide them into two groups; operating plants and new licensing plants. For new licensees there's no requirement from the A-46 point of view. They have to satisfy the current licensing criteria for operating plants. We believe those things should be done by the utility members.

First, they have to look at the equipment from the systematic point of view, develop an equipment list that should be looked at. Secondly, a walk-through inspection is necessary in order to convince us that two things will be answered from this walk-through; one is to verify the anchorages; the other thing is to identify and address the deficiencies and outliers.

MR. EBERSOLE: May I ask a question? I think you said you were developing or had developed a set of criteria

for walk-through operations. Where do you say, oh, that anchorage is adequate, or no, I'm not sure; I must analyze it.

MR. CHANG: This is being looked at by the EPRI program as well. The program was started about a year ago.

MR. EBERSOLE: Can you eyeball most stuff without analyzing it?

MR. CHANG: The idea is to do an analysis beforehand. They actually are looking at each type-by-type equipment, one by one, to look at the configuration -- well, this is from an envelope point of view, the center of gravity and all of that. And then from that point of view and the study of the capacity of anchorages such as expansion anchor bolts, they can establish how many anchor bolts of what size should be needed. Then the end product of that kind of study is a walk-through checklist and sometimes, a screening table. So those will be the end products of the walk-through to use.

So in other words, the detail work is done beforehand. Before the walk-through they will have those table guidelines at hand.

MR. KERR: The walk-through is just to see if the equipment is in the plant; is that right?

MR. CHANG: The walk-through is to make sure that the anchorage is adequate.

MR. KERR: But you've already done that by analysis.

MR. ANDERSON: Let me try that one. The purpose of

developing the anchorage review guidelines is to get some pre-determined anchorage configurations and anchorage loads for a typical cabinet, and typical anchorage layouts so you can go through and look at each piece of equipment, inspect its anchorage, and you can screen it. Because if you have already determined that that type of anchorage with that number of bolts and that configuration is enveloped by one you have already analyzed, then you go to the next one.

MR. KERR: The analysis then is a generic analysis; it's not an analysis for each piece of equipment separately.

MR. ANDERSON: That's correct, and we think that you can screen out most of the anchorage systems on this basis. The ones that won't pass your screen you have to do a specific analysis on.

MR. KERR: You kick it to see if it vibrates or something.

MR. ANDERSON: I don't know whether that's going to be one of the guidelines or not.

MR. CHANG: For each type of equipment and different types of analysis, you do an analysis first for the EPRI program to come up with what they think is adequate for the anchorage. For each type of equipment and the anchorage they would have that summarized in the form of a checklist and screening tables for the walkthrough to use.

So, you do the work actually beforehand and you use

the end product to check the adequacy.

MR. EBERSOLE: Does this include such things as verifying whether the doors come open on the panel boards and so forth under shock effects?

I've seen some switchboards where you could open one door at a time, but if you open two adjacent ones at the same time you create short circuits.

MR. CHANG: I don't think that is part of the anchorage considerations.

That sort of thing should be looked at. But, that is not part of the anchorage consideration.

MR. EBERSOLE: It might be worth your while to open doors and see --

MR. CHANG: They are required to open doors to look at the inside devices to make sure they are anchored.

MR. EBERSOLE: Open two at a time in an opposite direction. Sometimes you see some interesting effects when they bump into each other.

MR. ANDERSON: The doors and fasteners are also part of the experience. They look specifically for these in the data base.

MR. CHANG: They look at these to make sure they are not going to swing open.

Anchorages are one thing they have to address. The other thing they have to address is to verify the

functionality of equipment. Actually, we are mainly concerned about relays here.

I did not define the word "deficiencies" here. Deficiencies are obvious inadequacies from the walkthrough. By using A-46 criteria they are obviously inadequate.

This is different from the outliers. Outliers are things that are not included in the data base. However, it may be okay upon further evaluation. That is why on outliers we are relying on additional studies such as testing.

MR. KERR: How many outliers is a licensee supposed to find?

MR. CHANG: How many?

MR. KERR: Yes.

MR. CHANG: We don't expect too many outliers, really. But there will always be some oddball configurations.

This outlier is going to catch those outliers.

MR. KERR: If you get a report from a licensee that says, "We didn't find any outliers," do you tell him to go back and look again?

MR. CHANG: We will talk about how this will be implemented. There are two ways to implement our requirement. One is the so-called generic approach that the utility can treat this as a group.

MR. KERR: I was just trying -- see, you are not

going to be the person that makes a judgment on a report from the licensee. It will be somebody else. I can foresee --

MR. CHANG: Actually, if they are using the generic approach, the SQUG group will actually sort of certify that good work is done by them.

MR. KERR: I can see a letter going out by an applicant -- judging by the letters that I see -- saying, here is some additional questions. One of the additional questions can be, you didn't find enough outliers, go back and look again.

MR. ANDERSON: We haven't established any criteria, of course, on how many outliers.

MR. KERR: I know you haven't and that is the reason I wonder if the reviewer will have to establish criteria.

MR. ANDERSON: With the type of review that we are proposing, I think the generic group has taken the responsibility for overseeing this review.

What we mean by outliers is outside the data base. We don't have sufficient experience data to verify seismic adequacy.

MR. CHANG: For implementation, this will be implemented by the issuance of a generic letter. This will be done after the CRGR package has been commented upon by the general public and been through CRGR again.

(Slide)

Now, about a scope of this A-46 study. One thing that is not mentioned here is the level of earthquake loading that we are considering.

For A-46, just like in the new licensing criteria, we are looking at a level only up to one SSE. Not beyond one SSE. This is consistent with the current licensing criteria.

Also, this is limited to equipment only, mechanical and electrical equipment. Things like piping, ductwork, cable trays, they are not included in the A-46. Again, this is consistent with the current licensing criteria.

There are several assumptions. The first assumption is that SSE does not cause LOCA. We think we have a lot of justification on that assumption.

From all the earthquake experiences we have seen, and also the latest one from Chile, yes, you do see some piping damages. However, those damages can be summarized into two categories. One is the piping is corroded. The second one is, if a piece of pipe is connected to the building, let's say, the other one goes through the ground, there is not enough flexibility between the two ends and it may break because of differential anchor movement. We have never seen any pipe break because of inertial load only.

Now the reason we do not consider LOCA is more than that. Because, back in 1979, there were IE bulletins issued, 79-02, 07, and 79-14. The utilities are required to go back

and check the pipe stress analysis and also check the as-built configuration to the design configuration.

So we believe that problem is actually being looked at again by this 79 IE bulletin effort. So, we believe there is really no need to consider LOCA in A-46.

MR. EBERSOLE: LOCA is a unique phenomenon. It spans from the large LOCA to the small LOCA, and it could include the opening of PORVs on the hypothesis that valves don't close when they open.

MR. CHANG: That's why PORV is equipment that has to be looked at for seismic quality.

MR. EBERSOLE: Let's talk about the secondary side of PWRs.

Is LOCA in this context also taken to be your LOCA so to speak in the secondary system's feedwater and main steam?

MR. CHANG: No. When we talk about LOCA we only talk about the coolant.

MR. EBERSOLE: So you will assume then an SSE may bring about a failure in the secondary side?

MR. CHANG: No, we don't think so.

MR. EBERSOLE: You don't say that.

MR. CHANG: We really don't think the piping will break, regardless of what kind of piping you are talking about, because of the fact that it has been reevaluated again

during the 1979 IE bulletin review.

MR. EBERSOLE: Secondary and lower grades of piping are not so intensively analyzed as a primary loop.

MR. CHANG: Up to the main steam feedwater, those things were looked at during the 1979 review.

MR. ANDERSON: Our assumption with regard to pipe break also applies to the secondary and feedwater systems.

MR. EBERSOLE: That's what I am getting at. The first statement is foreshortened, isn't it?

MR. ANDERSON: That's true. But it applies to the secondary and feedwater systems. Also the components, the ADVs, the valving and the other components in the secondary system are part of the scope of the A-46.

MR. EBERSOLE: I wish you would expand that first line about a paragraph, about what you consider does not occur in a LOCA.

MR. CHANG: We just want to point out as far as LOCA is concerned, we don't postulate that.

MR. EBERSOLE: But you also don't --

MR. CHANG: Actually, there is much more than --

MR. EBERSOLE: Much more than that.

MR. CHANG: Yes.

Also, LOCA does not occur simultaneously with or during SSE. We just believe the possibility is too low.

We also have conservative assumptions. That is, we

assume offsite power will be lost during or following earthquake.

When we talk about shutdown, we are actually talking about hot shutdown. This is what we are proposing in the package. And we propose that a minimum of 72 hours -- actually the other days I think the subcommittee questioned whether we really need 72 hours or not. Probably this is on the conservative side. But, we believe 72 hours might be adequate to do the following things:

One is, after earthquake you can go down and check the equipment to make sure everything is okay. And, in case you find some minor damages, then you will have time enough to take care of them.

MR. EBERSOLE: On the bottom line, should that not also be expanded to say "and normal heat sinks and condensers." Offsite power will be lost and normal heat sinks will be lost.

MR. ANDERSON: To be rigorous about it, that would be true.

MR. CHANG: Equipment scope. As we have heard several times earlier, this is restricted to active electrical and mechanical components, including instrumentation and controls needed to achieve and maintain hot shutdown.

As far as tanks and heat exchangers, if they are required to achieve and maintain hot shutdown, then we will

only look at the anchorages. The tanks and the heat exchangers themselves are not included in the scope of A-46.

At the beginning, in scoping A-46, we did look at whether we should consider the masonry wall reviews, some aux feed systems, RCS piping, and seismic interaction items or not. Later, upon reevaluation, we found that those concerns are either addressed by IE bulletin or generic letters. So, they have really been taken care of earlier. There is no point to addressing them again here.

MR. WYLIE: Are you speaking of the functional review of those systems, or are you talking about the seismic review.

MR. CHANG: Masonry walls. Okay.

MR. WYLIE: I understand that one.

MR. CHANG: We make sure --

MR. WYLIE: What about aux feed system?

MR. CHANG: Aux feed again, from a seismic point of view, they have been studied by a requirement -- I think it is a generic letter of certain types of aux feed. The seismic adequacy part has been looked at for a number of PWR plants.

MR. WYLIE: For anchorages and pumps?

MR. CHANG: Yes.

Plants affected. This is restricted to operating plants not reviewed to current criteria as documented by SERs.

As I said earlier, the current criteria is described

in Standard Review Plan 3.10 and IEEE 344 1975 and Reg Guide 1.100. There are about 49 sites and 72 units in the scope of A-46 review.

For SEP plants, only the functional credibility part will be reviewed. The structural integrity part has already been addressed by the SEP program.

(Slide)

Implementation requirements. Those are steps that we think -- the procedure steps that utilities should follow. First of all, they have to develop the equipment list required for hot shutdown only, of course.

And then they have to compare the plant-specific site spectra with the bounding spectra. It has to be enveloped by the bounding spectra in order to utilize the seismic experience data base.

Thirdly, they have to do a walkthrough inspection to address the concerns of anchorage and deficiency and outliers. And also, they have to address the functional capability question on relays.

For equipment unique to nuclear power plants, those equipment we believe cannot be addressed by using the seismic experience data base because the data base is from non-nuclear plants. So, for those equipment unique to nuclear plants, we believe you have to check against the test data.

And, for replacement parts, if there are equipment

after the review that turns out to be inadequate, or the functional capability part cannot be answered by the review, then we require them to be several ways. Either they have to be tested, or they may be replaced by qualified equipment.

By qualified, here, we mean either by using the current licensing criteria, or they can utilize A-46 criteria to evaluate the replacement equipment.

MR. EBERSOLE: There is a scattering of walkthroughs beginning at Diablo Canyon that it is required that you look not at the equipment list, the qualified equipment list, but look at the system interfaces to see whether non-required equipment may fall down and ruin qualified equipment. You know, the system interface, seismic interface.

Do you intend to do that on your walkthrough? I wouldn't think it is part of your scope looking at older plants?

MR. CHANG: I believe that falls in the scope of USI A-17, system interaction. However, we are going to look for interferences during the walkthrough phase. But the systematic review of system interaction will be left until USI A-17.

MR. EBERSOLE: You will not do it even in the seismic context? This is sort of a specialized system interaction.

MR. CHANG: It is not even in the seismic context.

MR. WYLIE: For example, the A-17 that would address any electrical or fluid system interactions due to seismic disturbances.

MR. ANDERSON: That's correct. The USI A-17 will include at least the total scope of A-46. And at that time we will take a comprehensive look if we get a requirement in that area to look closely at seismic type interactions, the type of concern that Mr. Ebersole was referring to.

MR. WYLIE: Thank you.

(Slide)

MR. CHANG: Just a few words on the relay review guidelines.

As I said earlier, the actual procedure of the relay review is being studied by the SQUGs group. Those are the guidelines that the NRC Staff thinks should be followed.

First of all, to identify all relays associated with equipment needed to bring the plant to hot shutdown.

Now, for those relays that must function during an earthquake, they have to do one of three things: Either to verify with test data, to replace with qualified relays, or qualify by test.

MR. EBERSOLE: Isn't there a flaw with respect to -- there is another TAP or USI, whatever it is, that has to do with control equipment with interacting safety systems, and you would not look presumably at the control systems which

might interact under special conditions of earthquakes. Yet, they might be the ones which would, in fact, work improperly.

MR. ANDERSON: USI A-47, Safety Implications and Control Systems.

MR. EBERSOLE: Right.

MR. ANDERSON: That's correct. Control systems may be in a little broader context than they are in A-46. As a matter of fact, the seismic concerns on A-47 are pretty well answered by the A-46 data base, because all of the equipment and instruments concerned with an A-47 are represented at least by type, by the same stuff we have in A-46.

MR. CHANG: For relays which are not required to function during earthquake. However, they may be called upon to function after earthquake. They can do one of the three things also. But there is an alternative. The licensee can also show chatter or change of status does not affect plant shutdown. If he can do so, that is the end of it.

Relay verification can be deferred until the test data base is complete because we believe the functionality of the relay question can only be answered by a test, and they are in the process of trying to complete the test data base.

[Slide.]

The SQUG group is in the process of developing a review procedure. That includes the identification of relays to be evaluated, definition of functionality requirements,

development of evaluation procedures and review, and those procedures will be reviewed by NRC Staff and SSRAP when it is completed.

MR. EBERSOLE: There are presumably a lot of plants in the field that we don't know anything about yet, about relay chatter, so it seems to me sort of a clear and rather present hazard if we have even modest earthquakes. So wouldn't it be prudent to say if we do have relay chatter that we need some assurance -- and we invoke that we won't have a LOCA -- that we take advantage of the fact that we now have time, like we do in a power outage, and evolutions that take place which lock up the equipment in wrong arrays of various sorts are reversible by the operator.

MR. CHANG: During the relay review, they have to do it in a systematic way from a systems point of view, look at systems, at the line drawings, the relays in the line drawings.

MR. EBERSOLE: I'm talking about analog overrides as a case in point. If I get locked up in some configuration, I have got to get out of an overlock, overrides would become very important by the operator.

MR. CHANG: If this can happen, they better do something.

MR. ANDERSON: The evidence that we have seen so far gives us a pretty warm feeling that we are not going to get

into that situation. It turns out the relays are really a lot more rugged than we thought they were. In addition, what we are finding out is that chatter, even if it occurs, may not be that big a problem because of circuit designs, delays and inertia, that sort of thing.

MR. EBERSOLE: You can back out.

MR. ANDERSON: We feel comfortable with delaying that verification for some time period until we could get the test data complete.

MR. EBERSOLE: I am thinking about the black picture where a bunch of valves open when they should shut, and a bunch shuts when they should open. That can produce some hazards.

MR. ANDERSON: Due to seismic motion, we think that is kind of unlikely right now.

MR. CHANG: That point was evidenced by the Chilean earthquake review. During the review, they were able to talk to operators several days after the earthquake, so they still have those things fresh in their mind. According to what the operators said, the general purpose relays, they functioned without problem. The ones in which they have seen some problem are the protection relays.

MR. EBERSOLE: Big relays for power systems.

MR. CHANG: That's right, and Jim is going to elaborate on those further later on.

Talking about a scope of relay, we asked around and we found out that typically for a relay required for hot shutdown, you are talking about 800 to 1000 relays in a plant. However, we believe the relays needed to function during earthquake will be much, much less than that number, probably 20 or 30. That is just a gut feeling.

There are about six to eight types of relays, electromechanical relays, in a typical plant. I think that is all I have for my presentation.

MR. MARK: You spoke of the small number that might be required to function of those relays, but there may be a number that could malfunction as well.

MR. CHANG: True; but based on the Chilean earthquake, a 7.8 earthquake, only in the protected relays have they seen some problems. All the general purpose relays, they function well. So that gives us a warm feeling that the scope of the problem is really not that big.

MR. MARK: I'm not trying to make a case that there is a horrendous problem, but as well as the things you want to function positively, there are some that if they function negatively, you are in trouble for that reason.

MR. ANDERSON: Well, lumping that into one class, I guess, we are concerned about the ones that function when you don't want them to that can preclude some later function or put the plant in bad condition, so that is part of the set we

are talking about.

MR. MARK: Fine.

MR. WYLIE: Any other questions for Mr. Chang?

[No response.]

If not, I will call on Mr. Thomas to present the SQUG report.

Incidentally, there is a handout of his over here someplace.

Let's take a break at this time.

[Recess.]

MR. WARD: We will come to order.

MR. WYLIE: Mr. Jim Thomas of Duke Power Company, representing SQUG, will make the presentation.

Jim.

MR. THOMAS: Thank you.

What I would like to do is start off by really kind of emphasizing what we have done in a little over the past year, start out with maybe where we were in April of last year when we made a presentation to the subcommittee, and kind of bring you up to date from that point.

[Slide.]

At that particular time, the conclusions of the Utility Group itself, based on the work that we had done with the experience data plus just our own experience in the design and operating of the power plants, is that the seismic

resistance of standard power plant equipment when properly anchored was verified during our pilot program, and on that basis, explicit seismic qualification of the equipment in the operating plants to current standards was not justified.

Also, based on the broad basis that we were looking at equipment and the depth of our survey, that the seismic qualification issue itself was not of a significant concern, and at that time no further action should be required.

As you have heard in the discussions by the Staff, what we had done is we had started this program working with the Staff and had later decided that we would have a third party to review our work, the Senior Seismic Review and Advisory Panel, so even though our group had made those conclusions, there were still some outstanding concerns by the Staff and also the ACRS Subcommittee.

[Slide.]

So based on the concerns that still existed, SQUG continued activities to further our knowledge in the area. One of the things was to totally define the equipment that would be required to perform in a seismic event to assure that you didn't have any safety problems at the plant. So SQUG began work on definition of generic equipment to envelope all plants.

We surveyed all the utilities. We had input both by the utilities and the Staff, all utilities and SQUG, to come

up with a list of equipment that would be required. One of their concerns was that we had pretty well fully addressed and resolved most issues for the eight classes, but there was this kind of concern: what about the equipment outside the eight classes; how could you say that is truly represented?

So we initiated some work in regard to looking at the data we had. Taking a close look at the surveys that had really included all classes of equipment in that we were trying to find failures, we would always ask the question were there any failures and whether it was in the eight classes or not. We would try to take a look at that.

The point was we were not finding failures in any class of equipment.

Another one was the functionality issue. The surveys that were being done were really to look for structural-type damage or damage to the equipment in that some of the earthquakes were a number of years previous but we haven't had much opportunity and really had not applied the appropriate personnel to address operability during strong motion in regard to experience data.

On the second and third items, we kind of enlisted some help from EPRI. The first was to gather some additional test data that we could use to try to demonstrate the equipment beyond the eight classes was very rugged and kind of collate a lot of the testing that various utilities had done

over the years, various AEs, in regard to the equipment in these plants; and also to take a close look at test data on relays and try to determine really how rugged were the relays; and also we started trying to take a look at exactly what equipment would be required to function, and if it had a relay in that system, would relay chatter give us a problem.

So we started trying to exclude some of the relays that may be in these systems by the fact that even if chatter did exist, it would not give you any problems if you were to have a seismic event. Systems that can handle it due to the actual design of the systems.

The fourth item that we were working on was to try to develop a kind of generic implementation plan. I think I will hold that until a little later and get back to it toward the conclusion of my discussions, but as I said, we were working in two areas, on items 2 and 3, one with EPRI collecting a lot of data for us, and the other we were trying to make some systems-type studies.

It was in the middle of that work that the Chile earthquake occurred.

[Slide.]

We knew very quickly that the earthquake was a very large earthquake. As previously has been said, it was a 7.8 magnitude. That had a number of large aftershocks. It affected a very large area. We knew that there were a lot of

facilities in that affected area that could possibly add some information and some background to what we were trying to do with our testing surveys, and we also saw that it was really an opportunity to try to find if there were any holes in our previous conclusions to see if there were failures that had not been seen in other earthquakes that might affect some of our original conclusions.

So we decided to immediately send a team as soon as possible after the event.

[Slide.]

They actually arrived on March 7th to get a very quick look immediately following the earthquake and try to get the data as quick as we could, but we had a number of meetings to really study what we might could learn if we made a real in-depth survey of the earthquake, and what type of team would we need to really contribute significantly beyond what we had learned from previous earthquake surveys.

We came to the conclusion that one of the main areas was the operability issue during strong motion, and on that basis decided that we should send some people with systems-type experience to interview operators and to determine really what type of problems operability during strong motion might present, or lack of operability, relay chatter in particular.

So we sent a second team in May. We had the EQE to

essentially continue the work that had been done by the previous team, which was primarily EQE. Also, Dennis Ostrom from Southern California Edison and myself went along to try to look at these things as to what is happening during strong motion. I was looking in particular with regard to the operability issue and what happens to relays.

[Slide.]

We wanted to make sure that we asked the right questions, so we spent quite a bit of time actually interviewing our own operators, various utilities, interviewing design people, trying to determine what type questions should you ask to really find out what kind of problems the earthquake would give with regard to potential system misoperation, malfunctions.

I won't go through these in detail, but we developed quite a list of questions to hopefully get us to weak links or weak areas or any kind of contradictions to our earlier conclusions.

[Slide.]

This is just a continuation of those type questions.

MR. MOELLER: Excuse me. Does Chile have any nuclear power plants?

MR. THOMAS: They have some research plants. They don't have any commercial power plants.

MR. MOELLER: Was this earthquake felt in Argentina?

MR. THOMAS: Let me get to the next slide.

MR. MOELLER: Okay.

[Slide.]

MR. THOMAS: The earthquake was felt over an area 200 miles by 100 miles, a very large area in regard to where the strong motions were felt. I know it is difficult to see here, but what you are seeing on this is actual records that were taken in the horizontal directions. I know that is difficult to read. But the facilities that we were looking at ran from down here in the Rapel area up to north of Las Ventanas and over Santiago, quite a large area, and strong motions being felt. Here is about .64, .57, about .469. So large motions over a very large area.

To maybe give you a better -- hopefully, you can see this a little better. This is a summary of some of the stronger peak accelerations. The average here of the two horizontal motions. YOu can see this .58, .64, large magnitude, long area, and also very long duration. The durations were in the neighborhood of 50 seconds of strong motion.

[Slide.]

Just an example of this. You can see, starting from zero, continuing, starting over after 50 seconds, we are getting pretty significant motion. We have quite a bit of data on the motion, the actual strip charts that we can make

available.

[Slide.]

This one is one of the largest. You can see that it had a horizontal of .43 in one direction, .67 in another, and a vertical of .86. So we are really looking at a very large earthquake in regard to motion and duration.

[Slide.]

As I said, there were quite a number of facilities in the area.

The second team and this first team collectively visited six power plants that were hydro and fossil. We attempted to get into the research nuclear reactor, but being a military government, we were never able to get access while we were there. The day after we left, we got a message, yes, come on in. That's kind of the way it was.

We don't know of any major problems that they had in any type of their control systems.

MR. MOELLER: What are the five commercial facilities? What do you mean?

MR. THOMAS: Well, for example, some of the large apartment buildings may have had some type of equipment, that type of thing.

MR. MOELLER: What specifically in the water treatment plants?

MR. THOMAS: They have quite a few pumps, motors, a

lot of control systems. The other four facilities -- one I'll get some slides in a moment -- there was a hospital that had an emergency generator. I'll show you what happened there.

But, anyway, these facilities contained quite a bit of equipment, a lot of it supplementing the original eight classes, and a lot of it that we took a close look at to try to find problems of anything typical beyond the 8 classes, anything that we would think might have a bearing on our general conclusions.

We were searching for problems.

MR. WYLIE: Jim, wasn't one of those refineries a copper refinery?

MR. THOMAS: Yes, one is a copper refinery. I've got some 35 millimeter slides. I'll show you a little of that. One of them was a very large oil refinery, a tremendous number of tanks. It's kind of outside the scope of what we are talking about. But a lot of piping, tremendous amount of tanks.

One of the problems we did find was very large tanks did have some problems, around a quarter of a million gallons type tanks. They did have what we would call design problems for earthquakes.

MR. MOELLER: In the water system, do they have elevated tanks on stilts and so forth?

MR. THOMAS: I don't recall seeing that at either of

the facilities we visited. I was kind of surprised. It's totally different from what we normally do. I think they treat it and pump it to another area, and in the other area, then it's pumped up to a storage tank.

MR. SIESS: They weren't tanks on stilts? The spheres weren't?

MR. THOMAS: Yes, at the refinery, that is correct.

MR. SIESS: But they did no damage to them?

MR. EBERSOLE: Did any of the big tanks that sit on the ground burst?

MR. THOMAS: Yes.

MR. EBERSOLE: They did?

MR. THOMAS: Yes. The large tanks --

MR. EBERSOLE: Like condensate storage tanks?

MR. THOMAS: Those types, no, we didn't see any failures of those type tanks.

MR. EBERSOLE: Oil storage tanks did, though?

MR. THOMAS: Yes, the very large quarter of a million gallon type, the ones that are --

MR. EBERSOLE: They're thin as paper, aren't they?

MR. THOMAS: They are vertical, they are 60, 70 feet tall, about at least that in diameter.

One of the failure modes is they develop what is called an elephant's foot. The tank at its base just kind of moves over and pooches out at the base, and you get some

separation from the wall and the bottom plate, and you lose the contents very quickly. In a number of cases it caused implosion of the top of the tank.

MR. EBERSOLE: Were those all contained with dikes or did any of them get away?

MR. THOMAS: None of the ones we saw got away. They were contained.

MR. EBERSOLE: Does American Petroleum Institute permit that? You know, like around Los Angeles where they have hundreds of them?

MR. THOMAS: From what I know -- I'm not an expert in the area -- from what I know, from what we discussed, the way we do things is better than what we saw in Chile.

MR. SIESS: I recall Peter saying 10 percent of the tanks failed, ruptured, lost their contents, but that a much larger proportion had distress buckling; is that right?

MR. THOMAS: That is correct. They maintained their integrity as far as containing liquid, but they did show some stress and some buckling.

Maybe the best thing to do is to show a few of these slides.

[Slide.]

The first few I will go through very quickly.

I intend just to show you that we did see a good bit of damage. We seem to have lost the integrity of the focus.

We did see a good deal of damage.

MR. MOELLER: Is that taken from a tall building nearby?

MR. THOMAS: It is taken from a helicopter. This is the initial team that hired a helicopter to take some aerial shots. This is in San Antonio. You can see some of the collapsed walls. This is in the Port of San Antonio.

[Slide.]

You can see the frames that have fallen over. This is not due to inertial forces, but due to the problems with the ground just essentially falling into the water. This was a lot of area that was not really what you would call a good foundation. It was filled earth in many areas.

Anyway, you can see the type damage they saw.

[Slide.]

One bridge you saw collapse is going into the water. They say a lot of the reason that this probably collapsed was a lot due to some erosion they had seen during the flood. The earthquake kind of finished it off.

This one was one that was an older bridge, not in use. It was actually being used for target practice by the military.

[Laughter.]

MR. MOELLER: What is the bridge in between? Is that a walking bridge?

MR. THOMAS: That is something that they -- it's a quick fix to take people across the river. This was about three days after the earthquake. This is a temporary structure to provide access for walking.

[Slide.]

Some of the taller buildings you can see quite a bit of damage. You can actually see where they had bending in the rebar.

[Slide.]

This one is a kind of interesting leaning tower.

MR. EBERSOLE: That could be a tourist attraction if they propped it up so it stays that way.

MR. THOMAS: It had already been demolished by the time the second team arrived. It was a bit of a danger.

MR. EBERSOLE: It could compete with Piza.

[Slide.]

MR. THOMAS: This one is one I'd like to talk about a little bit, particularly. This was a hospital in San Antonio. It's really on two different foundations, this area and this area over to the right. It is a relatively modern structure and --

[Slide.]

-- it saw quite a bit of internal damage, as you can see. The collapsed concrete around a lot of those structures really was seeing quite a bit of motion. This is a little bit

misleading in that some of this is stucco, but you can see also concrete actually did suffer some problems.

The interesting part was that this hospital had recently been equipped with relatively modern diesel emergency power system, and had a very similar, although smaller, control system as the type of control we use in nuclear power plants.

[Slide.]

That is a sideways picture of that.

MR. WARD: It wasn't anchored?

MR. THOMAS: That was not due to seismic, that was due to -- I'll either get it upside down or -- that's right now. There is kind of an interesting story about this diesel control system. The technician at the hospital was home during the time of the earthquake, and he became very concerned that his power system may have failed during the strong motion. They did lose power almost immediately. He was very concerned about the welfare at the hospital. So he immediately ran from his home, which was, I understand, on the order of a quarter mile or half mile away or so, and when he arrived, he found that the diesel had started and was running. And not only that, they continued to run it for a period of weeks to provide not only power to the remaining portions of the hospital that they could use, but to some emergency shelters that they set up at a church and a school.

I would like to point out that this little control system does have various types of general purpose relays that we have been talking about that needed to be looked at.

It went a long way to give us a good feeling that the general purpose type relays are pretty rugged when it comes to seismic, because we know for a fact that this had to be seeing tremendous amounts of forces due to the effects on the hospital.

This was in one of the rooms, the back part of the hospital.

[Slide.]

MR. EBERSOLE: That was a fast start diesel. I'm wondering whether or not there was an elapsed time of zero energy where you could have the relay chatter all over the place and it wouldn't matter, anyway.

Was there a blackout interval that would have protected you from relay chatter?

MR. THOMAS: I'm not totally familiar with the actual circuitry of the diesel control.

MR. EBERSOLE: If you are in a total blackout, who cares about relay chatter? It's when you're not, that it hurts.

MR. THOMAS: We are talking about something with chatter that would get something out of sync and the automatic start signal never properly being accomplished.

MR. EBERSOLE: If you could have a clean break so there's no power, then relay chatter doesn't really matter; right? If it's all over before you start going again.

MR. THOMAS: The relays themselves have power because you've got battery back-up.

MR. EBERSOLE: So the batteries persisted?

MR. THOMAS: The batteries had to persist for the automatic control system to function, they could help the diesel start. So the relays did see power and they performed directly on the automatic start signals.

MR. EBERSOLE: It was a fast start, I guess?

MR. THOMAS: I guess you could call it a fast start.

MR. EBERSOLE: Okay.

MR. KERR: It wasn't tested every two weeks, probably. Or was it?

MR. THOMAS: It was tested, I think, about every six weeks. I can get that data. We have it in our data sheets. This was the copper refinery. I think one -- the copper refineries suffered a lot of damage to its furnaces. The brick fell in on molten copper.

[Slide.]

The main thing it added to it was it increased our original data base, particularly in relation to motor-operated valves at high levels.

The only problems the plant had, other than the

collapse of the brick and the furnaces, was a few cases where something fell on a mercury monometer and caused sloshing of mercury. There were some totally unprotected thermocouple wires, not cable, just pretty small wire that was strung a lot like a handrail between two different structures, and the relative motion broke the wire.

But as far as functionality of the controls and equipment, they had no problems.

MR. MOELLER: Excuse me. In the previous slide, that stack stayed up, this is after the event?

[Slide.]

MR. THOMAS: Yes.

MR. MOELLER: Was it seismically designed?

MR. THOMAS: Most of the structures, particularly that type, are designed to a seismic, I think of something like .2 g static design basis.

MR. WARD: What was the ground acceleration here, Jim, at the smelter, for example?

MR. THOMAS: I think it was in the neighborhood of .35.

MR. EBERSOLE: Jim, were there any -- in a general context, were there many fires developed as a result of the earthquake?

MR. THOMAS: No. That's one of our questions of anything like that, such as flooding or fires. We saw no

evidence of that in industrial facilities.

Now in some of the homes and things, they might have had some local fires caused by appliances or something like that.

[Slide.]

The control facility at the refineries was large enough that they had their own power plant. The interest thing was it was mostly German equipment. So we saw quite a variety of what we had been seeing in our previous surveys of types of equipment, but again they saw no types of instrumentation problems, no false alarms, no malfunctions, no misoperations.

[Slide.]

The Las Ventanas power plant was a very interesting one. I have taken out a lot of the slides that had to do with some piping and some snubbers. I did that in the interest of time, but we did learn quite a bit about what piping can do and what supports are.

But again, as far as what we were trying to learn for A-46, they had quite a bit of equipment throughout the plants that added to our data base.

[Slide.]

[Slide.]

For example, something I discovered, cable trays and the type of supports they had saw no problems at all.

[Slide.]

The control room itself. Very typical. The type switches, the displays, the indicating lights, the alarm panels, all CRT screens, indicators; very similar to the types that you see in the older nuclear operating plants. The structure of the board itself, the way it's designed.

MR. WYLIE: Jim, I don't believe you mentioned this is an American-designed plant.

MR. THOMAS: Yes. One unit was Charles P. Maine, and the other one was EBASCO, I believe, and on that basis had practically all American equipment.

The motor control centers, the switchgear.

One of the things that was not in the original 8 classes that we were trying to look and see if we had problems.

[Slide.]

This converter system, very similar, identical, in fact, to some converters that are used in some of the older plants.

[Slide.]

This one is very interesting. It's a burner control system, manufactured by Forney Engineering in Dallas. It contains literally hundreds of relays. Each bay on each site has about 200 relays. There are various types. There are general purpose type relays that we use in various systems.

So we really felt a lot better about the performance of general purpose relays.

MR. REMICK: Question: Did the generating plants ride out the quake? Did they stay operating, or did they go down?

MR. THOMAS: A little bit of all cases. Some of them were not operating during the quake, but had some auxiliaries running, that continued to run.

Some of them were operating and tripped due to problems on the system. They do see some problems in switchyards. They have some ceramic porcelain type failures that caused failures. One plant tripped. It was kind of interesting.

One of the things about Chile is they see quite a few earthquakes. They have seen three major ones, I guess, in the past 20 years or so, very similar, of this magnitude.

So when we talked to operators, we were not getting feedback from just this one instance, but from what they had learned -- one in 1961 and 1970 and one in the '80s.

One of the units here, he said, well, it always trips off because of vibration. One of the turbines is too damned sensitive.

[Laughter.]

So they trip off for various reasons.

Most of the cases, when they do trip, it's due to

protecting themselves from what's going on outside. Some of them did ride through.

I think one of the slides that we used in a different presentation is that from a lot of the California experience was if it is below about .3, usually they stay on line. Most of them stayed on line below a .3 ground motion.

[Slide.]

Quite a bit of pneumatics, so we got another good, real good feeling about the capability of pneumatics.

[Slide.]

The hydro plant at Rapel did see quite a bit of motion in regard to the dam itself and the structures. They did see millions in damage that they're going to have repair. They didn't cause any leaks or anything, just something they're going to have to go back and fix.

The plant is still in operation. It was not in operation at the time. The used it for peaking purposes, but they were able to make a quick survey and determine that they could continue to use it. But again, back to the electrical equipment.

[Slide.]

The mechanical equipment that is required to operate the plant, the same story again. They didn't have any kind of problems with the equipment. They had no misoperations, no systems starting when they shouldn't or stopped when they

should not have, no relay chatter.

Again, the thing that is quite impressive, with all of the relays that are used in alarm circuits and the types of relays, we still could not find any evidence of any false alarms.

MR. WYLIE: The ceiling didn't fall down.

MR. THOMAS: The ceiling didn't fall down.

This particular site, though --

[Slide.]

-- back in this direction, there is a hill, and up on top of the hill, overlooking the site of the dam itself, they have a pretty sophisticated switchyard and substation, and inside that structure, which is very strong seismically, hd a lot of shear walls that ended up showing cracking, very strong shear walls. So we know we've got -- I guess some of the seismic people thought they saw a tremendous amount of amplification due to apology, and that structure is the only place where we found any equipment damage.

[Slide.]

So going from the hydro, this is the control room itself from the plant that is down.

[Slide.]

In the turbine building area here, --

[Slide.]

-- we leave the plant and go up to the substation.

I believe these batteries are still in the plant also.

[Slide.]

This is up at the substation. They did see some bending of the straps. These are very lightweight straps. No functional problems with the batteries, no failures. But they did have some relay mechanical problems with the internals of five relays. The estimates of the motion are the forces that they say there. We don't have a record there, but just due to the effect of some of the bending of some of the anchorages, somewhere in the neighborhood of .6, .7, .8 caused some internals of some protective relays to either jam or some very small springs, which were soldered at the end of them, to break lose.

It's my personal opinion, I don't really think it was a design problem, but more or less, since it was only three out of something like a hundred relays that broke, I think it might have been more of a manufacturing problem.

MR. WYLIE: These are basically line protective relays for transmission lines, and really this is sort of an antique type relay.

MR. THOMAS: That's true, but it was the only evidence of equipment failure that was due to or appears to be due to inertial forces, rather than interaction. We've given you some evidence previously in previous reports, and we had one other case here where some interaction, like on a motor

operator interacting by the pipe that it's mounted on swinging quite a bit and crashing the valve into a structure had some breakage. That's not really the type failures that we were concerned about, and even those still remain very rare.

[Slide.]

MR. EBERSOLE: This is the only kind of relay failure you saw, right?

MR. THOMAS: At the refinery, one of the protective relays caused the emergency power, a generator, the start cycle to trip during the start. The operator immediately reset that particular relay. Then the turbine generator did come up, and no problems after that. That was a protective relay.

These relays also were protective relays. We saw no cases of any other type of relay either having any damage or malfunctioning.

MR. WYLIE: These are basically induction disks, protective --

MR. THOMAS: Correct. Again, they're older type relays. They're not really modern solid-state.

One case of interest, even though I think we did learn that it was something that probably bears looking at, if you have such an application, is that large oil-filled transformers have in many cases fault pressure relays applied, so that you can get -- if you get any kind of shorts inside,

you see an increase in pressure due to the oil reacting with that, and you can trip off of that pressure. A seismic event will slosh the oil around, and the relays correctly sense a pressure and trip.

That's kind of a systems type thing. I don't expect to see any of that or very limited amounts of that, if any at all, in the type system we're seeing, that needed to function, because as we said earlier, these protective relays are applied like in switchyards and very large transformers and electric lines.

This is an example of some of the internals that had a problem. I can read here that this is an MHO measuring relay for phase fault. It actually had a little coil spring that came loose, as I was talking about earlier. The end of the spring was soldered, so they had to replace the relay. It didn't cause a problem during the event, but when they were trying to investigate what had happened, they did find a problem with these relays.

I don't have a slide of it, but there was one other equipment problem at that particular substation, and that was some switchgear that was manufactured in Europe. I believe it was French. That is kind of one of the things that we would call an outlier. It was very short. It didn't look anything at all like a switchgear that GE makes. It essentially didn't have any structural support, either in the front or the back.

The only support it had was a very small, little diagonal strap that was about three feet long.

There was a lineup of these switchgears, probably about eight days. All of them bent over in one direction and caused some tearing of the cabinet wall in the back. They crashed into and probably were stopped by some of the GE switchgear that we typically use.

Again, they had no functional problems. It worked properly. And after the earthquake, they essentially straightened it up and give it a little bit of a fix in the back where it tore, but they didn't do anything other than straighten it up.

So the switchgear was kind of an outlier, as we called it, and the five relays were really the only equipment damage we saw.

That kind of just gives you a taste of the 5000 slides that we collected and the type of things that we're talking about.

Kind of to summarize where we are at and what we have done in the past year and a half, --

[Slide.]

-- we have continued to look at earthquakes as they occur, even though we thought the database we had at the time was totally sufficient. We still cannot find any problem. We cannot find any generic area that we think shows any type of

concern that all of the mechanical and electrical equipment of the type we used in our power plants are not inherently seismically rugged.

This is an example of three of the investigations we've made since 1983. We've got two of them fairly large, the Morgan Hill, of course the Chile, and Coalinga in '83.

Where we are now, I guess, is probably the best way to summarize.

[Slide.]

As was stated in the Staff's presentation, we had an effort to identify what types of equipment are needed to assure that you can get to a hot shutdown/safe shutdown during a seismic event. So we did a lot of work to generate such a list, with interaction from the Staff and comments. And while we were doing that, we were saying, "What type of data do we have to support the ruggedness," other than what we had presented in the pilot program, the original eight classes.

It was in this area that you can talk about the EPRI programs that have been initiated to support our work. Also, that involved collecting the test data for equipments that were not specifically in the eight classes.

Also, the Chile earthquake gave us quite a bit here to add in that. So we were trying to develop this list and determine what could we say, based on all of our experience, all of our testing, and all of our engineering judgment. What

can we put together in the form of documentation of just how rugged it is, and then how could you use that documentation if you were to survey a plant to verify that you didn't have anything that was not consistent with our generic conclusions?

You've got some outliers or something is a little different. I think the example of the European switchgear, with no support in the front and back, is a good example of things that we would want to look for and verify that we don't have. Most of us feel, just on experience, we're not going to see that anyway.

Anyway, we're going to develop the list of equipment, very preliminary. We think the total classes of generic equipment required is limited to about 21 classes.

I'll give you an example. You've seen what the eight classes are. One additional, we kind of lumped battery chargers and inverters together, because if you look at them, the cabinets are structurally the same. Essentially, the internal components are the same. One additional class might be composed of battery chargers and inverters.

We are continuing to work with EPRI. They are also helping us look at the anchorage issue, trying to develop some simplistic methods that are technically sound, analytically sound, but would facilitate a walkdown to verify you had adequate anchorage.

They are also continuing to put together further

test data. This test data, by the way, has, if anything, just further justified and supported all of the original conclusions that we made based on experience data.

[Slide.]

MR. EBERSOLE: May I ask a question? If I'm looking at the station type batteries, not the 1-E batteries, the ones that do the switchyard functions, and I was looking for the very worst, most fragile installation I could find across all of our plants, what would that be? Are there controls on that?

You know, these are inert, stationary, static devices. They sit there like pots. And I could imagine, really, a sloppy designer could just stick it up on wooden shelves, and say, "I'll I've got to do is hold it up."

Yet if I fail that battery early on as a preferred failure, it has drastic consequences in reducing the station's switchgear to total inoperability.

MR. THOMAS: I think what you're saying is, correct if such a thing happened. What we are seeing in totally non-nuclear applications is any type of application, the commercially available in general practice are installing those types of batteries --

MR. EBERSOLE: Somebody put them on good mounts.

MR. THOMAS: Yes. We have not found any battery failures.

MR EBERSOLE: Do you find that to be judgmental requirements or common sense? Just put them under the proper -- in the proper supports. I don't know of any IEEE standards, do you, on mounting the station batteries?

Chuck, do you?

MR. WYLIE: No. I don't think there are any standards on mounting the batteries.

MR. EBERSOLE: So you could just put them on bookshelves.

MR. THOMAS: Let me give you one other thing that we get from experience. Some of these emergency diesels at some of the power plants and also at some of the substations, they have battery backups that they can get their diesel or whatever started. It's a very small battery system, usually maybe just two or three cells. Most of them were mounted on a rolling frame that had wheels. The method of anchoring that was with a small chain to the diesel frame or just the cable itself.

So during the earthquake, obviously these things -- we've got a number of slides of where the batteries of the same type, the same type cells, are just sitting there on wheels, free to move anywhere, and we could not find any evidence of any malfunctions. We did find evidence of some impacts where it had rolled into the frame and chipped some paint off. So we are seeing, really, outliers everywhere we

go as to what you would do in regard to batteries, and we still cannot find any failures, even doing things like that.

MR. WYLIE: It's a good thing you didn't anchor that frame.

[Laughter.]

MR. THOMAS: One of the final items was attempting to limit the scope of the relays. We have done quite a bit of that through some systems type analysis -- what systems really and truly could be affected by relay chatter, and also at the same time, which ones do you need to worry about the most, such that you make darn sure that you don't have any chatter.

MR. EBERSOLE: The ones that are predisposed to produce or not produce this Type V event, coupling the load to a high-pressure system would be a most interesting set.

MR. THOMAS: That's the one we put on one of our high priorities. Also the ones that may be involved in assuring you have your emergency power system, DC power, and the resulting AC through the inverters are very high priority items, to make sure you don't have any problems in relay.

Again, the Chile experience and surprisingly the test data that we are gathering show that most of the type relays are surprisingly rugged, even in the Chile levels. You can eventually make most relays chatter if they're an electrical/mechanical type, but it's a lot higher than you normally expect for most relays.

Also, I guess to look at it, just based on my experience of these older plants, a lot of these systems, even in those days, used a lot of solid-state logic in small areas rather than relays. The relays are not everywhere. A lot of cases -- I can't say that that's what happens, but it appears in some cases that solid-state may have been used in some critical applications, because they are worried about relay chatter.

MR. ETHERINGTON: Wouldn't the spring weight, the ratio of the spring weight to the mass of the moving part, be some indication of the likelihood of chatter?

MR. THOMAS: Yes.

MR. ETHERINGTON: Isn't the spring force much greater than the weight in the mass in most cases?

MR. THOMAS: Yes, that's true. So we're continuing we're still working on this aspect of limiting -- "limiting" is probably not as good a word as "trying to focus in on" -- which areas of relays we really spend our time on.

The Chile experience gave a lot better warm feeling in that area. We are continuing to work with EPRI in their work to try to come up with some plant walk-through guidelines, both from looking at outliers and looking at anchorages.

The implementation program itself would involve a test walk-through to verify that what we have come up with on

these guidelines could truly generically be used. We would take a test walk-through some time in the future to feed back, to try to come up with a generic plan for walk-throughs.

Our plans are for the SQUG plants we would provide seminars to the SQUG members and that the member himself could conduct the actual walk-throughs based on the generic approach developed by SQUG.

We feel that SQUG would provide assistance to the individual members in these walk-throughs, and that we are still working on plans, how would we audit these results.

We have discussed a SQUG audit of one of its members and also maybe some audits of audits by the senior seismic review and advisory panel and NRC team members.

So this is really ongoing work that we plan for somewhere over the next six to nine months to a full year. That essentially concludes that remarks.

MR. MARK: I have a question. Perhaps you said. Is there a building code and sort of earthquake level that people are preparing for on these plants that you went through?

MR. THOMAS: In Chile?

MR. MARK: Yes.

MR. THOMAS: In general, the power plants have looked at the structural design aspects from about a .2 g, as far as specs on equipment, they have none. I think that's a

good point.

I would like to maybe bring up our last day in Chile. We were able to arrange a meeting with some of the central office people, some of the engineers that both are involved in the operating and somewhat in the design of the plants.

We had learned that they do have seismic criteria in design of the structural aspects, and I asked them a question particularly in regard to the control instrumentation, if based on their experience and everything, that in the future specifications or modifications to a plant, or for a new plant, would they include seismic criteria for control instrumentation or control and mechanical equipment.

You have to kind of appreciate we were going through a language barrier, so it took a little time for our questions to get interpreted, and then usually there was a team of three or four people that had to talk about their answer before it would come back to us. So we'd ask a question and we'd sit there for 15 minutes waiting for the answer.

And their answer to that particular question I thought was very interesting. Again the question was do you plan to include any specifications for seismic design for any of your modifications in regards to control equipment or mechanical equipment? Their answer was, "Why should we?" They feel that the experience has borne out that they don't

need to be concerned with that. They have got other things to worry about, they don't have to bother with that aspect.

MR. WYLIE: Any other questions?

MR. MOELLER: Along those lines one comment one could make, you had mentioned that they had had a severe earthquake in the '70s and one in the '60s, '70s and '80s. Maybe their plants had been pretty well shaken down.

[Laughter.]

You know what I mean. What is left there is pretty resistant.

MR. THOMAS: That's true. We tried to find out if they had made any modifications over the years to the type equipment we're worried about. Essentially they have not.

I think one interesting point, I took out some slides for time's sake, but one of the latter plants they had put in some seismic considerations in piping by installing a snubber. The slides show -- it's quite spectacular -- the snubber ripped out the I-beam to which it was attached or bent it, severely deformed it. The pipe took the snubber and everything with it. No problems for the pipe.

[Laughter.]

We had a lot of cases in the slides to where the pipes totally destroyed their support system, ripped it totally out of the ceiling or out of the floor. All of the supports were gone, the pipes are still there, still working,

no repairs necessary.

[Laughter.]

MR. MARK: One of the distinctions, which I think you people called attention to, was things above 40 feet as compared to things less high than that.

Were the things you examined including things on both sides of that?

MR. THOMAS: Oh, yes. We added to our data base very much at the Chile earthquake things way above 40 feet. I think the 40 feet -- correct me if I am wrong, Newt -- but th 40 feet was kind of an arbitrary number selected by the Senior Seismic Review and Advisory Panel, based on a data base.

I think with the Chile earthquake that the arbitrary aspect of that is pointed out quite a bit.

MR. MARK: Good.

MR. WYLIE: Any other questions?

[No response.]

I would like to thank the Staff and members of SQUG for their presentation.

MR. KERR: Can one assume if there's going to be another earthquake 10 years from there, that you're preparing for that?

MR. THOMAS: The people in Chile are assured -- assured us that they didn't think that this one was this decade's big one.

MR. WYLIE: Isn't it true they said since 1906, they have had 12 large earthquakes? So they've got their experience.

Does the Staff have any other comments?

MR. ANDERSON: No.

MR. HERNAN: I would like to follow up a little bit on a concern that Jesse had earlier in the meeting. I think part of it was clarified. As far as new plants like Vogtle, our reg guide -- I'm sorry, Standard Review Plan, Section 3.10, covers all plants whose CPs were docketed after October 27th, 1972.

Should those plants -- those plants are required to have fully qualified equipment. Should they have to replace equipment, they would have to go through the same process that they had to go through initially. For the plants, the older plants that come under A-46 resolution, I talked to the EQ branch chief a while ago, they would also have to go through a similar comparison test, should they replace with a different type component.

I have got extra copies of the Standard Review Plan if any of you are interested.

MR. WYLIE: Thank you.

Mr. Chairman, that is our presentation.

As I mentioned, the Staff has sent the package to the EDO to be sent out for public comment. We wrote a letter

back in May of last year on this program and the question really before the committee now, I guess, of what action we take even now, or later when the public comments are received, whether we write another letter or not.

MR. WARD: Is there any sentiment on the committee for writing the letter?

MR. REED: I think the data base that this people accumulated is very fine, and they have done a very good job in the categories, the eight categories.

I read the past letter and it seems to me that it was calling for more work, and how do you undo a letter, except by producing another letter?

It would seem to me that ACRS ought to produce a letter saying what our judgment is now, with this presentation.

MR. WARD: Charlie, do you think you have heard enough to be convinced that the program that they have developed since our last letter has covered the concerns that were expressed?

MR. WYLIE: I think so. I think they have a sound program and I believe it does answer the questions that would be raised.

If you like, I will prepare a letter.

MR. WARD: Why don't you draft a letter and we will consider it on Saturday.

Any other comment?

Bill?

MR. KERR: Are you suggesting that the ACRS write a letter saying that enough has been done in some area of the seismic issue?

[Laughter.]

I just want to make sure I understood --

MR. WARD: This might be a good opportunity --

MR. WYLIE: I will turn the meeting back over to you.

MR. WARD: Thank you.

Let's see. Dr. Moeller, unless your feelings will be hurt, we will skip your subcommittee report and put it back to Saturday where it was originally intended, and we will go ahead with agenda item No. 5, which is the NRC maintenance and surveillance program plan.

Mr. Reed, I believe you lead off.

MR. REED: Well, that is a surprise. I'm sometimes not ready when agendas get changed that fast.

Let me refer the committee to Tab 5. That is the tab that we are working on, and let me point out that I recently became the chairman of the Maintenance Practices and Procedures Subcommittee, although I have been a member for about a year and a half, and I have been very, very surprised by the change in direction and the refocusing of the

regulatory activities and the improvement that has taken place in the maintenance program plan over the past one and a half years. I guess we haven't really put out a letter in that period because there has been swift change in transition.

However, I did write a letter in May, a proposed letter in May 1984, saying -- which was critical of what was going on in the maintenance program prior. I was concerned in that draft letter, which never came before the full committee, it never was published, I was concerned what was going to happen as far as we were going to burden the workmen in the work place with lots of unnecessary paper, in my opinion, and all kinds of activities that would divert them from applying their skill in the work place.

Now I am pleased. I think what we will see here today -- is Dr. Booher here? I think he will be presenting the status we now have. I think you will see it is considerably refocused and they have selected something like six technical issues that are sometimes called projects which are to be the major regulatory activities in phase one. And he is in that phase, even though there has been lots of change over the one and a half years that I have been following the maintenance program plan.

Now, in addition to the six technical issues of projects, which I am sure he is going to present, there are two issues which we might want to reflect on as he is making

his presentations, and he may touch on them just a bit.

Those two issues -- one is a Japanese comparison issue. I think there have been maybe three trips. I know of one by INPO, and there's been one, I guess, by Mr. Denton and others to Japan, to try to figure out the reason that Japanese performance seems to be better.

So there has been this USA-Japanese interfacing, and I don't think that will come up today.

I have been told by Dr. Booher that that is still under review and perhaps in about a year there will be closed session presentations trying to relate experiences from the Japanese maintenance and the way they do it versus perhaps the way their people do it with respect to the USA.

Now I think we should perhaps think about whether the Japanese comparisons are closely relatable to the United States power plant, nuclear power plant situation.

The other thing -- and it shows up in the Japanese, it's an issue -- could be an issue -- is the natural ability selection issue, and that has been taken up in a combined meeting somewhat which was Human Factors and the Maintenance program plan.

That was a meeting, I believe, on June 19th, 1985 where the combined meeting took place.

I do think we ought to reflect again on whether maintenance people should have high mechanical comprehension

and dexterity. We may not be able to conclude anything if we do produce the letter from this presentation today.

The last subcommittee meeting was on June 18th, and it was attended by Dr. Kerr, Mr. Wylie, Mr. Ward and myself, and I believe we had presentations from five NRC Staff members. And I guess I am ready to turn the meeting over to Booher and Company.

(Slide)

MR. BOOHER: Good afternoon. I think it has been well over a year since I have been here before the full committee. I have talked to the subcommittee a number of times.

As Mr. Reed points out, there have been a number of changes. One change in particular which I am very happy about, is we now have some support in house. We have a new Maintenance Section. Greg Cwalina has been selected as our maintenance leader. He is sitting back there.

We have a number of other people with us today, if you want to go into any depth on some of the issues. I just plan to cover pretty much of an overview. We talked to the subcommittee, and I think Mr. Reed covered quite well some of the main issues that might still be handled.

Right now, today, I just want to go over these as a major outline of our objectives and scope, current status, programs, summary. We are in Phase I, so we have Phase I

projects ongoing. In particular, there is a survey, and we will talk a little bit about the progress there.

(Slide)

We almost ran out of space on this slide, so we cannot afford to have too many more meetings on this plan.

As you can see, we start out -- last November of 1983, Bill Russell had the idea of having a workshop. We had a couple of workshops in town. Brought in the experts from around the area that we knew of, and, also in-house. We also got a pilot study on maintenance indicators.

In January of 1984, the Commission came out with policy and planning guidance, which told us to go ahead and either consider this as part of the Human Factors Program Plan, or to pursue it alone to come up with some recommendation of what we can do in regulation of maintenance.

In May of 1984 was when we had Bill Russell down after his trip to Japan, in closed session to the subcommittee and the full committee n the Japanese study, part 1. At that time, when we talked about the program plan, we had in particular, five phases. A five-phase program, with emphasis on increased regulation fairly rapidly. This was revised substantially with comments at that time. Dr. Michaelson was head of the Maintenance Subcommittee, and also Mr. Reed's comments.

By June of 1984 we had a draft plan. By this time

the organization in the industry, NUMARC was formed, and had some comments, fairly severe, on the program plan.

In the meantime we had -- through the year we briefed a number of the standards groups, because our emphasis was to try to get the industry moving on their own, if possible. And if that were the case, then we could, as we have in other areas, like training, step back and see how well they are doing, evaluate, and go on from there.

By October 1984, we had an updated plan to NUMARC. An ACRS subcommittee was briefed in Seattle on the Japanese.

In December of 1984, our first pilot study was completed. Basically, that came up with some indicators. In the meantime, industry had come up with their own proposed maintenance indicators, some ten indicators.

So, by January 1985, we finally had Phase I plan for the plant approved by the EDO. NUMARC had proposed their indicators, and we had a task force to look at their indicators to see if we thought those were good.

It turns out that we did think they were certainly as good as we could come up with at this point. Industry would collect data on them, and we hoped that at that time we would be able to share the data to make an independent evaluation.

Since then it has become at this stage, we are not going to be able to get access to the data, and that has

held us up somewhat on that aspect of the program.

By April, we submitted to the Commission the 85-129, the actual pro_ram plan, which is pretty much what the committee has before them.

And in May of 1985 we started a survey project.

And, of course, in June we briefed the subcommittee, and that is where we are today.

MR. MARK: Could you say a word more about the remark you made, not being able to get hold of data.

MR. BOOHER: Yes. I had that for a little later.

MR. MARK: Okay, that is fine.

MR. BOOHER: I do have that in the plan.

(Slide)

Our specific objectives. These have been listed to some degree. We say they are always motherhood, because of how we measure effectiveness, and how we are going to identify these practices, and all these things we would like to do.

The main thing I would like to point out, it is not our intent in this program -- at least Phase I -- to address the technical problem of how to maintain specific components. Our objective is to identify factors that contribute to programmatic aspects of maintenance, overall maintenance effectiveness.

Along that line, I believe we have no contest with industry. We were saying we had something like 35 percent of

the problems occurring out there in the field due to maintenance. Industry did their own study. They claimed we were conservative, it is something like 40 percent.

The only issue they have is they are better at correcting this problem than NRC is by coming out with new regulation. So, that is not an issue. So, we are pretty much in agreement on the objectives. NUMARC went along with this.

The only other thing was, they said they thought this was probably going to cover something like 75 percent of all the activities in the plant. Certainly we don't plan to come out with regulations, at least right now, that is going to try to fill that kind of ratchet on the industry.

MR. MOELLER: Excuse me. You, of course, have mentioned NUMARC on the fourth item on that chart, reducing occupational exposure. Is that item closely tied into the group at INPO that is working with industry to reduce doses?

MR. BOOHER: That's correct. In fact, since we called this an integrated NRC program, we are really working through the people working on the ALARA program. And NRR is not directly in my section.

(Slide)

Now, as far as scope, again I think this is one of the most important things that happened between NUMARC and ourselves back and forth. As you know, in our SALP ratings we have a maintenance category, we have a surveillance category.

We really kind of defined -- we call our plan Maintenance and Surveillance Program Plan, because we really don't think we could make major improvements in the industry just by trying to attack maintenance as it was defined in the past, particularly when we are thinking of just corrective maintenance, the man out there just trying to do his job once there has been a problem.

We also have to address programmatically, what is happening out there with our surveillance and test requirements. We could get into the Japanese a little bit.

Really, what we are talking about, is we use the surveillance and test program to assure availability, whereas the Japanese use them for preventive maintenance programs. So, we cannot compare one thing against another unless we broaden our scope to include both.

The other thing is, we want to get beyond just safety-related equipment. Again, we are trying to define the status in industry practices in the Phase I. Not coming up, necessarily, with rules and regulations to tell industry what has to be done from a regulatory standpoint.

So, we are getting beyond safety-related equipment. We are getting into balance of plant.

Again, the Japanese do cover considerable -- with their preventive maintenance programs, not only safety-related equipment as defined, but also others. And also the Salem

experience has been the same way. We came out requiring Salem to have a preventive maintenance program on certain equipments. They voluntarily have gone well beyond that because they find it is really cost effective to do that.

(Slide)

In the program plan we center around -- this is how I got started. We have identified problems. Again, as I said, there is no real contest with the industry in these problems. We do think there is maintenance performance problems. There seems to be a need for improvement in maintenance that is not being performed in many areas. Our inspection reports bear this out. Low SALP scores in some areas do.

I don't want to get into Davis-Besse, but that is a potential indication there of perhaps some maintenance problems.

Of course, resultant failures due to improper maintenance performance.

We haven't seen this necessarily improving since we started in 1983. In fact, abnormal reports to Congress are still on the increase. When we did our little calculation on the percentage of them, versus other causes, maintenance seems to be increasing over the past ten years, and that trend is still there.

Maintenance operations interface. This really is

borne out by the wrong unit/wrong training problem. Generic issue 102, which we are working with that really is not exactly the same thing. But we are coordinating that with this program plan. What we are doing is looking for short-term solutions first within the program plan.

If that means there is some longer term, we will get to that as soon as we come up with our report to the EDO in March.

Of course, the challenge to the safety systems, this was a big factor again, comparing the Japanese versus us in terms of trip rates. Maybe ten or twenty times greater in the U.S. versus the Japanese. On the other hand, we look at certain plants within the U.S. and they are performing just as well.

So, certainly it seems to be a possibility that maybe some are doing worse than others. There are some outliers.

In fact, when we study the 1983 data on trip rates, 40 percent of these were due to equipment malfunctions; another 40 percent -- 82 of them challenged the reactor protector system; 47 percent were due to personnel error during the maintenance and test, and 73 percent of these challenged the system.

So, it is certainly a very strong problem, a good indication that we should be looking at this area.

Of course, occupational exposures. The main thing there is maintenance personnel account for 75 percent of the exposures. If there is some way to reduce that and reduce it systematically, that is something that wants to be considered in the program.

(Slide)

So, what is the strategy?

The strategy of the program plan is not to be reactive, not to just take off and come up with some ideas, because frankly, we can't seem to get too many people to agree on what is the right solution. So, we have taken the broad scope, first of all, in order to cover maintenance and surveillance, and also components beyond safety-related equipment.

We are going to focus on six technical issues. We will enumerate those for you.

First, was human error in maintenance.

Second, indicators of maintenance efficiency of performance.

Third one was, how useful was that in counteracting aging and service wear effects.

Fourth was management organizational impacts. The amount of resources and the communication back and forth from management, does that have an effect positively or negatively on maintenance performance.

Of course we don't have adequate criterion and standards in the area at this point to really come up with an answer if someone were to look for it in the industry.

The other is the maintenance and operations interface, because that is a key thing, we believe, to such things as wrong unit/wrong train for problems. We are going to use a phased approach. Again, we had the five-phased approach. We are going to have a one-phased approach which is to go out pretty much like we were in training and come up with a rule, and work it from that direction.

We now have two phases. Phase I is to survey the current maintenance practices and evaluate their effectiveness. We have a report due in next April, 1986, on that.

The second phase, if we get into it and it is approved by the EDO, will be to then identify distinct maintenance problems, determine their impact on plant safety and worker dose.

So, for the next year we are not getting into specific problems. We are trying to look at, are there programmatic problems.

Here again the industry says they have done a root cause analysis. I have not seen that. I have heard reports on it, in which they agree that there are a lot of problems. But, they think they are more plant specific and they cannot

come up with any programmatic areas that they would recommend going forward with some kind of generic solution.

MR. EBERSOLE: Is there a topic in there anyplace that you might call management of maintenance and the motivation to have high levels of maintenance?

I get a little disturbed by the notion that the workmen in the workplace --

MR. BOOHER: That was one of the technical issues, management and organization of maintenance.

MR. EBERSOLE: When you have a well-maintained plant, it does not always depend on the excellence of the man down at the bottom.

MR. BOOHER: Not in the least. I think it has got to go both ways. All the motivation in the world is not going to give them the skills.

MR. EBERSOLE: Right. So, how are you going to draw out the limits?

MR. BOOHER: At this point we are in an investigating stage, to see whether or not those are what come up as being key problems. We are not trying to define real limits at this time. It is a tough one. We are trying to be open and objective, and it is very difficult.

We just went to a plant on our first survey which I will submit to you was Kewaunee. It was very difficult not to use the adjective "good" in front of things that we saw in

terms of communications and these kinds of things. Because if we are going to call them good, someone else we are going to have to call bad.

We are really not trying to do that yet. We are trying to define what are the practices out there. Then, hopefully, can start looking at some of the maintenance indicator data coming in, to see if there are some relationships between either management or skills or communications. These kind of things, against the actual performance of the plant.

But, at this point we are not trying to preguess the answers.

MR. LEWIS: On the same point, Jesse, looking at the practices, I am just curious at how deeply you have looked. For example, we have had in the last year or so a number of fairly eggregious maintenance-induced accidents at nuclear power plants. The attitude of management is probably well measured by finding out what happened to the people who committed these sins. Are they still in place? Have they been sent to China for reeducation?

Have you made any effort to look at case histories of that kind?

MR. BOOHER: In our study we will have six case histories. We have looked at these things in the past as they have come up. It has been reactive. We always use hindsight

to say that didn't happen. But it has been very difficult to come up with how do you make a good management, a good attitude? When you see it there, you know it.

MR. LEWIS: I'm not thinking of hindsighting, but just assessing the attitudes of management by what they do to people who make dreadful mistakes.

MR. REED: In direct response to that, Hal, I can say one case that I know of where the wrong unit/wrong train was violated in about eight ways. The person was terminated. However, he was caused to be reinstated, at least as an employee of the company, but at a coal plant. It was the union.

MR. BOOHER: I can assure you in Phase One we have a questionnaire in the protocol which very much we are going to cover these areas. We have a whole category for management and organization, and those kinds of things are there. I will just say Phase One marching orders are not to prejudge. If it comes out that way, we will see it in that report.

MR. LEWIS: I'm not talking about prejudging; I'm talking about collecting specific information. That is not prejudging.

MR. BOOHER: No question of specific information. We will collect it in that area. In fact, I think there is kind of a decision tree approach to some of these things. You find problems there. You are going to find a lot more

problems on down the line. We are not trying to come up with the fact that people have made some mistakes along the way as being the root cause of poor maintenance performance.

MR. CWALINA: Hal, if I could add to that, as part of the wrong unit/wrong train surveys that we are involved in, those questions are specifically asked at the site visits that were going on: what happens to the people who are involved in those events?

MR. LEWIS: That's very good, and I'm glad you said that, but there are some generalities and specifics that very often different people will tell you what our practice is, and you look, and sometimes it is not what is enforced.

I have some specifics in mind which this is the wrong forum for, but cases where the same mistake seems to have been made over and over again.

MR. CWALINA: We do ask the specifics. As a matter of fact, many of the interviews are conducted with the people who actually cause the event, both wrong unit/wrong train event.

MR. KERR: Has Mr. Reed asked if members are being surveyed to see if they use mechanical aptitude testing? You have asked that question, I assume?

MR. REED: I believe I have pursued that.

[Slide.]

MR. BOOHER: Phase One projects. This is an

outline. The first two are perhaps the main ones, survey of current practices and maintenance performance indicators. The others are ongoing kinds of activities, although we have, like 8 and 9 on here, we have some activity in that area. In fact, on 9 we have quite a bit of activity. We don't have contractor support for that.

[Slide.]

The site survey of current maintenance practices. We have six tasks. Pacific Northwest Laboratory competed with other labs for this task, and in supporting this. In site visits we have something like four to six people per visit and about two contractors, one person from our shop, someone from the region, from I&E.

As I say, there are six sites. I can name those for you if you are interested: Kewaunee, Millstone -- which is going to be done at the end of the month -- Brunswick, Turkey Point, Arkansas 1 and Rancho Seco. Now, we have just completed the Kewaunee visit. We had two purposes there. One was to actually collect the data. We also were using a protocol which was broken into categories, like manager organization, facilities and equipment, personnel, and they were very helpful in helping us also refine that to see if it was the type of document that we could use to get system data.

MR. REED: Did I notice that was heavily skewed towards PWRs rather than BWRs? Wasn't that about 5 to 1?

MR. BOOHER: I dont' think that was intended.

Greg, would you comment on that?

MR. CWALINA: Yes. The purpose of that, we wanted to get a wide range, which we have done, if you will notice. We had two G.E. plants, two Westinghouse, one B&W and one C.E. so we could hit all the major vendors.

MR. REED: I think that is a good idea, to get the types because therein lies the difference in radioactivity and radioactive exposure of maintenance workers. I have been noticing the figures on BWRs versus PWRs recently.

MR. BOOHER: We also have one from each region. We looked at our own possibility of regional bias, which we wanted to make sure that when we go to look at SALP scores, for example, perhaps one region is not scoring with the same criteria as another, so our protocol will be used the same on each site.

We also have a questionnaire which we are in the process of developing right now which will go to each regional inspector for all plants in order to also gather data, similar data, but again, it is a questionnaire data. We want to use the quickest form we can so by the end of the year we can try to make some kind of statement about the entire industry as far as practices in the maintenance area.

Of course, these other six sites will be our case studies in much more depth.

MR. EBERSOLE: Do you look at maintenance training programs? I just came from Georgia Power. They have extensive maintenance training. Is this a common practice?

MR. BOOHER: That is certainly in the category. One complaint we might be getting from administrators is that they are in a radical change in the maintenance training area because of the INPO accreditation process in which maintenance personnel are, of course, some of the people who are to be accredited, and those programs have been behind the operators but it is a fairly radical change for a lot of them, so whatever we see today may not be much representative of what we might see next year, and so on.

At any rate, we take that into account. We certainly are looking at maintenance training programs.

MR. MARK: Are you able to talk with the INPO people to find out what approaches they are using?

MR. BOOHER: Talk with the INPO people?

MR. MARK: Yes.

MR. BOOHER: Yes, very much. In fact, that gets into our whole training qualifications policy statement agreement between INPO, industry and NRC, and we have a certain amount of going along with them to observe their process. We also are doing a certain amount of audits behind them to see if we agree with them.

We are also attending the accreditation meetings, so

all this has worked into the plan under training. So we are kind of hitting it from another angle than just maintenance by itself. We take that into account.

MR. EBERSOLE: Is there adequate incentive in terms of compensation and career for maintenance workers at a nuclear plant? There is a great to-do about being operators, the humongous salaries, which I am worried about a little bit since there may be higher salaries but no better operators.

In the case of maintenance like airplane maintenance, I am just as much interested in how the plane is put together as how it is flown.

MR. BOOHER: Attending the maintenance superintendent workshops down in INPO, that is one of the big complaints. If a person had a choice in the maintenance area that he could he work either fossil plant or nuclear plant for the same salary, he would say: Why should I do it?

MR. EBERSOLE: So this is analogous to saying a truck mechanic can work on a 747?

MR. REED: Jesse, I think here is another way to give an evaluation and answer to you. My experience is that even though operators are well paid and they get bonuses, many of them, a monthly bonus for maintaining their licenses, what happens in the world that I have been in is that all the time operators and licensed personnel are trying to transfer into maintenance because of the issue of day work. It is mostly

day work. There is substantial overtime in refueling events. You will always have a problem. Everyone wants to get into maintenance.

I am not sure that is true of all plants, but the plants I am familiar with.

MR. EBERSOLE: He said the maintenance people get the same salary ratings and so forth as commercial coal plants and so forth. There is no distinguishing degrees of excellence or anything.

MR. REED: There is grease, coal and dirt in coal plants, and radioactivity -- I think really maintenance workers have not yet -- if you talk to workers -- have not been clubbed to death with respect to paper and diversions, and I think they pretty much are still plying their skills, and they ply it in a much cleaner atmosphere.

MR. LEWIS: Could I ask a question out of ignorance just for people who actually work in it? When we say maintenance, I suddenly realize I don't know what it means. Do maintenance workers spend most of their time maintaining in the sense of adjusting, tuning things? Do they spend most of their time conducting tests required by the tech specs or do they occasionally sometimes fix things?

MR. REED: In my experience, the testing, the periodic and routine ongoing testing is generally done by Operations and computerized callup system on backshifts.

MR. LEWIS: That is not done by Maintenance.

MR. REED: That's true, except for instrumentation and control if you want to call that also maintenance. I am thinking of electrical and mechanical maintenance. During the nonrefueling period when you are in operation, the maintenance personnel are doing valve adjustments here and there and overhauling and getting prepared for the next refueling. That kind of thing.

Of course, during refueling, they are very much involved in the big aspects, such as head lifts and pump overhaul and those kinds of things.

MR. LEWIS: So it is the sort of thing I would normally think of as maintenance.

MR. KERR: I expect they spend a significant amount of their time filling out forms and signing things too, don't they?

MR. REED: It is a growing thing, the paperwork aspect.

MR. KERR: Mr. Booher, in your trip to Kewaunee did you encounter any significant surprises?

MR. BOOHER: I have not been totally -- I didn't personally go. I wasn't on the site visit. I don't know if we have anyone here who has actually done -- Brinkman from I&E was on that.

MR. BRINKMAN: I'm Don Brinkman. I'm with the

Office of Inspection and Enforcement.

I accompanied Dr. Booher's people on the visit. I don't believe we really discovered any surprises there other than we were pleased to see the attitude of the workers at the Kewaunee plant. They seemed to be very diligent in their work.

MR. KERR: You were surprised at that?

MR. BRINKMAN: I was surprised at the level of their interest in their work.

MR. REED: Weren't you also surprised by the number of personnel or lack of number of personnel?

MR. BRINKMAN: I was quite surprised at the small staff they had.

MR. MARK: Were you well received?

MR. BRINKMAN: Yes, we were.

MR. MARK: That should have surprised you.

[Laughter.]

MR. WARD: Does anyone else have any suggestions for things Mr. Brinkman might have been surprised at?

[Laughter.]

MR. KERR: I was curious because if he wasn't surprised at something, it seems to me there wasn't there a whole lot of point in making that trip. You spend a lot of effort and personnel on something of this sort. I would anticipate that you would encounter something unusual.

Apparently not.

MR. BOOHER: You must realize also this plant was picked first because it does have a good record. One of the main purposes of this was not necessarily to find surprises or problems; it was to see how well we could use this protocol because we are going to be using it again on other plants ultimately. If it works, we hope to use this in Phase Two as actual probable assessment criteria tool for regions and for audits and this sort of thing.

So we want to make sure we are catching everything in terms of being able to describe it, not necessarily good or bad at this point.

MR. REED: I can't pass up this opportunity. I'm sorry. I might point out Kewaunee is one of those plants that uses natural ability selection testing and has used it for years.

MR. BOOHER: We had to add that one in.

MR. LEWIS: So does my university, but it doesn't help.

MR. BOOHER: Maintenance performance indicators. Again I say we started something Research had been working on indicators, developing this for some time. Everyone agreed it would be nice if we had some quantitative measurements to help our subjective opinions used by the experts.

[Slide.]

When NUMARC said they were going to come up with and develop the indicators, that sounded great, and we have held off considerably waiting to reach some kind of agreement, perhaps we could get this data so that by the end of next year we could have independent evaluation of their statistical analysis of the data, and see if these things really do what we hope they will.

In our case we would like to see whether or not there is some kind of distribution. Some we might want to put more concentration on than others. Unfortunately, at the present time, we received a letter from NUMARC -- I believe it was just last month, a few weeks ago -- which stated that it looked as though we would not be able to receive the data from NUMARC, because INPO has really collected the data for them, and they are having a difficult time, as you know, getting any kind of access to plant-specific data which would be given to INPO.

Also there is a lawsuit going on right now which is another problem. If we get the data, would we be required to give it in the Freedom of Information Act? This is all up in the air. Right now it looks like we are going to have to go out and collect data on as many of these indicators ourselves, as long as it is publicly available data.

MR. REED: Are you in agreement -- I believe there are 10 INPO indicators which looks very solid to me.

MR. BOOHER: We saw nothing wrong with those. We added two other ones which INPO itself said they wanted to collect on those two others, but they didn't know how to do it. That was going to be a follow-on. As far as sitting around this room with experts saying, hey, this is okay, everyone is in agreement. As far as having any real data to follow up and validate it and see if it really relates to something that we can call safety, we don't have that. But at least it is certainly the best starting point we could think of.

As I say, we are not going to get that data directly from INPO.

MR. REED: As I remember the indicators -- and I see three of them here on your next page right away -- they are available to the NRC every month?

MR. BOOHER: That is right. Those we can get. Others we are going to try and get.

MR. REED: I noticed those others that look on radiation, there is a minor separation there. I think you are trying to cull out for maintenance workers. That might not be available, but of course under 10 CFR 20, all the other radiation information --

MR. BOOHER: I'm not discouraged. I think the problem is we could have been doing this six months ago, but we waited to get -- agreed to do this together, and we didn't

want to go off doing something -- collecting data at the same time when we are going to get it from another source. And that was just something that was unfortunate, but we can't do much about it.

I do think we can get that data. Not only that-- I don't know, maybe we might even be able to get some voluntarily, because the industry does have it in the proper form now.

A lot of the big problem with NUMARC was having cooperation from utilities, what they were asking for, not everyone had it in the same form. There was a great deal of work to get it. How do you define preventive maintenance or corrective maintenance in terms of reporting these kinds of figures?

MR. EBERSOLE: I wonder if you could tell me a little bit about the makeup of NUMARC and its qualifications and authority and what makes it so good.

MR. BOOHER: What makes it so good, it is staffed totally by --

MR. EBERSOLE: How big is it?

MR. BOOHER: How big an organization?

MR. EBERSOLE: Yes.

MR. BOOHER: As I understand, it doesn't really have a budget at this point. It's all been volunteer, and so it is a pretty small organization. But they claim to represent the

entire utility industry.

MR. REED: Jesse, I think there are about 50 executives, utility executives, who are on the NUMARC membership list. Is that correct?

MR. BOOHER: That's essentially it. It was formed at the time when we were thinking about coming up with operating experience rule, something like 50 people appeared to the Commission one day and all said we're vice presidents or above, and here is our initiative, we will take care of the problem.

And I think it was a grand step forward. Because if they made a decision, it was going to happen, they had the money to back it up. And we found it has come through in the operating experience because of new plants being licensed. That's where it came down. Either they have shift advisers for the requirements we set, or six months, so that was a real hard problem to correct.

MR. REED: Are you going to keep the pressure on to try to pry that data loose?

MR. WYLIE: Yes, definitely.

MR. REED: The plant people, in the final analysis, it comes down to the poor plant organization to produce the data. So anything that can unburden repetitious data, fine, you can keep the pressure on. I'm sure you should be successful.

MR. BOOHER: The pressure is still coming from helping Vic Stello's group. This may not be -- particularly if this lawsuit gets settled, something could be worked out. Also perhaps we can get the data without having it specifically identified which plant it is. If we have 80 points, we can do some statistical analysis.

On the other hand, they said we could figure out who the plants were if they did that.

[Slide.]

At any rate, I think things are moving along on schedule. The main thing, industry is still going to have this data when they present it a year from now. We would like to be able to say yes, that's good data, it's validated right, it really does show the trends. I think we should have some kind of independent look at it. And that's what we will be working on.

MR. AXTMANN: Did you select Salem with a dart board?

MR. BOOHER: Salem was selected strictly because they're the only plant that we have required to have a preventive maintenance program, and they have now the experience of having come from having none to having one, both in terms of also a lot of cost data on what that has taken --

MR. EBERSOLE: They inherited that from that event, didn't they?

MR. BOOHER: Certainly did.

MR. EBERSOLE: I guess Davis-Besse will inherit the same thing?

MR. BOOHER: I can't speak to that at the present time.

Oh, Project 4 was a participation in standards groups. A number of the standards groups have been doing work and since 1983 they really did get off the dime in a lot of areas, particularly IEEE has been working -- every couple of months have been meeting and trying to come up with some good practices themselves. ANS 3.9 was a subcommittee formed. The chairman there is actually Tom Fitzgerald from American Nuclear Insurers. He's been trying for five years to try to get something going. That's kind of in a hold status right now because INPO says they are also providing good practices along the same line.

And we do have members in all of these. Tommy Lee has been designated as a member, who comes from the I&E groups and works in our section and is off at one of those meetings right now.

[Slide.]

Program integration. This is nice work, but we are really trying very, very hard to get our act together within NRC. I think just as a good example, research reliability program, they have been coming up with a little questionnaire

or survey themselves, rather than going off to different plants. They are going to be coming with us on the Millstone plant. They are looking at it for a different purpose. They are trying to look at what types of reliability programs are out there. They are not all the same, and get data on that. But they will be working together on that.

We looked at some of the programs that are shown in the program plans.

[Slide.]

We actually have a pretty good write-up, I'm impressed with the write-up. I didn't write it, some of the people on my staff did. It really tells you what some of the other areas are doing. When we specify actual interface areas for each of these programs, the phase one or phase two, and what it would be we would expect.

Also when they have a report, we don't just look at it and quickly comment. We are actually analyzing it. If we can't do it, we have our contractor do it and write interface descriptions of how one program relates to the other, and how one could help the other, and that will be in our final report as well.

So that is a fairly big effort on the Staff's part, but it's another thing that we want single phase solutions in these areas.

[Slide.]

The sixth program is the analysis of the Japanese vs. US maintenance programs experience. I cannot say a whole lot here.

John Jankovic, who is the project manager of the program, is here today. We have a NUREG CR-3883 which is on the street, which tells the results of the comparison we did.

Again we have stopped work in that area because indsutry has sent their own team over to look at the Japanese practice. We found, I guess it's VEPCO has also been doing things on their own, trying to adopt some of these practices, and they seem to be very happy with it.

I think what is going to happen next year when we get into phase two is we hope these results will be very useful in helping determine the appropriate balance between surveillance testing and preventive maintenance. What is the trade-off there. That's going to become the real crux of the issue. Can you back off on some of the surveillance and test requirements in return for an increase in preventive maintenance. Is there a tradeoff there. Because that is really what we are comparing, when we are comparing the Japanese vs. us.

MR. WARD: Are the Japanese looking to do just the opposite?

MR. BOOHER: The Japanese are not looking to do more surveillance and tests. They are looking to do less

preventive maintenance. They think they are overdoing it because of their long outages.

Of course, that again is required by the government. So they are looking for a little data to say that they can shorten those.

MR. REED: I know at the subcommittee meeting you mentioned how you had paired plants for evaluation, and we had some comment about that, and I wondered if perhaps they should have been paired on performance statistics more than vintage.

How do you still feel about that? For instance, I have the feeling that if a Kewaunee plant was compared against say the better Japanese, you would not find all that much difference.

MR. BOOHER: That might be a comparison in the future. What has been done has been done.

John, would you like to give us the rationale for why we did it that way? I know it seemed at the time it was the only way to do it.

MR. JANKOVIC: I am John Jankovic, from the Maintenance and Surveillance Section of Dr. Booher's staff.

I would like to point out that one of the objectives of the study was to identify a number of philosophies, management approaches to maintenance. And we did look at differences, not just similarities.

In that respect the report was successful, because

we identified the Japanese approach, emphasizing preventive maintenance as the primary element of their maintenance philosophy, while we didn't find it at those plants which were selected from the U.S.

MR. REED: Well, I keep thinking that maintenance is very much tied to human beings, their aptitudes, skills, vocation, and these kinds of things. And I'm not so sure that philosophy -- that is how many times -- whether you do lots of surveillance testing or whether you do balance of plant maintenance, yearly, in depth -- I'm not so sure that that is going to lead us to maintenance improvement in the long run.

So I keep digging away at look at the human aspects in the maintenance activity. And I was happy to hear that you surveyed Kewaunee and came away impressed. But I also know that Kewaunee is that kind of dedicated, motivated, coupled, small organization, and I am sure they minimize paper and they have done a good job. The record speaks for it.

MR. BOOHER: There may be similarities between the Kewaunee attitude and Japanese attitude. It may be difficult to get the rest of the industry --

MR. REED: There's a thread there. That's why I'd like to see if it can be put together.

MR. BOOHER: As I say, VEPCO, for example, is trying to evolve on this, really trying it.

John, can we say something about that?

MR. JANKOVIC: About two weeks ago VEPCO management gave a presentation to our Division of Licensing, and the subject was their upgraded approach to maintenance. And they told us that they tried to implement the Japanese quality circle approach, and they had their maintenance superintendent here and even members from the first selected team. There were six craft people in a team plus the foreman, and they get indoctrination about the quality, importance of quality of their work, and they get a little training, not technical training, but team approach to work.

Within that team they are free to do assignments to each other. But maybe the most important aspect of this team approach is that before they start a job, they have a pre-job discussion, what are the critical aspects of the work, what they have to watch out for in particular, and once they finish the job, they have also a little discussion. Was the procedure correct, was their approach correct, what improvement can be done.

This was the first time from Surry, and they -- VEPCO will have another team in September in place at North Anna. They are scheduled, of course, for transferring the entire maintenance department to this approach, to this team approach, by next September.

MR. REED: I believe, and I have read some on that, I believe the quality circle approach -- I believe it probably

is a better thing to work where you have large organizations and lots more people, and that is the way to couple things together. There is a difference, though, I think, between that and the Kewaunee thing, where you have very small organizations who, on an individual basis, do perform like teams.

So the human side is very important --

MR. BOOHER: Certainly we as human factors specialists don't want to ignore that at all.

MR. JANKOVIC: I would like to add a closing remark to our visit to Kewaunee. One of the observations we made was that the personnel in the maintenance department is unique there, because they have been there since the beginning of the plant. They participated in the construction. They are very dedicated to their organization, and their turnover rate is less than 2 percent a year.

MR. REED: Do you think that is unique? If you were to go out and check all the plants in the United States, you think it's that unique?

MR. JANKOVIC: At the moment we think it is unique. We will be able to tell you more half a year from now when we finish our survey.

MR. BOOHER: I guess we need to move along.

[Slide.]

The seventh topic is one that we do not have

actually formulated yet. Mr. Reed has discussed that with other members of the Staff, and we have his comments and recommendations. This is an area that we inherited from the Research organization because their funds have been cut in the Human Factors and Research. So we do not have an actual ongoing task right now. This is sort of a list of things we feel we probably need, in that area, and we will be working, of course, closely with INPO and the accreditation program in anything we do there.

[Slide.]

The eighth area is, we've tagged along on a bigger research study, which is a feasibility study investigation, investigating ultrasonic testing. Apparently Pacific Northwest Lab is doing what the call round-robin experiment or test of inspectors. They have six sets of two sets of inspectors. They have been trained by EPRI on pipe crack detection, and they want to see how well this holds up in a different situation. All we're doing is participating in that exercise at a very low level, but looking for any human factors aspect that might come out of that.

I think one of the findings that they're coming up with is, inspectors who are on there are complaining because they don't get any feedback and knowing whether or not they're doing the thing rightly or wrongly. There seems to be a wide range among the inspectors, where supposedly they are all

qualified at the same level. They're getting something like a 39 percent difference in their performance on these people who have been trained.

I don't know how the data is going to turn out ultimately, but at this point, it just was a chance for us to look at some human error potential in something like crack detection.

[Slide.]

Our final project in Phase 1 is to participate in the human error in wrong unit/wrong train units. At his point, we are about halfway through looking at the plants. The goal here was to look at short-term solutions, low cost, and what we're doing, of course, is starting with the LERs and actually going down to the plant and trying to analyze the root causes, in many cases talking to the person who committed this error to find out why they did it.

Again, preliminary information is not real surprising. One area is labeling. Another area is procedures. But a couple of other areas seem to be getting into the area of maybe like fatigue. Some people thought these courses were very exhausting at the time and tend to have sort of a mindset that was just sort of going, not really thinking, down old paths.

It was still too early to come up with any real answers here.

MR. REED: I hope if you are interviewing these people and trying to find out why they did it, as you said, that you realize that the individual will tend to rationalize his action, and that you ought to be checking with an evaluation. I'm sure the companies make evaluations.

MR. BOOHER: I think this is probably just one data point. It's got to come all the way down to look at it.

Drew, you participated in some of these. Would you care to give Mr. Reed a flavor for how this is done?

MR. PERSINKO: My name is Drew Persinko. I'm in the Maintenance Surveillance Section.

I've been going on the wrong unit/wrong train interviews thus far. As Dr. Booher said, interviewing the particular individual who made the mistake is only one of the points that we talk to. We also speak to the maintenance supervisor, production supervisor, somebody very knowledgeable with the particular events that have occurred, so we get both sides of the picture.

We just felt it would be good to speak to the individual. We thought we could get some of his viewpoints, what he was seeing as he was walking out there. I think that has been useful. That's where we get some of the idea that his mind -- he had been practicing on something for a week, and his mind was set on it. It seemed like almost nothing would have changed his mind at that point.

MR. REED: I hope you people are very cautious in doing that kind of thing. You can get crosscurrents to union grievance proceedings and all kinds of activities. It's like going out and asking a criminal, perhaps in a jail, why he is there, and he certainly would say, "I'm not guilty, and I shouldn't be here."

So you've got to be very careful when you get into the human aspects of a utility activity. I'm a little surprised that the utilities aren't a bit turned off by you getting into that depth.

MR. PERSINKO: Most, in fact just about all utilities have been very interested in what we've been doing. We realize the problems that may arise with unionization. In one case -- only one case out of all the interviews that we have conducted -- the individual wanted somebody there from the union. But this wasn't forced upon him. He didn't have to speak to us, if he didn't want to. But they all agreed to it, and it had been checked out with the union ahead of time.

For the most part, all the utilities and the individuals involved have been very receptive to what we have been doing.

[Slide.]

MR. BOOHER: As a wrap-up, just to give a feel for the progress we have made since the past year, both NRC and industry have made progress, I think it probably would be

worthwhile if some of the industry members could come and brief the ACRS -- NUMARC, INPO -- I don't know how long it's been since you've had a discussion from them on what they are doing, particularly in maintenance.

I won't go through all these, because we've already covered most of them. We do have the new section. We are staffed up. We're into Phase 1. We're on schedule. Draft reports should be coming out like maybe March of next year. Industry, in the meantime, we have kept the pressure on. Standards groups are formed; they're actually coming along with some things.

I think this next year is going to be very, very critical on whether there is true progress, and we will have a baseline from them on to measure progress.

MR. REED: I'm a little surprised by your recommending that maybe the ACRS should have the industry come and brief them. I had not considered that. I am finding that the Staff, I think, is doing a very good job in having industry come in. They might see things differently. I could ask them the question.

Is the NRC Staff interfering and going down and interviewing people and raising a ruckus?

MR. BOOHER: We're open to that kind of criticism. We work very hard to avoid it. I don't think we're going to have that at this point.

MR. REED: We will ask the question of the Full Committee, if they want to be briefed by industry. Quite frankly, I have been so pleased with the progress in the last year and a half that I don't feel it's necessary.

MR. BOOHER: I'm glad to hear that. Myself, I am just a little impatient. I feel some of these things, like the indicators in particular, we hoped to be a little further along on.

Also, I'm not quite sure at this point, without a little more communication, of how well industry is doing themselves on some of the tasks they said they are doing that we have kind of backed off on.

MR. REMICK: What you want is indicators of individual plants, is that it? You don't want the industrial averages.

MR. BOOHER: That's right. We don't want an amassment of averages. The Regions have pointed out very definitely that we certainly don't want anything to replace something like our subjective experts with numbers that we cannot really tie to what does that mean.

Also, we would like to see what is their plan for collecting the data, and what do these numbers mean.

MR. WARD: Do you have any indication from sampling, for example, that you can expect there to be large significant differences, a significant range in the values of these

indicators?

MR. BOOHER: We don't have anything at the present time. I really don't know how it's going to turn out. We just have a feeling -- in order to pick those indicators, I have a lot of confidence that those do reflect differences in performance.

MR. WARD: You said a lot of people have agreed on those being valid indicators subjectively?

MR. BOOHER: The reason they've done that is, within the NRC, it was a task force which was headed by at least Branch Chiefs or above, which had representation from the AEOD, who have worked on problems of this nature, from IE, from two Regions, and all agree that these indicators, by name, are fine. But again, the problem is, numbers mean nothing if we don't know what lies behind them. And those indicators, if valid and reliable, are great.

Industry, themselves, spent quite a bit of time through the NUMARC organization and INPO -- they went through something like a hundred possibilities and narrowed down to these ten. One was: Are these something that would look like it would be meaningful. Secondly, are they something they can get the data on?

Even so, it was difficult getting data on those ten. I know C. O. Woody said that was one of their most difficult problems, because at the beginning, some of the

utilities said, "We're going to have to back off some of the work we're doing in maintenance in order to get you this kind of data." Now that they have it, the skids are greased to provide that kind of data.

MR. MARK: You said, I believe, close to when you started, that from the LERs, I think, the number of maintenance problems is increasing rather than falling off.

MR. BOOHER: That was the abnormal events reports to Congress. It wasn't necessarily the LERs. The number is significant, events that have been reported to Congress. Last year, we presented a curve showing something like four or five of those a year, maybe. The percentage of those which have maintenance involvement or maintenance causes have been increasing.

MR. MARK: Is there a measure of that increase? Has it doubled in five years, or has it gone up ten percent in five years, or what?

MR. BOOHER: I don't have it off the top of my head. John, do you recall.

MR. MARK: I don't want a number.

MR. JANKOVICH: We plotted the regression equation for the data. When you compare the absolute number of abnormal occurrences to the number of maintenance-related, we find that the slope is twice as much as the number of evens. So the maintenance-related evens go up twice as fast as the

number of other all together.

MR. MARK: Is there a term in there that has to do with the details of the reportings that are now available as compared to some time ago?

MR. JANKOVICH: The reporting system has been constant during the period, the past ten years. There were no changes in this reporting system, not like in the LER system.

MR. MARK: It's the only thing in the agency that has that property.

[laughter.]

MR. BOOHER: Again, we say we think it just was what got us into this area. We used whatever indications we could to see if there is a problem. Industry is not disagreeing with us, at least in the meetings that we have both been to together.

MR. REED: Is that the end? That's the total presentation, the one-hour presentation?

MR. BOOHER: Yes.

MR. REED: It looks like it's very timely, and I would like to thank you for it. I think that's a good way to make the presentation. One person, if he can handle it all, rather than the others who did in subcommittee, who put it all together.

I would like to thank you and the people from your group that are here to fill in on some of the answering.

Now I would like to ask you a question: Do you want a letter from the ACRS?

MR. BOOHER: I would like a letter. I have talked with Bill Russell. I think, yes, we would like a letter. I think you have seen where we started. It's been over a year. We are into Phase 1. We would like a letter, if it has -- you have the plan; you can see where we are. Have you got criticisms or further directions, anything that can be done? We would welcome it.

MR. REED: Suppose the letter had a comment in it that we think the plan is moving along fine? I personally feel that this is a very complex issue, the whole maintenance issue. It's human-related. There are ways of doing maintenance one way, and you can come out with a very good job. There are ways of doing it another way in a different situation, a different nature, different time, and you come out with another recommendation.

So I would like to think that at least the subcommittee is kept informed before you make final conclusions and put them on the street. Are we going to be informed?

MR. BOOHER: I don't see any problem. For example, we intend, as soon as we get the protocol finalized, even though we're using that, and also the questionnaire, we would like the subcommittee to look at these to see if they are

reasonable, these indicators. We would like to work along with the subcommittee.

Again, Phase 1, the whole idea is not to come up with answers, but to try to get the best grasp of the problem that we can, so that in Phase 2 we can actually work on the problems, and everyone is in agreement that these are the problems that we should be working on.

MR. REED: So you would try to show the subcommittee draft proposed releases and documents, perhaps before you're too far down the pike with them on the street.

MR. BOOHER: I think that would probably be reasonable. We would have to clear that higher up, but I have no problem.

MR. REED: We would like to be informed, I think. Thank you very much.

MR. WARD: Okay. Let's take a break, a ten-minute break, and come back for the future activities discussion.

[Whereupon, at 4:30 o'clock, p.m., the transcribed portion of the meeting was concluded.]

CERTIFICATE OF OFFICIAL REPORTER

This is to certify that the attached proceedings before the United States Nuclear Regulatory Commission in the matter of: ADVISORY COMMITTEE ON REACTOR SAFEGUARDS

Name of Proceeding: 304th General Meeting (Public Session)

Docket No.:

Place: Washington, D. C.

Date: Thursday, August 8, 1985

were held as herein appears and that this is the original transcript thereof for the file of the United States Nuclear Regulatory Commission.

(Signature) Suzanne B. Young

(Typed Name of Reporter) Suzanne B. Young

Ann Riley & Associates, Ltd.

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(Signature) Mimie Meltzer

(Typed Name of Reporter) Mimie Meltzer

Ann Riley & Associates, Ltd.

GESSAR II SEVERE ACCIDENT ISSUES

A PRESENTATION TO THE ADVISORY
COMMITTEE ON REACTOR SAFEGUARDS

WASHINGTON, D.C.

GENERAL ELECTRIC COMPANY

AUGUST 8, 1985

HYDROGEN ISSUES

- o RATE AND AMOUNT
  - GENERATION RATES VARY FROM 0.4 TO 1.6 LB_M/SEC
  - 1300-2300 LB_M TOTAL IN-VESSEL HYDROGEN
  - ONLY ENOUGH OXYGEN TO SUPPORT COMBUSTION OF 2480 LB_M HYDROGEN (~67 PERCENT OF ACTIVE CLAD MWR)

- o HYDROGEN DETONATIONS
  - INSIGNIFICANT RISK REDUCTION FOR ADDITIONAL HYDROGEN CONTROL (BASED ON PRA RESULTS WITH DETONATIONS)
    - CURRENT UNDERSTANDING--LOW LIKELIHOOD OF DETONATIONS IN MARK III
    - RISK EVEN LOWER THAN ORIGINAL PRA RESULTS

  - SER SHOWS NO RISK REDUCTION FOR HYDROGEN CONTROL FOR INTERNAL EVENTS, FACTOR OF 2 FOR SEISMIC RISK (BASED ON DRYWELL FAILURE BY LOCAL DETONATIONS, GE ANALYSES DISAGREE)

- o GE COMMITMENT: PROVIDE A HYDROGEN CONTROL SYSTEM CONSISTENT WITH OUTCOME OF HCOG PROGRAM AND NRC REVIEW
  - NRC REQUIRING DIVERSE POWER SUPPLY FOR IGNITERS (BEYOND HCOG POSITION OF POWER FROM EDG)
  - GE FINDS NO TECHNICAL JUSTIFICATION FOR DIVERSE POWER SOURCE

- o GE POSITION:
  - HYDROGEN CONTROL UNNECESSARY--ABSOLUTE RISK ALREADY LOW
  - NO JUSTIFICATION FOR IGNITER SYSTEM ON COST-BENEFIT BASIS

EFFECT OF STANDING FLAMES ON SEALS

- ISSUE: CAN STANDING FLAMES FROM HYDROGEN DEGRADE DRYWELL SEALS LEADING TO POOL BYPASS?

- ASSESSMENT:

  - DRYWELL EQUIPMENT HATCH HAS A 5 FOOT CONCRETE SHIELD PLUG

  - PERSONNEL AIRLOCKS ARE DOUBLE SUBMARINE DOORS WITH CEMENT SHIELD PLUG ON WETWELL SIDE

  - ELECTRICAL PENETRATIONS ARE 5 FOOT LONG AND POTTED WITH A PORTLAND CEMENT MIXTURE

- CONCLUSION:

  NO EFFECT OF STANDING FLAMES ON DRYWELL SEALS

DAH

ABLATION OF RPV PEDESTAL

- o PEDESTAL IS A STEEL-CONCRETE COMPOSITE CONSTRUCTION
  - TWO CONCENTRIC STEEL SHELLS
  - CONNECTED WITH STEEL SHEAR TIES
  - CONCRETE FILLED BETWEEN THE SHELLS

- o EVALUATED SUPPORT CAPABILITY AFTER ABLATION
  - ASSUME LOSS OF 1.4M OF CONCRETE
  - ASSUME ONLY SUPPORT IS OUTER STEEL SHELL
  - ASSUME OUTER SHELL TEMPERATURE IS 1100°F

- o RESULTS
  - LOADS ON OUTER SHELL

WEIGHT OF RPV	2300 KIPS
WEIGHT OF SHIELD WALL + EQPT	2700 KIPS
WEIGHT OF PEDESTAL	1100 KIPS
TOTAL	6100 KIPS

  - COMPRESSION IN STEEL SHELL = 3.4 KSI
  - YIELD STRENGTH OF STEEL AT 1100°F = 21 KSI

- o CONCLUSIONS
  - PEDESTAL WILL CARRY LOADS - SUBSTANTIAL MARGIN
  - NO LOSS OF PEDESTAL, DRYWELL OR CONTAINMENT STRUCTURAL INTEGRITY

5-6

GESSAR-II PRA REVIEW

DETAILED DISCUSSION OF HYDROGEN

PRESENTED BY

TREVOR PRATT

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PRESENTED TO THE ACRS

AUGUST 8, 1985

BROOKHAVEN NATIONAL LABORATORY
ASSOCIATED UNIVERSITIES, INC.

HYDROGEN ASSESSMENTS

- GESSAR II PRA REVIEW:
  - BASED ON FULL CORE MELTDOWN ACCIDENTS
  - INITIAL SUBMITTAL INCLUDES NO PROVISION FOR H_2 CONTROL DURING SEVERE ACCIDENTS
  - CONSEQUENTLY, VERY HIGH PROBABILITY OF EARLY CONTAINMENT FAILURE AND SIGNIFICANT PROBABILITY OF EARLY LOSS OF DRYWELL INTEGRITY (VIA DETONATION)
  - CONTAINMENT EVENT TREES IN SUPPLEMENT NO. 2 SER (NUREG-0979) DO NOT CONSIDER H_2 CONTROL
  - IMPACT OF H_2 CONTROL ADDRESSED IN SUPPLEMENT NO. 4 TO SER

HYDROGEN ASSESSMENTS (CONT.)

- HCOG/NRC INTERACTIONS:
  - DEALS WITH DEGRADED CORE ACCIDENTS (CORE REMAINS IN-VESSEL)
  - AIM IS TO MAINTAIN CONTAINMENT AND DRYWELL INTEGRITY BY H_2 CONTROL
  - RATES AND AMOUNT OF H_2 GENERATION ARE IMPORTANT FOR DESIGN OF H_2 CONTROL DEVICE
  - ISSUES RELATED TO DELIBERATE IGNITION:
    - OPTIMUM IGNITION SOURCES
    - TYPE OF POWER SOURCE
    - LIMITATIONS OF IGNITION SOURCES
    - EFFECT OF STANDING FLAMES

HYDROGEN DETONATIONS

- H_2 GENERATION

- H_2 DISTRIBUTION

- POTENTIAL FOR DETONATIONS:
    - IGNITION SOURCE
    - DDT

- MAGNITUDE OF SHOCK LOAD

- RESPONSE OF STRUCTURES TO LOADS

H_2 GENERATION

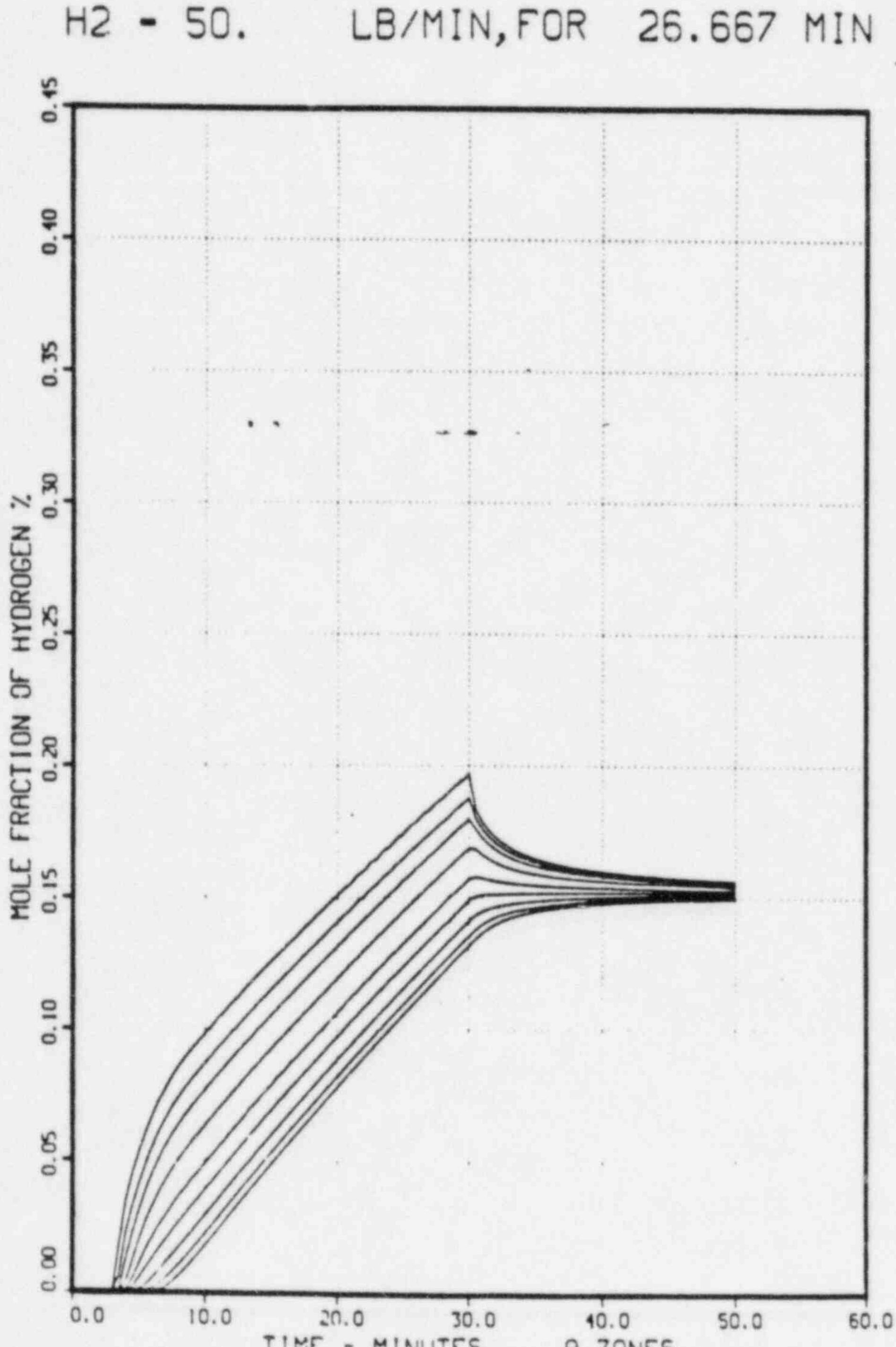
- RATE OF RELEASE FROM PRIMARY SYSTEM
- TOTAL AMOUNT GENERATED
- GE AND BNL APPROACHES SIMILAR (BASED ON MARCH CODE)
- GE AND BNL PERFORMED SENSITIVITY STUDIES TO ASSESS IMPACT OF UNCERTAINTIES
- FOR REFERENCE:
  - MASS ZR IN CLADDING 72,000 LB
  - MASS ZR IN BOXES 64,000 LB
  - POTENTIAL H_2 MASS 6,200 LB
  - 1,700 LB H_2 PRODUCES 20 VOLUME PERCENT IN CONTAINMENT

H_2 DISTRIBUTION

- GE CALCULATED DISTRIBUTION USING IN-HOUSE CODE

- BNL DISTRIBUTION BASED ON IN-HOUSE CODE AND HECTRE CALCULATIONS AT SNL

- EXAMPLE: 50 LB/MIN FOR 27 MINUTES (1350 LB TOTAL H_2 RELEASE)


H2 - 50. LB/MIN,FOR 26.667 MIN
MOLE FRACTION OF HYDROGEN %
0.00
0.05
0.10
0.15
0.20
0.25
0.30
0.35
0.40
0.45
0.0
10.0
20.0
30.0
40.0
50.0
60.0
TIME - MINUTES, 9 ZONES

QUANTIFICATION OF CET

- H_2 IGNITION:
  - DELIBERATE IGNITION DEVICE NOT INCLUDED
  - HIGH PROBABILITY OF IGNITION AT TIME OF POWER RESTORATION
- H_2 FLAMMABILITY LIMITS:
  - >4 VOLUME PERCENT UPWARD PROPAGATION
  - >9 VOLUME PERCENT DOWNWARD PROPAGATION
- H_2 DETONABILITY LIMIT
  - >18 VOLUME PERCENT
- PROBABILITY OF H_2 EVENTS BASED ON PROBABILITY OF POWER RESTORATION AND FRACTION OF TIME LIMITS ARE EXCEEDED

COMPARISON OF CONDITIONAL PROBABILITIES FOR H_2 PHENOMENA

(CLASS I TRANSIENT WITH LOOP - POWER RESTORED PRIOR TO VESSEL FAILURE)

	GE	BNL
GLOBAL DETONATION	0.1	0.0
GLOBAL COMBUSTION	0.3	0.66
LOCAL DETONATION	0.3	0.08
LOCAL COMBUSTION	0.3	0.26

DYNAMIC LOADS RESULTING FROM H_2 PHENOMENA

- GE AND BNL CALCULATE SIMILAR LOADS FOR H_2 DEFLAGRATIONS

- GE ASSESSMENT OF H_2 DETONATIONS

  - $\frac{P_{PEAK}}{P_{INITIAL}}$ = 17 (STRUCTURE PARALLEL TO WAVE)

  - $\frac{P_{PEAK}}{P_{INITIAL}}$ = 41.7 (STRUCTURE PERPENDICULAR TO WAVE)

  - WAVE TREATED AS EQUIVALENT TRIANGULAR PULSE

- NRC ASSESSMENT OF H_2 DETONATIONS BASED ON CALCULATIONS AT SNL USING CSQ CODE

RESPONSE OF STRUCTURES

- DYNAMIC SHOCK LOADS CONVERTED INTO EQUIVALENT STATIC LOADS BY DYNAMIC LOAD FACTORS

- EQUIVALENT STATIC LOADS COMPARED AGAINST CAPACITIES OF STRUCTURES

- GE CONCLUDED:

  - DETONATIONS FAIL CONTAINMENT

  - GLOBAL DETONATIONS FAIL DRYWELL ROOF UNDERWATER

- NRC CONCLUDED:

  - DETONATIONS FAIL CONTAINMENT

  - POTENTIAL FOR FAILURE OF DRYWELL WALL AS WELL AS ROOF UNDERWATER

HYDROGEN BURN EVENT TREE FOR RESTORATION OF POWER BEFORE CORE SLUMP

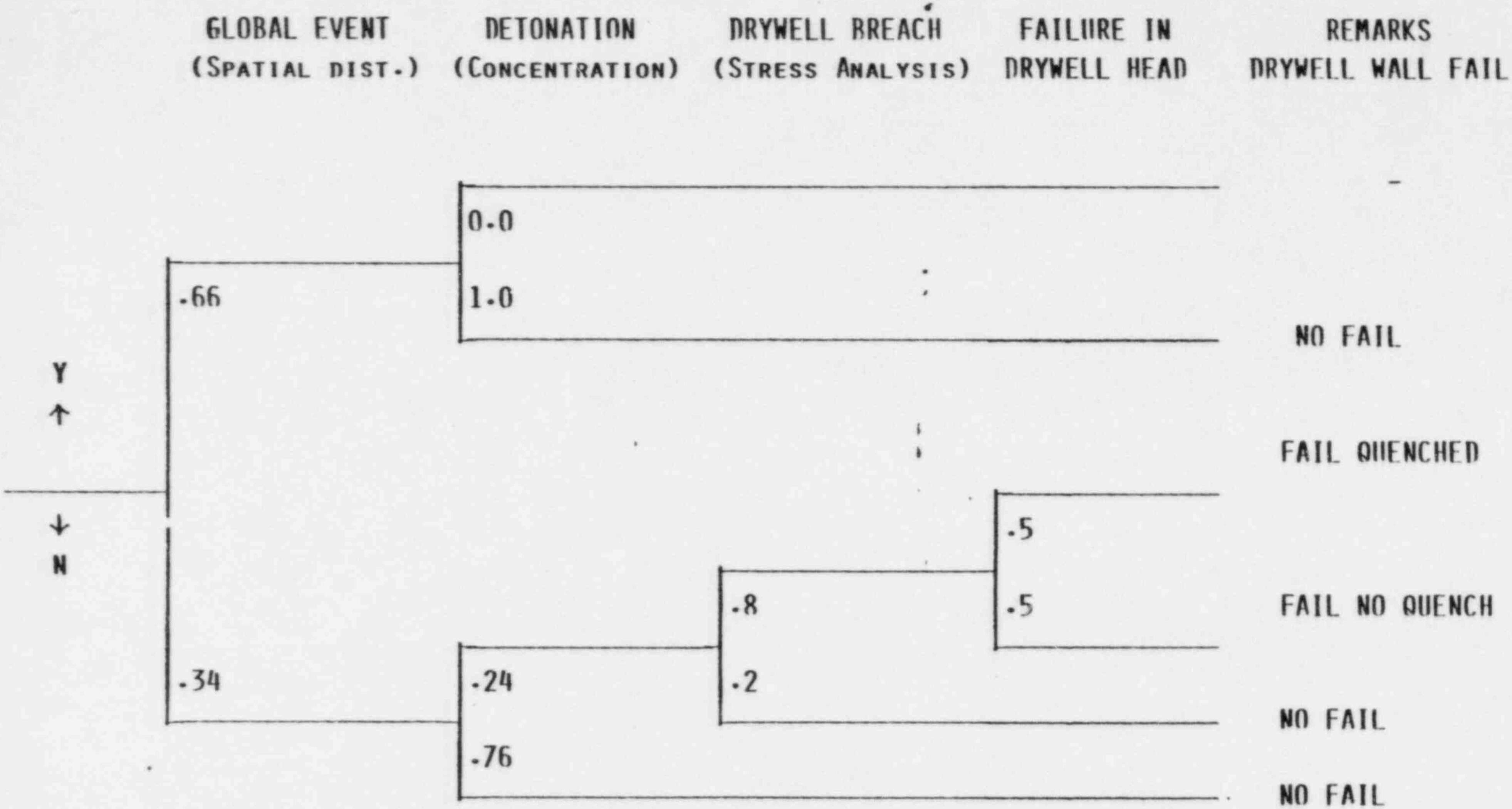


Table 15.1 Conditional consequences predicted by the staff for internally initiated events and probability of occurrence with and without UPPS, per reactor year

Release category*	Early fatality	Early injury	Latent fatality	Person-rems	Probability	
					w/o UPPS	w/UPPS
1-T-L3	0	0	40	7 x E5**	3 x E-6	9 x E-7
1-T-E3	0	0.0005	200	3 x E6	8 x E-6	1 x E-6
1-T-I2Q	0	3	200	3 x E6	1 x E-5	1 x E-6
2-T-B3	0	0	300	5 x E6	4 x E-6	4 x E-7
ATWS	0	1	400	6 x E6	3 x E-6	3 x E-6
1-T-I2	0	6	500	8 x E6	3 x E-6	3 x E-7
1-SB-E1	0.006	10	600	9 x E6	1 x E-9	1 x E-9

*See definitions in Table 15.15.
**7 x E5 = 7 x 10^5.

Notes:

(1) All conditional mean consequences were calculated using the upper range BNL source term values described in SSER 2.

(2) The calculations assumed the Shippingport site, with public evacuation within 10 miles and relocation 12 hours after plume passage.

(3) Mean consequences were computed over 91 different weather conditions.

DEFLAGRATION

GLOBAL - NO IGNITORS

- FAILURE OF WETWELL SEAL ASSUMED UNIT PROBABILITY
- SMALL PROBABILITY OF RPV PIPE BREACH OR DRYWELL SEAL FAILURE LEADING TO E1 OR E2 RELEASE, OTHERWISE E3 RELEASE
- ABOUT FACTOR OF 3 IN PERSON-REM CONSEQUENCES

LOCAL - WETWELL SEAL MAY FAIL

- SMALL PROBABILITY OF RPV PIPE BREACH OR DRYWELL SEAL FAILURE LEADING TO E2 OR E3 RELEASE OTHERWISE L3 RELEASE
- ABOUT FACTOR OF 4 IN PERSON-REM CONSEQUENCES

LOCAL DETONATIONS

1-SB-E1 PORTRAYS DRYWELL AND WETWELL EARLY FAILURE

CREDIT FOR PRIMARY SYSTEM RETENTION AND POOL SCRUBBING OF VOLATILES

PERSON-REM CONSEQUENCES ABOUT AN ORDER OF MAGNITUDE GREATER THAN 1-T-L3

1 - T - I2, 1 - T - I2Q PORTRAYS DRYWELL HEAD FAILURE DUE TO DETONATION SHOCK LOAD

ABOUT FACTOR OF 3 IN PERSON-REM CONSEQUENCES DEPENDING ON FAILURE LOCATION

STATUS OF HCOG CONSIDERATIONS

- NRC STAFF POSITION ON ACCEPTABLE HYDROGEN RELEASE HISTORIES DEFINED IN LETTER FROM BERNERO TO HOBBS, DATED JUNE 24, 1985

  - CASE A: 150 GPM STARTED 3100S AFTER SCRAM

  - CASE B: 5000 GPM FLOW

  - CASE C: CASE A FOLLOWED BY 0.1 LB/S H_2 UNTIL 75% MWR

- ABOVE WILL BE USED FOR 1/4 SCALE TEST PROGRAM

- HCOG TEST PROGRAM TO CONFIRM ADEQUACY OF DELIBERATE IGNITION

- HCOG TEST PROGRAM WILL NOT TEST FOR OPTIMUM IGNITION SOURCES

EFFECT OF STANDING WETWELL HYDROGEN FLAMES

- DETAILS PROVIDED BY DR. PARCZEWSKI (NRC) IN APPENDIX A TO NUREG-1037 (CPWG REPORT)

- HEAT FLUXES PROVIDED BY CLWG (NUREG-1079)

- SEAL TEMPERATURES ARE SIGNIFICANTLY ELEVATED BUT REMAIN BELOW FAILURE

- LATER IN ACCIDENT HIGH DRYWELL TEMPERATURES DURING CORE/CONCRETE INTERACTIONS MAY CAUSE SEALS TO EXCEED FAILURE LIMIT

6-7

GESSAR-II PRA REVIEW

EFFECT OF A CORE MELT ON VESSEL SUPPORT INTEGRITY

PRESENTED BY

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AUGUST 8, 1985

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ASSOCIATED UNIVERSITIES, INC. aui

TOPICS

- ABLATION OF SUPPORT

- SIGNIFICANCE OF LOSS OF CONTAINMENT INTEGRITY FOLLOWING SUPPORT FAILURE

- EFFECT OF CONTAINMENT VENTING

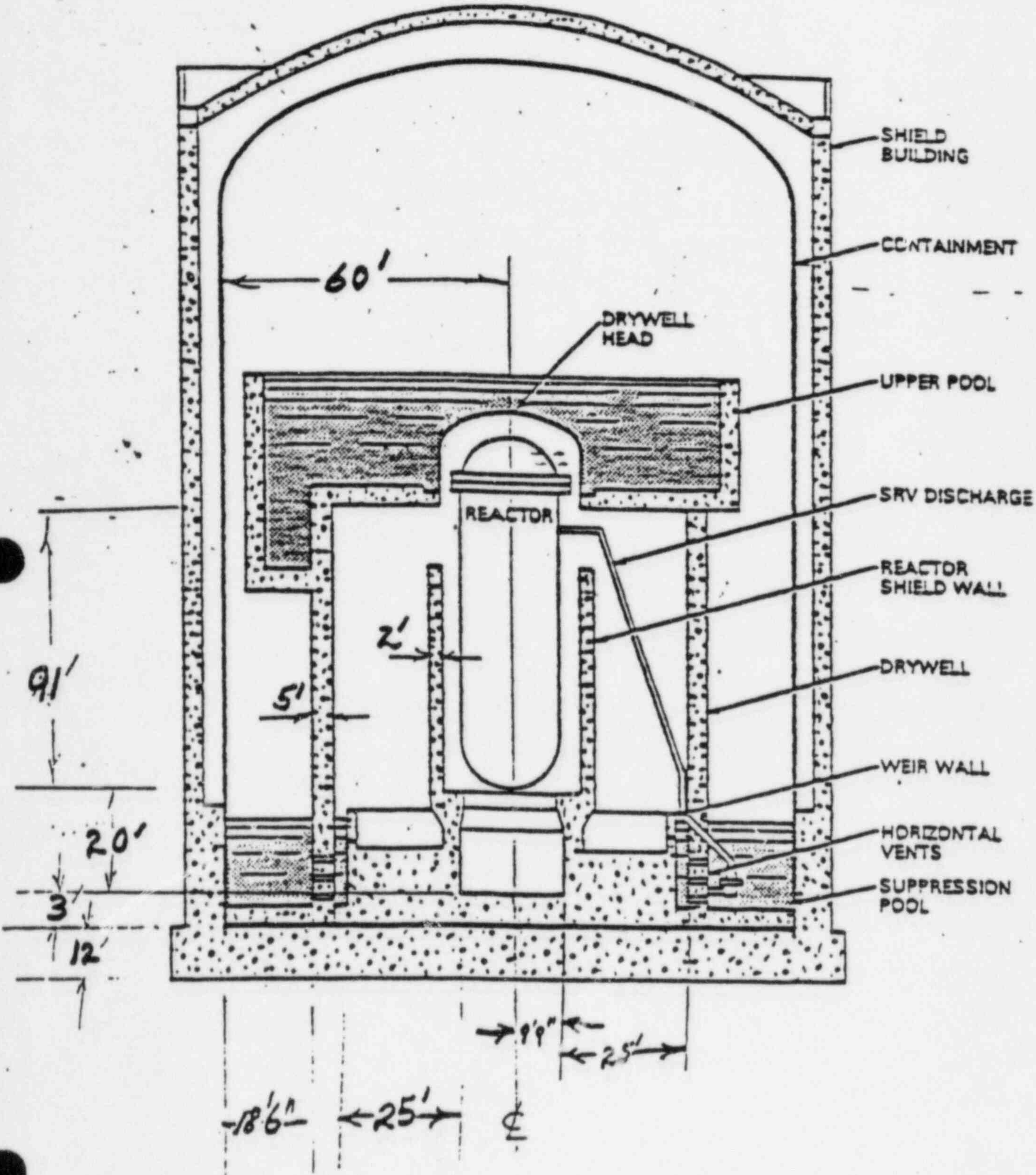
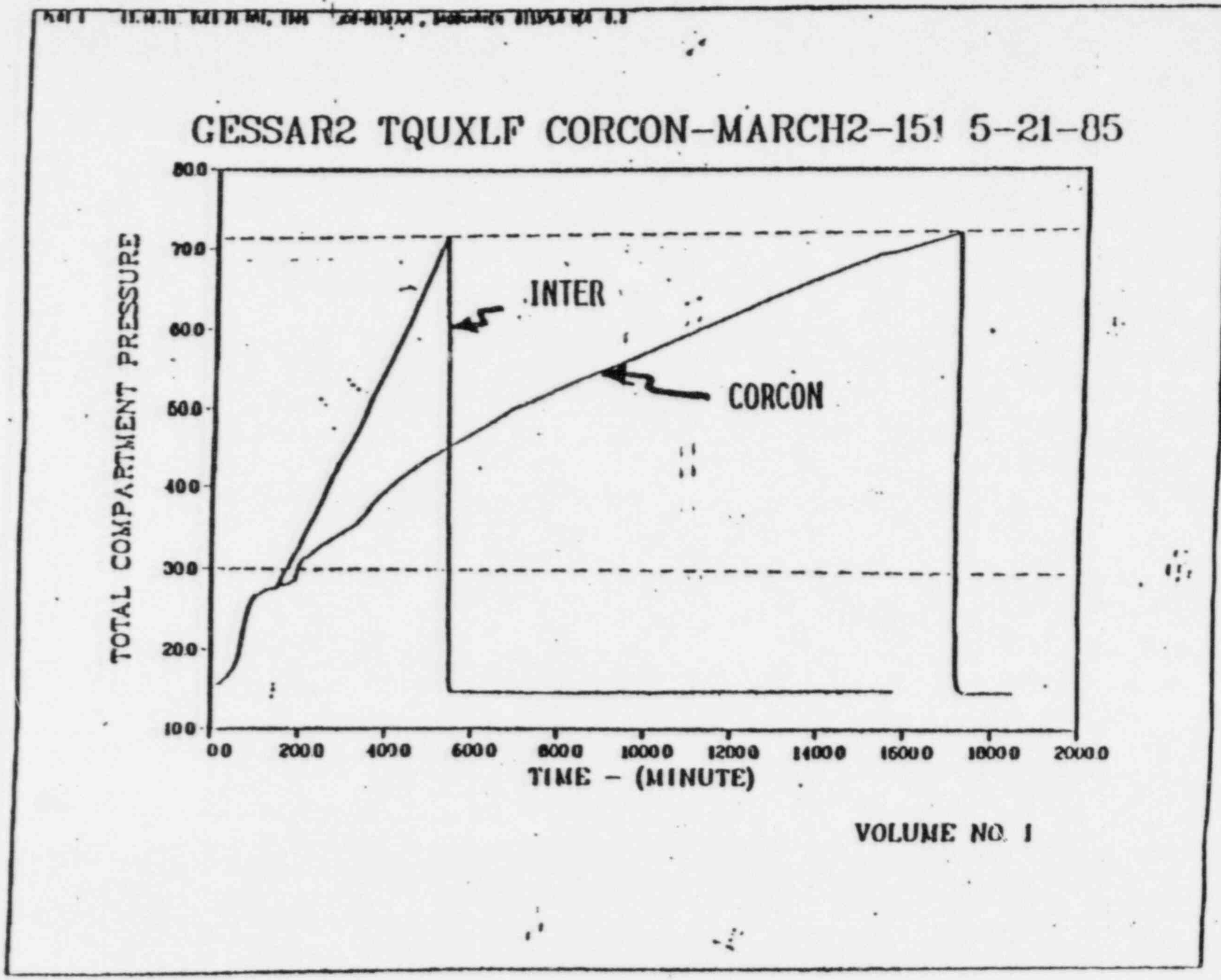
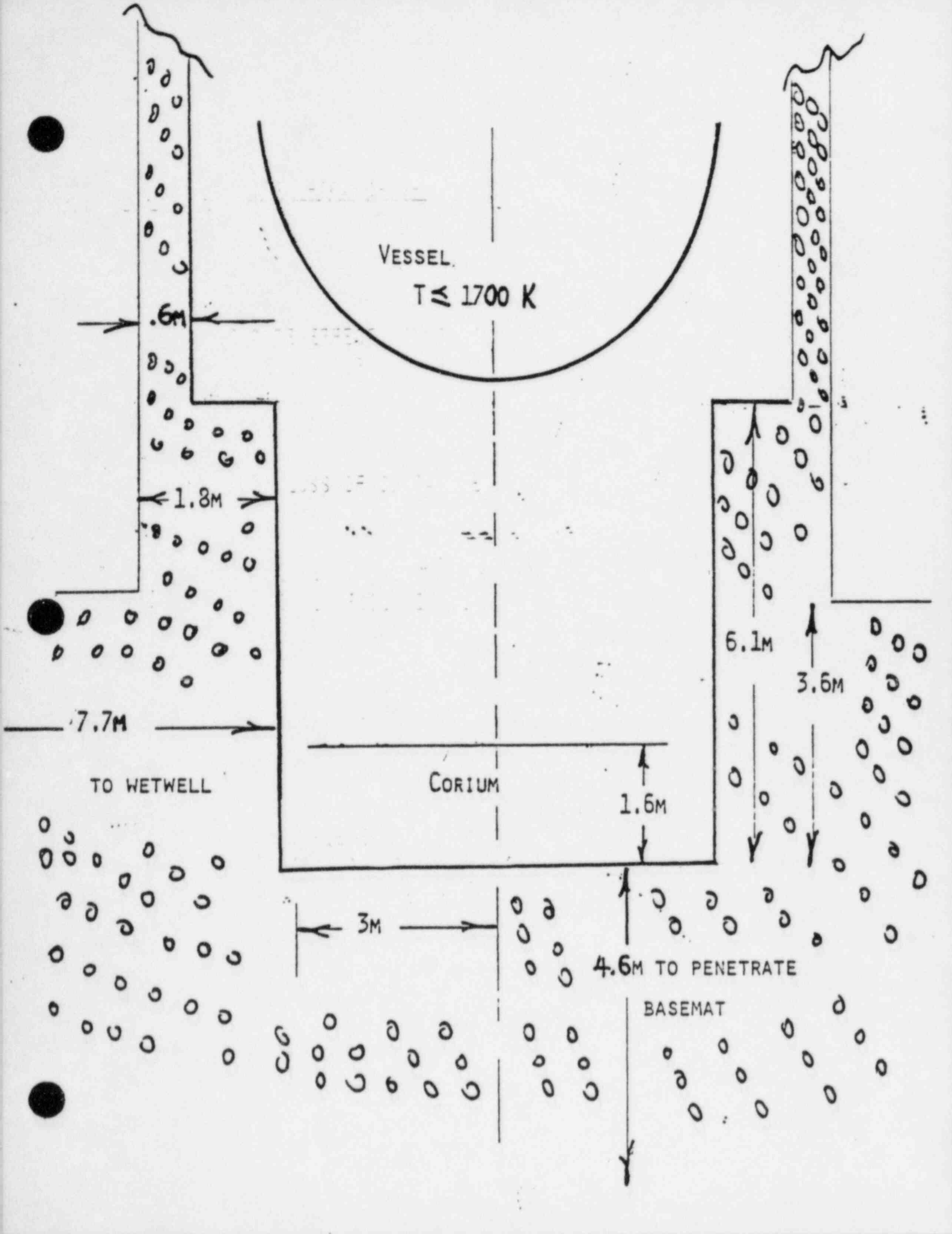


Figure 15.1 Principal features of MARK III containment


GESSAR2 TQUXLF CORCON-MARCH2-151 5-21-85
TOTAL COMPARTMENT PRESSURE
TIME - (MINUTE)
INTER
CORCON
100.0
200.0
300.0
400.0
500.0
600.0
700.0
800.0
0.0
2000
4000
6000
8000
10000
12000
14000
16000
18000
20000
VOLUME NO. 1


VESSEL
T ≲ 1700 K
.6M
1.8M
7.7M
TO WETWELL
CORIUM
1.6M
6.1M
3.6M
3M
4.6M TO PENETRATE
BASEMAT

Ablation Rates

$$\dot{q} = \rho\left[C_p(\text{CONCRETE})(T\ \text{ABLATION} - T\ \text{INITIAL}) + \lambda\ \text{ABLATION}\right]\dot{x}$$

$\dot{q}$ = 10 - 20 W/CM^2 (LOWER CAVITY)

$\dot{q}$ = 12 - 3 W/CM^2 (SURROUNDING)

ρ = 2.5 GM/CM^3, C = 1 J/GM/K, λ = 240 J/GM

$\dot{x}$ = ABLATION RATE INITIAL = 10-20 CM/HR (LOWER CAVITY)

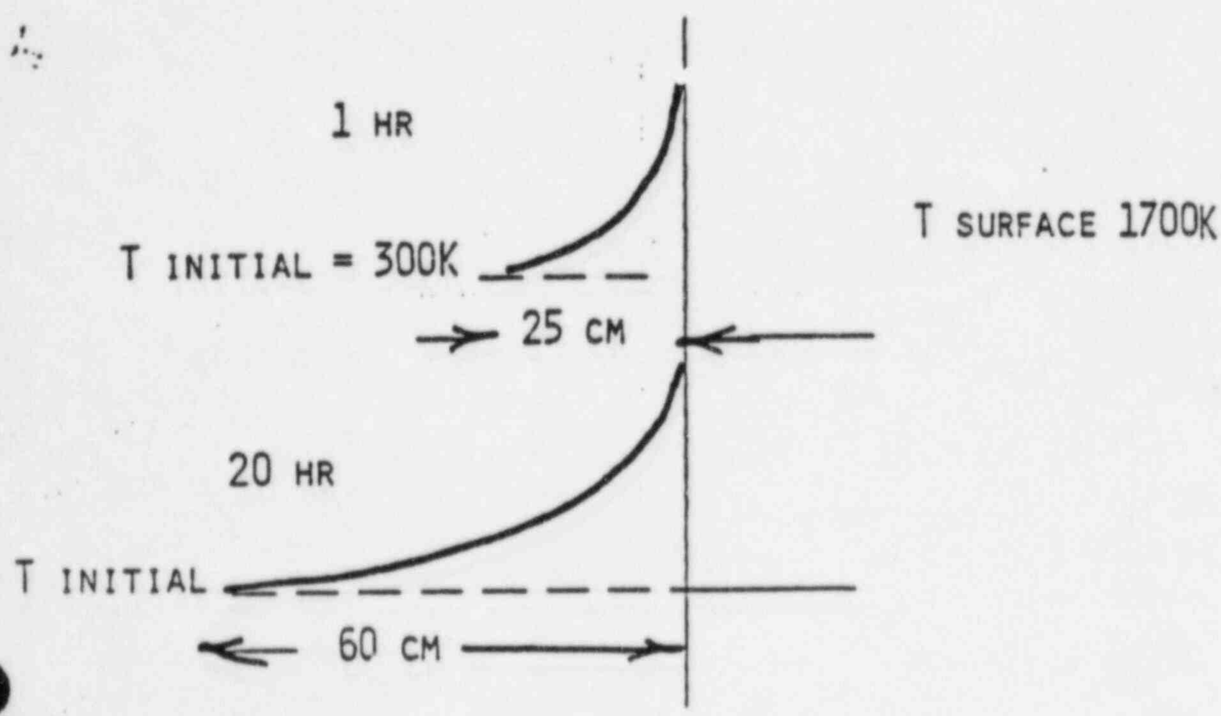
= 12-3 CM/HR (SURROUNDING)

Δx 10 HRS ≈ 120 CM AXIAL

≈ 140 CM RADIAL, PEDESTAL INTEGRITY DOUBTFUL

Thermal Gradient

$$\nabla^2 T = \alpha\,\partial T/\partial t$$



SIGNIFICANCE OF LOSS OF VESSEL SUPPORT

- MEASURE EFFECT RELATIVE TO RISK ESTIMATES IN TABLE 15.9 OF SUPPLEMENT 4 TO SER (NUREG-0979)

- EARLY LOSS OF CONTAINMENT INTEGRITY

  - LATE CONTAINMENT FAILURES (L2, L3) BECOME EARLY FAILURE (I2, I3)

- EARLY LOSS OF CONTAINMENT INTEGRITY PLUS LOSS OF DRYWELL INTEGRITY

  - COMPLETE POOL SCRUBBING SEQUENCES (E3, I3, L3, B3) BECOME PARTIAL POOL SCRUBBING SEQUENCES (E2, I2)

Table 15.1 Conditional consequences predicted by the staff for internally initiated events and probability of occurrence with and without UPPS, per reactor year

Release category*	Early fatality	Early injury	Latent fatality	Person-rems	Probability	
					w/o UPPS	w/UPPS
1-T-L3	0	0	40	7 x E5**	3 x E-6	9 x E-7
1-T-E3	0	0.0005	200	3 x E6	8 x E-6	1 x E-6
1-T-I2Q	0	3	200	3 x E6	1 x E-5	1 x E-6
2-T-B3	0	0	300	5 x E6	4 x E-6	4 x E-7
ATWS	0	1	400	6 x E6	3 x E-6	3 x E-6
1-T-I2	0	6	500	8 x E6	3 x E-6	3 x E-7
1-SB-E1	0.006	10	600	9 x E6	1 x E-9	1 x E-9

*See definitions in Table 15.15.
**7 x E5 = 7 x 10^5.

Notes:

(1) All conditional mean consequences were calculated using the upper range BNL source term values described in SSER 2.

(2) The calculations assumed the Shippingport site, with public evacuation within 10 miles and relocation 12 hours after plume passage.

(3) Mean consequences were computed over 91 different weather conditions.

Table 15.9 Public risk from internal events (person-rems per unit per year) for GESSAR II base case and with design modifications

Release*	GESSAR w/o UPSS	Perfect H_2 control	Base case with UPPS	UPPS and perfect hydrogen control	10-hour battery capacity	DC charger generator	UPPS and igniters	Unlimited generator and UPPS	Unlimited generator and UPPS and perfect hydrogen control	Unlimited generator and UPPS igniters
1-T-E2	3	-	0.5	-	1	1	-	0.3	-	-
1-T-E2Q	1	-	0.2	-	0.4	0.3	-	0.1	-	-
1-T-E3	23	-	4	-	10	8	9	2	-	4
1-T-I2	22	-	3	-	9	7	-	1	-	-
1-T-I2Q	31	-	4	-	12	10	-	1	-	-
1-T-I3	12	-	2	-	5	4	2	0.5	-	0.5
1-T-L2	-	-	-	-	-	-	-	-	-	-
1-T-L3	2	22	0.6	3	1	1	0.6	0.5	2	0.5
1-SB-E1	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
II-T-B3	20	20	2	2	20	20	2	2	2	2
ATWS	18	18	18	18	18	18	18	18	18	18
Total	131	59	33	23	76	68	31	25	22	25

*See Table 15.15 for a description of the release categories.

SIGNIFICANCE OF LOSS OF VESSEL SUPPORT (CONT.)

- EARLY LOSS OF CONTAINMENT INTEGRITY:
  - GESSAR W/O UPPS: 131 PERSON-REM PER YEAR
  - WITH EARLY LOSS: 139 PERSON-REM PER YEAR

- EARLY LOSS OF CONTAINMENT INTEGRITY PLUS LOSS OF DRYWELL INTEGRITY:
  - GESSAR W/O UPPS: 131 PERSON-REM PF YEAR
  - WITH EARLY LOSS: 227 PERSON-REM PER YEAR

EFFECT OF CONTAINMENT VENTING

- "CLEAN" VENTING:
  - ATTEMPTS TO MITIGATE CLASS 2 AND ATWS SEQUENCES
  - MEASURE EFFECT RELATIVE TO RISK ESTIMATES IN SER
  - CLASS 2 SEQUENCES SIGNIFICANTLY REDUCED BY UPPS
  - ABILITY TO MITIGATE ATWS BY VENTING UNCERTAIN
- VENTING AFTER CORE DAMAGE:
  - MINIMAL IMPACT ON EARLY H_2 PHENOMENA
  - HENCE H_2 CONTROL NEEDED EVEN WITH VENTING

SQUG CONCLUSIONS

- SEISMIC RESISTANCE OF STANDARD POWER PLANT EQUIPMENT, WHEN PROPERLY ANCHORED, WAS VERIFIED DURING THE PILOT PROGRAM.

- EXPLICIT, SEISMIC QUALIFICATION OF THIS EQUIPMENT IS NOT JUSTIFIED.

- SEISMIC QUALIFICATION IS NOT A SIGNIFICANT SAFETY CONCERN, THEREFORE, FURTHER ACTION IS NOT REQUIRED.

SUBJECT: QUESTIONS FOR OPERATOR INTERVIEWS DURING THE PLANT SURVEY IN CHILE

1. What was plant status prior to earthquake?

2. Does the plant have any special earthquake procedures? What are they? Are copies available?

3. During strong motion in the event did automatic action of the plant systems take place? What were these automatic actions? If auto-action did not take place, should it have? In the absence of auto-action (based on alarms, etc.) did the operator take action? What action did he take? What alarms were initiated? Any misleading information? Did the plant respond properly (auto or manual)?

4. After the strong motion was over, what was the plant status? Were any auto-actions which were needed taking place? Were systems resetting to normal? Was the operator required to take manual action? If so, what action did he take and did the plant respond as it was supposed to?

   - Was off-site power lost?
   - Was auxiliary power lost?
   - Was diesel power available?
   - Was d.c. power available and was load shedding required?
   - Did power distribution (internal) respond to loss of power or to relay chatter?

5. In determining failures or damage to equipment: were there any misoperations or malfunctions of equipment of a mechanical nature? (Were there breaker trips which were not electrical in nature?) Were there misoperations or malfunctions of equipment due to relay chatter?

   - What type of equipment? Type of relay?
   - Any damage due to induced improper system alignments?
   - Any events recorders or computer printouts available?
   - Any problems with momentary contacts on switches? Maintained contacts?
   - Any mercury switches? Problems?
   - Any system change of state not attributable to relay chatter?
   - Were any printed circuit cards broken or other such failures? Were there problems with cables or cable terminations?

6. Were there structural failures which affected systems function? Large pipes 2 1/2" small? Pipe supports? Instrument tubing, instr air?

7. Were there reduced or increased flows in cooling systems? Other degraded functions?

8. Any damage to Control Boards? CRT's?

9. What worked that wasn't expected to work?
What failed that was expected to work?

10. What people related problems were experienced? Access to tools, procedures, damage control equipment, communications, etc.

11. What secondary events occurred? Fires? Spills?

12. Any problems with equipment in operation? Cranes? Portable equipment? Maintenance in progress?

13. Is there seismic monitoring equipment at the site?

14. For problems encountered at power plants, were they considered a "systems" problem or an "operation" problem?

    - Steam cycle?
    - Condensate?
    - Feedwater?
    - Power?

Questions related to switchyard functions:

1. Have there been any design changes to prevent vibrations from triggering fault pressure relays when there has been no system damage that would require action?

2. Are there any special switching arrangements developed for earthquake response? Any line isolation provisions?

3. Are there any special provisions for starting if off-site power is lost due to the earthquake? (black start)

4. Were any problems encountered in synchronizing the plant with the transmission system after the earthquake?

5. Were there any degradations in the relaying communication system? What type system - microwave or carrier? Any special procedures related to degraded communications?

6. Does dispatch system exist? Did it create any problems?

SQUG PROGRAM OUTLINE

1. SCREEN ESSENTIAL EQUIPMENT LIST

   - COVERED IN SQUG PROGRAM
   - OTHER DATA AVAILABLE (EXPERIENCE, TEST)
   - ENGINEERING JUDGMENT

2. DOCUMENT SEISMIC RUGGEDNESS OF EQUIPMENT

   - ASSIGN RUGGEDNESS LEVELS WHICH CAN BE JUSTIFIED
   - IDENTIFY EXCEPTIONS/VULNERABILITIES FOR EACH EQUIPMENT CLASS
   - DEFINE DATA NEEDS, IF ANY

3. COMPLETE/REVIEW EPRI PROGRAMS, DEVELOP ANCHORAGE INSPECTION GUIDELINES

   - ANCHORAGE
   - TEST DATA ASSIMILATION

4. DEVELOP SIMPLIFIED APPROACH FOR DETERMINING REQUIRED SEISMIC RUGGEDNESS IN NUCLEAR PLANTS

   o ELEVATIONS LESS THAN 40 FEET

   o HIGHER ELEVATIONS

5. ATTEMPT TO LIMIT SCOPE OF RELAY FUNCTIONALITY REQUIREMENTS ON GENERIC BASIS

6. DEVELOP PLANT WALK-THROUGH GUIDELINES AND TEAM

7. PERFORM "TEST" WALK-THROUGH

8. DEVELOP PLANS FOR SQUG MEMBER IMPLEMENTATION

   o SEMINARS

   o GENERIC SQUG TEAM APPROACH

   o SSRAP/NRC AUDIT

SQUG ACTIVITIES PROMPTED BY ACRS/STAFF CONCERNS

1. Definition of generic equipment required to achieve safe shutdown.

2. Develop rationale to assure seismic ruggedness of equipment beyond the 8 classes defined in the Pilot Program.

3. Functionality During Strong-Motion (primarily relays)

4. SQUG's Generic Implementation Plan

   - Equipment Screening
   - Plant Walkdown Procedures
   - Audit Function

USI A-46 ACRS PRESENTATION

AUGUST 8, 1985

- SUMMARY OF USI A-46 PROGRAM — T. Y. Chang, N. R. Anderson

- PROPOSED RESOLUTION, SCOPE AND BASIS

- IMPLEMENTATION REQUIREMENTS

- STATUS OF ONGOING SQUG/EPRI ACTIVITIES — J. Thomas (SQUG)
  - ANCHORAGE GUIDELINES
  - TEST DATA BASE DEVELOPMENT
  - RELAY REVIEW PROCEDURE
  - SQUG GENERIC IMPLEMENTATION PLAN

BACKGROUND

- SEIMSIC SAFETY MARGIN IN OPERATING PLANT EQUIPMENT MAY VARY CONSIDERABLY
- SEISMIC QUALIFICATION OF EQUIPMENT IN OPERATING PLANTS NEEDS TO BE REASSESSED
- PROBABLY NOT PRACTICAL TO SEISMICALLY QUALIFY OPERATING PLANT EQUIPMENT USING CURRENT CRITERIA
- NEED TO DEFINE ALTERNATIVE METHODS
- TASK A-46 DESIGNATED AS USI IN DECEMBER 1980

SEISMIC QUALIFICATION OF EQUIPMENT USING SEISMIC EXPERIENCE DATA

- STAFF ESTABLISHED FEASIBILITY OF USING EXPERIENCE DATA (LLNL STUDY)
- SQUG CONDUCTED PILOT PROGRAM TO COLLECT AND EVALUATE SEISMIC EXPERIENCE DATA (SEPTEMBER 82)
- ADDITIONAL EXPERIENCE DATA COLLECTED FOR COALINGA, MORGAN HILL, CHILE EARTHQUAKES
- SSRAP FORMED JUNE 1983, JOINTLY SELECTED BY SQUG AND NRC
- SSRAP ISSUED REPORT IN JANUARY 1985
- SSRAP DEVELOPED RULES FOR USE OF DATA
- NRC STAFF PARTICIPATED IN DATA EVALUATION AND CLOSELY MONITORED SQUG/SSRAP EFFORTS
- PROPOSED STAFF POSITION BASED ON USE OF SEISMIC EXPERIENCE

SCOPE OF PILOT PROGRAM

°GATHERED AND DOCUMENTED EQUIPMENT AND EARTHQUAKE PERFORMANCE DATA FOR EIGHT CLASSES OF EQUIPMENT

- MOTOR CONTROL CENTERS
- LOW-VOLTAGE (480 v.) SWITCHGEAR
- METAL-CLAD (2.4 TO 4kV) SWITCHGEAR
- UNIT SUBSTATION TRANSFORMERS
- MOTOR-OPERATED VALVES
- AIR-OPERATED VALVES
- HORIZONTAL PUMPS AND MOTORS
- VERTICAL PUMPS AND MOTORS

°INVESTIGATED DATA ON ≈ 3000 ITEMS OF EQUIPMENT IN CONVENTIONAL (NON-NUCLEAR) PLANTS

<u>SSRAP CONCLUSIONS FOR 8 EQUIPMENT CLASSES</u>

° EQUIPMENT INSTALLED IN NUCLEAR POWER PLANTS IS GENERALLY SIMILAR AND AT LEAST AS RUGGED AS THAT INSTALLED IN CONVENTIONAL POWER PLANTS

° THIS EQUIPMENT, WHEN PROPERLY ANCHORED AND WITH SOME RESERVATIONS, HAS AN INHERENT SEISMIC RUGGEDNESS AND HAS A DEMONSTRATED CAPABILITY TO WITHSTAND SUBSTANTIAL SEISMIC MOTION WITHOUT STRUCTURAL DAMAGE

° FUNCTIONALITY AFTER THE STRONG SHAKING HAS ENDED HAS ALSO BEEN DEMONSTRATED, BUT THE ABSENCE OF RELAY CHATTER DURING STRONG SHAKING HAS NOT BEEN DEMONSTRATED

EQUIPMENT BEYOND 8 CLASSES

- NO REQUIREMENT FOR COLLECTING ADDITIONAL SEISMIC EXPERIENCE DATA
- BASIS FOR SEISMIC ADEQUACY MUST BE DOCUMENTED FOR EACH EQUIPMENT TYPE. THIS CAN BE PROVIDED BY:
  - VERIFICATION EQUIPMENT EXISTS IN DATA BASE PLANTS
  - TEST DATA CURRENTLY BEING COLLECTED BY EPRI/SQUG

THREE CONCERNS

1. EQUIPMENT ANCHORAGES

2. RELAY OPERABILITY

3. OUTLIERS

PROPOSED RESOLUTION

- OPERATING PLANTS
  - DEVELOP EQUIPMENT LIST
  - PERFORM WALK THROUGH INSPECTION
  - VERIFY ANCHORAGES
  - VERIFY FUNCTIONALITY OF EQUIPMENT (RELAYS)
  - IDENTIFY & ADDRESS DEFICIENCIES AND OUTLIERS
- NEW LICENSEES
  - NO REQUIREMENTS
- IMPLEMENT BY GENERIC LETTER

SCOPE OF SEISMIC ADEQUACY REVIEW

- ASSUMPTIONS
  - SSE DOES NOT CAUSE LOCA
  - LOCA DOES NOT OCCUR SIMULTANEOUSLY WITH OR DURING SSE
  - OFFSITE POWER WILL BE LOST DURING OR FOLLOWING SSE

- MAINTAIN HOT SHUTDOWN FOR A MINIMUM OF 72 HOURS.

- EQUIPMENT SCOPE
  - ACTIVE ELECTRICAL AND MECHANICAL COMPONENTS INCLUDING INSTRUMENTATION AND CONTROLS NEEDED TO ACHIEVE AND MAINTAIN HOT SHUTDOWN
  - ANCHORAGES ON TANKS, HEAT EXCHANGERS REQUIRED TO ACHIEVE AND MAINTAIN HOT SHUTDOWN
  - NO REQUIREMENT TO (1) REVIEW MASONRY WALLS, (2) REVIEW SOME AUX FEED SYSTEMS (3) INSPECT RCS PIPING (4) REVIEW SEISMIC INTERACTION ITEMS

- PLANTS AFFECTED
  - OPERATING PLANTS NOT REVIEWED TO CURRENT CRITERIA AS DOCUMENTED BY SER'S. ABOUT 49 SITES, 72 UNITS. SEP PLANTS WILL BE REVIEWED FOR FUNCTIONAL CAPABILITY ONLY

<u>IMPLEMENTATION REQUIREMENTS</u>

° DEVELOP EQUIPMENT LIST

° VERIFY ENVELOPE OF SITE FREE FIELD SPECTRA BY APPROPRIATE BOUNDING SPECTRA

° WALK-THROUGH INSPECTION
  - ANCHORAGE REVIEW
  - IDENTIFICATION AND REVIEW OF "DEFICIENCIES" AND "OUTLIERS"

° IDENTIFY ALL EQUIPMENT THAT MUST FUNCTION DURING STRONG SHAKING
  - RELAYS ARE MAJOR CONCERN

° REVIEW OF EQUIPMENT UNIQUE TO NUCLEAR PLANTS

° REPLACEMENT PARTS

RELAY REVIEW GUIDELINES

- NRC General Review Guidelines

  - Identify all relays associated with equipment needed to bring plant to hot shutdown
  - Relays which must function <u>during</u> strong shaking:

    - Verify with test data
    - Replace with qualified relays
    - Qualify by test

  - Relays which must function <u>after</u> strong shaking:

    - Verify, replace or qualify as above; or
    - Licensee show chatter or change of state does not affect plant shutdown

  - Relay verification can be deferred until test data base complete

RELAY REVIEW (CONTINUED)

- SQUG DEVELOPING REVIEW PROCEDURE
  - IDENTIFICATION OF RELAYS TO BE EVALUATED
  - DEFINITION OF FUNCTIONALITY REQUIREMENTS
  - DEVELOPMENT OF EVALUATION PROCEDURES
  - REVIEW BY NRC STAFF AND SSRAP

- CHILEAN EARTHQUAKE CONFIRMS NEED TO REVIEW RELAYS

- SCOPE OF RELAY REVIEW
  - TYPICAL BWR (DRESDEN/LASALLE)
    - 1000/1200 RELAYS
    - 6/8 RELAY TYPES
  - TYPICAL CE PWR (CALVERT CLIFFS)
    - 1100 RELAYS
    - 6 RELAY TYPES, 25-30 MANUFACTURES
  - TYPICAL B&W PWR (OCONEE)
    - 750/900 GENERAL PURPOSE/INCLUDING PROTECTIVE RELAYS
    - 25 MANUFACTURES

RELAY REVIEW (CONTINUED)

- TYPICAL W PWR (ZION)
  - 1100 RELAYS
  - 7 RELAY TYPES

NUCLEAR REGULATORY COMMISSION

MAINTENANCE AND SURVEILLANCE PROGRAM

PROGRAM MANAGER
DR. HAROLD R. BOOHER, CHIEF
LICENSEE QUALIFICATIONS BRANCH
DIVISION OF HUMAN FACTORS SAFETY/NRR

GREGORY C. CWALINA, SECTION LEADER
MAINTENANCE/SURVEILLANCE SECTION

OUTLINE

OBJECTIVES & SCOPE

CURRENT STATUS

PROGRAM SUMMARY

PHASE I PROJECTS

SURVEY PROGRESS

MAINTENANCE PROGRAM DEVELOPMENT

NOV 83	NRC MAINTENANCE WORKSHOP MAINTENANCE INDICATOR PILOT STUDY INITIATED
JAN 84	COMMISSION POLICY AND PLANNING GUIDANCE
MAY 84	US/JAPANESE STUDY PART I COMPLETED ACRS BRIEFED (MAINTENANCE SUBCOMMITTEE AND FULL COMMITTEE
JUN 84	DRAFT PLAN TO NUMARC ASME BRIEFED PUC BRIEFED
JUL 84	IEEE BRIEFED
SEP 84	ANSI BRIEFED
OCT 84	UPDATED PLAN TO NUMARC ACRS - MAINTENANCE SUBCOMMITTEE - JAPANESE STUDY BRIEFING
DEC 84	MAINTENANCE INDICATOR PILOT STUDY COMPLETED
JAN 85	PLAN PHASE I APPROVED NUMARC PROPOSED INDICATORS NRC INDICATOR TASK FORCE FORMED
MAR 85	REVISED MSPP (NUMARC COMMENTS)
APR 85	SUBMITTED TO COMMISSION (SECY-85-129)
MAY 85	SURVEY PROJECT INITIATED
JUN 85	COMPLETED REGIONAL BRIEFING/COORDINATION ACRS - MAINTENANCE SUBCOMMITTEE

NRC SPECIFIC OBJECTIVES

DETERMINE EFFECTIVENESS OF CURRENT MAINTENANCE PROGRAMS

IDENTIFY PRACTICES WHICH REDUCE HUMAN ERROR RATE IN PERFORMANCE OF MAINTENANCE

IMPROVE EFFECTIVENESS OF MAINTENANCE PROGRAMS IN ASSURING OPERABILITY OF SAFETY SYSTEMS

REDUCE UNNECESSARY AND UNANTICIPATED RADIOLOGICAL EXPOSURE TO MAINTENANCE PERSONNEL

DETERMINE REGULATORY APPROACH TO ASSURE EFFECTIVE MAINTENANCE PERFORMANCE

MSPP SCOPE

- ALL ASPECTS REQUIRED TO CARRY OUT A SYSTEMATIC MAINTENANCE PROGRAM
  - SURVEILLANCE AND TEST ACTIVITIES
  - EQUIPMENT REMOVAL FROM/RETURN TO SERVICE
  - POST-MAINTENANCE TESTING
  - MAINTENANCE MANAGEMENT/ADMIN. CONTROL
  - PERSONNEL SELECTION, QUALIFICATIONS, TRAINING
  - PROCEDURES
  - DOCUMENTATION
- THOSE COMPONENTS WHICH AFFECT PERFORMANCE OF SAFETY SYSTEMS

IDENTIFIED PROBLEMS

1. MAINTENANCE PERFORMANCE

2. FAILURES DUE TO IMPROPER PERFORMANCE

3. MAINTENANCE/OPERATIONS INTERFACE

4. CHALLENGES TO SAFETY SYSTEMS

5. OCCUPATIONAL EXPOSURES

STRATEGY

BROAD SCOPE

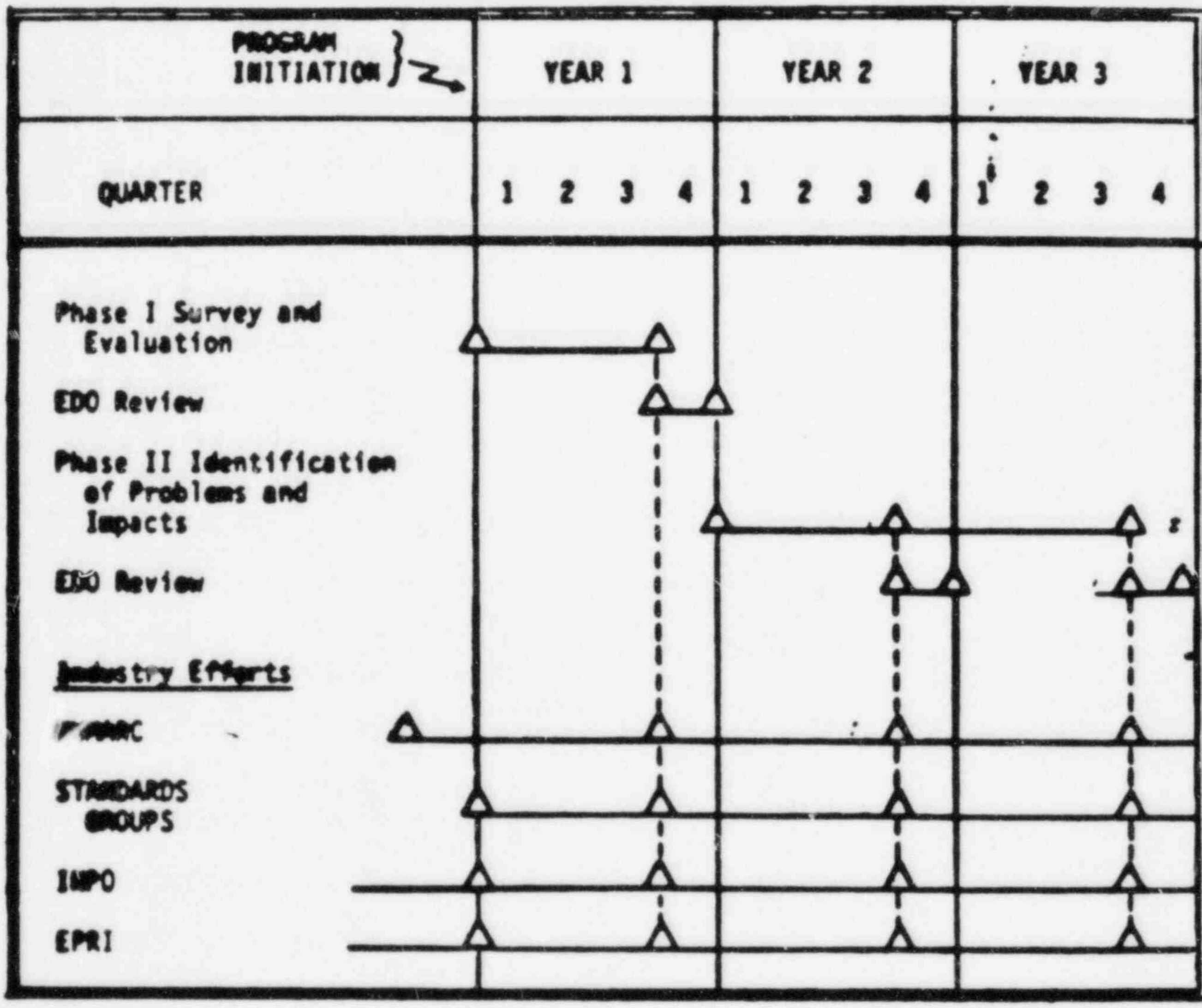
FOCUS ON TECHNICAL ISSUES

USE PHASED APPROACH

INTEGRATE STAFF ACTIVITIES

COORDINATE INDUSTRY INITIATIVES

FIGURE 3.1 PROGRAM PHASES



PHASE I PROJECTS

1. SURVEY OF CURRENT PRACTICES
2. MAINTENANCE PERFORMANCE INDICATORS
3. MONITOR INDUSTRY ACTIVITIES
4. PARTICIPATE IN STANDARDS GROUP
5. PROGRAM INTEGRATION (NRC AND INDUSTRY)
6. ANALYSIS OF JAPANESE/U.S. MAINTENANCE PROGRAMS
7. MAINTENANCE PERSONNEL QUALIFICATIONS
8. H.F. IN IN-SERVICE INSPECTION
9. HUMAN ERROR IN EVENTS INVOLVING WRONG UNIT OR WRONG TRAIN (GENERIC ISSUE 102)

SURVEY OF CURRENT MAINTENANCE PRACTICES

TASK 1 - DATA COLLECTION AND ASSESSMENT

TASK 2 - SALEM PREVENTIVE MAINTENANCE PROGRAM

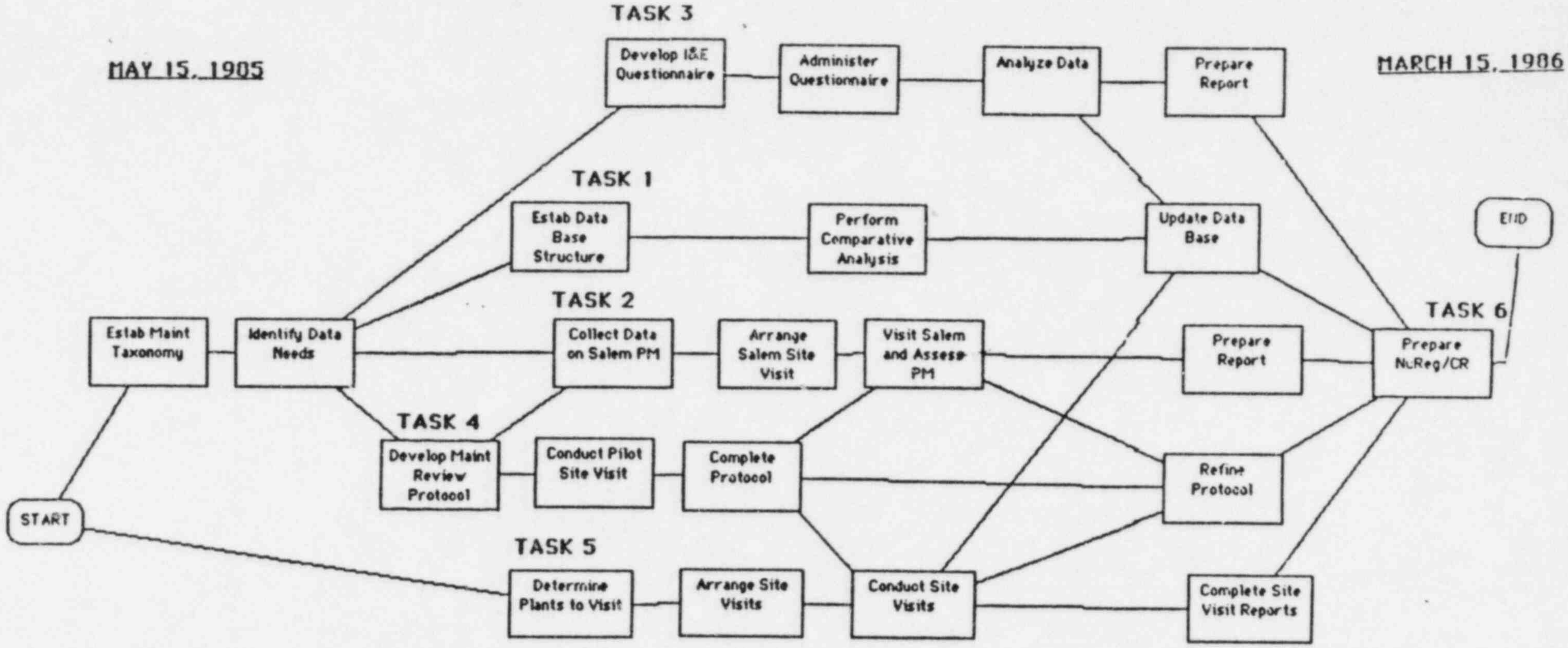
TASK 3 - QUESTIONNAIRE

TASK 4 - MAINTENANCE REVIEW PROTOCOL

TASK 5 - SITE SURVEYS

TASK 6 - SUMMARY REPORT

SUMMARY APPROACH AND SCHEDULE



2. MAINTENANCE PERFORMANCE INDICATORS

SCOPE:

- MONITOR INDUSTRY INDICATORS
- DEVELOP NRC INDICATORS IF WARRANTED

MILESTONES:

- PILOT STUDY, PNL, JAN - APR 1984
- ENDORSEMENT OF NUMARC INDICATORS, MAY 1985
- VERIFICATION OF INDUSTRY DATA
- DECISION ON NEED FOR NRC INDICATORS

NUMARC

MAINTENANCE PERFORMANCE INDICATORS

I. DATA AVAILABLE THROUGH EXISTING SOURCES

1. UNIT FORCED OUTAGE RATE
2. UNIT EQUIVALENT AVAILABILITY
3. NO. OF UNPLANNED AUTOMATIC SCRAMS DUE TO MAINTENANCE

II. DATA TO BE OBTAINED FROM UTILITIES

1. TOTAL RADIATION RATE PER UNIT DUE TO MAINTENANCE
2. OVERTIME WORKED BY MAINTENANCE PERSONNEL
3. LOST TIME ACCIDENT RATE NO. FOR MAINTENANCE PERSONNEL
4. AMOUNT OF OUTSTANDING NON-OUTAGE CM WORK
5. RATIO OF HIGHEST PRIORITY NON-OUTAGE CM WORK REQUESTS
6. PM ITEMS OVERDUE
7. RATIO OF PM TO CM

III. UNDER DEVELOPMENT

1. PERCENTAGE OF MAINTENANCE REWORK
2. SAFETY SYSTEM AVAILABILITY

3. MONITOR INDUSTRY ACTIVITIES

SCOPE:

- SUMMARIZE FINDINGS
- ASSESS APPLICABILITY
- DOCUMENT ACHIEVEMENTS

MILESTONES:

- COORDINATION WITH NUMARC

  JUNE, OCTOBER 1984

  JAN, FEBRUARY 1985

- ATTEND EPRI SEMINARS, MARCH, APRIL 1985
- REVIEW EPRI/MIT REPORT, JUNE 1985

4. PARTICIPATE IN STANDARD GROUPS

SCOPE:

- ENCOURAGE INDUSTRY INITIATIVES
- PROVIDE NRC CONTRIBUTIONS

MILESTONES:

- ANS 3.9

  SEPTEMBER 1984 - SUBCOMMITTEE FORMED

  MARCH 1985 - OUTLINE CIRCULATED

  FALL 1985 - NUMARC DRAFT DUE

- ASME OPERATIONS AND MAINTENANCE COMMITTEE

  APRIL 1985 - NO PM STANDARD

  SPRING 1985 - SEMINARS

  - COMPONENT STANDARDS DEVELOPMENT CONTINUES

- IEEE W.G. 3.3 - "PRACTICES"

  OCTOBER 1984 - W.G. FORMED

  SPRING 1985 - SCOPE DEFINITION

5. PROGRAM INTEGRATION

SCOPE:

- IDENTIFY RELATED PROGRAMS
- INTERPRET CONTENTS AND SCHEDULES
- PREVENT OVERLAP
- PRESENT UNIFIED POSTURE

MILESTONES:

- PROGRESS REPORTS, FINAL REPORTS ARE BEING REVIEWED

NRC PROGRAMS RELATED TO MAINTENANCE

	RESPONSIBLE ORGANIZATION
QUALITY ASSURANCE PROGRAM, R.G. 1.33	IE
SYSTEMS IMPORTANT TO SAFETY	IE
SAFETY IMPLICATIONS OF CONTROL SYSTEMS (USI A-47)	NRR
COMPREHENSIVE REEVALUATION OF STANDARD TECHNICAL SPECIFICATIONS	RES
SURVEILLANCE AND TEST REQUIREMENTS (ECCS OUTAGE CRITERIA)	RES
NUCLEAR PLANT AGING RESEARCH	RES
EFFECTIVENESS OF INDUSTRY ALARA PROGRAMS	NRR
EQUIPMENT QUALIFICATION - R.G. 1.89	NRR
RELIABILITY RESEARCH	RES
IMPROVING QUALITY	IE
TRAINING RULE - SECTION 306 WASTE ACT	NRR

6. ANALYSIS OF JAPANESE/U.S. MAINTENANCE PROGRAMS

SCOPE:

- COMPARE OPERATING EXPERIENCE
- COMPARE MAINTENANCE REQUIREMENTS
- ANALYZE ORGANIZATION AND MANAGEMENT

MILESTONES:

- APRIL 1984 - PROGRAM INITIATION
- MAY 1985 - PROJECT COMPLETED
- JULY 1985 - NUREG/CR-3883 AND 3883P PUBLISHED

7. MAINTENANCE PERSONNEL QUALIFICATIONS

NEED

- TO DETERMINE THE KSAs REQUIRED FOR MAINTENANCE JOB TASKS
- TO IDENTIFY THE RELEVANT SOURCES OF THE KSAs IN TERMS OF EDUCATION, TRAINING, AND APPRENTICESHIP PROGRAMS
- TO CONDUCT AN ANALYSIS OF APPLICABLE INDUSTRY GUIDELINES AND STANDARDS AGAINST JOB RELEVANT KSAs AND SOURCES

8. HUMAN FACTORS OF IN-SERVICE INSPECTIONS

SCOPE:

- IDENTIFY HUMAN ERROR POTENTIAL

MILESTONES:

MAY 1985	-	PROJECT INITIATION
JULY 1985	-	DATA COLLECTION
DECEMBER 1985	-	FINAL REPORT

9. HUMAN ERROR IN WRONG UNIT/WRONG TRAIN EVENTS

SCOPE:

- IDENTIFY PROBLEMS
- ANALYZE ROOT CAUSES
- DEFINE ACTIONS FOR RESOLUTIONS

MILESTONES:

- JANUARY 1984 - AEOD REPORT
- MAY-JULY 1984 - AEOD/NRR COORDINATION
- JUNE-DECEMBER 1985 - SITE VISITS
- JANUARY 1986 - FINAL REPORT

PROGRESS

NRC

- ° MAINTENANCE SECTION FORMED
- ° TASK FORCE REVIEW NUMARC DRAFT INDICATORS
- ° PARTICIPATION NEW STANDARDS EFFORTS
- ° REVIEW JAPANESE MAINTENANCE/OPERATIONS EXPERIENCE
- ° PARTICIPATION IE INSPECTION
- ° FEEDBACK NRC REGIONAL/RESIDENT INSPECTORS

INDUSTRY

- ° STANDARDS EFFORT INITIATED (IEEE, ANS)
- ° ANALYZE MAINTENANCE-RELATED CONTRIBUTION TO EVENTS
- ° REVIEW/REVISE INPO PLANT EVALUATION OBJECTIVES/CRITERIA IN MAINTENANCE AREA
- ° DEVELOP PRELIMINARY PERFORMANCE INDICATORS
- ° REVIEW INPO DRAFT MAINTENANCE GUIDELINES
- ° EVALUATE STATE OF MAINTENANCE IN INDUSTRY