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NUCLEAR REGULATORY COMMISSION

BRIEFING ON HYDROGEN CONTROL PROGRAM

PUBLIC MEETING

Nuclear Regulatory Commission
Room 1130
1717 H Street, N. W.
Washington, D. C.

Friday, November 19, 1982

The Commission convened, pursuant to notice, at 2:05 p.m.

COMMISSIONERS PRESENT:

NUNZIO PALLADINO, Chairman of the Commission
VICTOR GILINSKY, Commissioner
JOHN AHEARNE, Commissioner
JAMES ASSELSTINE, Commissioner

STAFF AND PRESENTERS SEATED AT COMMISSION TABLE:

W. DIRCKS
S. CHILK
M. MALSCH
E. CASE
R. MATTSON
W. BUTLER

AUDIENCE SPEAKERS:

C. TINKLER
J. LARKIN
P. STAHL

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P R O C E E D I N G S

CHAIRMAN PALLADINO: Good afternoon, ladies and gentlemen.

We are meeting this morning for the Commissioners to be briefed on the status of hydrogen control programs currently being undertaken by the NRC. I understand that the staff doesn't have any final product for Commission review at this time, but general discussion of the status of the programs would be useful.

I also understand that we will hear some information on programs being conducted by EPRI and by other countries.

Do any of my fellow Commissioners have other comments?

I will turn the meeting over to Mr. Dircks.

MR. DIRCKS: As you mentioned, Mr. Chairman, this is a status report. We think that it is important to bring you up to date, especially in reference to the hydrogen matters and several of the important policy issues facing the Commission, including the 82-1A paper that we have discussed. This deals with not only what NRR is doing in the area of hydrogen control updates, but with what the Research Program is doing, and ties back into the severe accident program.

(Commissioner Gilinsky joined the meeting.)

The staff is here today. Mr. Walt Butler will present the paper, but Roger Mattson is here to jump in at any point where it is necessary. Ed Case is also ready to deal with any questions.

Roger, I guess you do want to say a few things to start us off.

MR. MATTSON: This briefing is going to cover a lot of territory. We have a very thick package of slides in front of you. The way we have structured it is for Dr. Butler to take you through the slides in a rather summary fashion, giving you the opportunity to intercede at any point and to say that you want to understand a few more details. If we went into the details on all of it, we would be here a couple of days. Hydrogen is a technically complex subject in itself but, as Bill has said, it touches on a number of the areas that we are dealing with.

Let me introduce a few of the people who are in the room, so that you know the names associated with some of the work. In the Containment Sytems Branch that Walt is the Chief of, the person primarily responsible for the hydrogen work is Charles Tinkler, sitting over there.

Mort Flaishman is here, whom you have met in the development of the Interim Hydrogren Rules. John Larkin is here from Research also, who has the responsibility for overall guidance of the Hydrogren Research Program. Carl Neal and Nelson Soo are in the audience. They have the responsibility for the hydrogen unresolved safety issue in the Division of Safety Technology at NRR.

Let me start, before Walt takes it over. If I could have the first slide. By way of introduction, let me give a little history. Some of you have been here longer than others, and it might help to know to how we got to this point.

The NRC requirements on hydrogen have changed since Three Mile Island, and the evolution of these requirements is still going on. They started with the TMI Action Plan and recommendations that were contained there flowing from places like the short-term/long-term lessons learned. The Kamany and Rogovin people all spoke to the question of hydrogen that occurred in the accident.

At about that time, there was an important Commission paper, actually there were several editions of it, SECY-80-107 -- it is useful for the record to keep referencing that. In that paper, the staff was emphasizing in 1980 the connection of hydrogen control capability to containment volume and strength.

You will remember, there was a lot of back and forth between the Commission and the staff, with the ACRS involved, over exactly what should be our requirements for small, low strength containments. Subsequent to those discussion, there were Commission decisions to require hydrogen control systems in ice condensors and Mark III BWRs. Those requirements to have hydrogen control systems led then to certain license conditions being placed on the Sequoyah, McGuire and, a license you haven't seen yet, the Grand Gulf license.

Subsequent to those decisions, there were some hydrogen control rulemakings, the so-called Interim Rules, the first of which is in effective form, and the second only being issued in proposed form, and we will turn to those two things as we go along through the briefing to give you a status on them.

You also asked at about that same time -- The Commission asked the staff to develop a plan for an unresolved safety issue on hydrogen, the reason being to try to tie together all the diverse places that this issue shows up and give some semblance of management. We will talk to today about our progress in doing that.

COMMISSIONER AHEARNE: Semblance only?

MR. MATTSON: There is also a large research program that connects to research going on in industry and in other countries, that is aimed primarily at reducing the technical uncertainties that remain in the area of hydrogen, burning hydrogen control.

One other thing I want to say by way of introduction, and then you can see I have just followed the outline that is on this slide, you will hear us refer to two kinds of accidents this afternoon, and it is important that you understand the distinction that we are trying to make. The words we use are important words. On the one hand, we will talk about degraded core accidents, and on the other hand, we will talk about severe accidents.

Degraded core accidents are those that can be terminated short of coremelt and return to some form of coolability in the vessel. TMI is a degraded core accident. Severe accidents, as you come to understand them in SECY-82-1, are those that lead to core meltdown. So severe accidents is a broader class of accidents than degraded core accidents. Severe accidents include degraded core accidents.

Sometimes we lose track of them, and we will foul up in our own presentation.

COMMISSIONER AHEARNE: What was your last inclusion? What did that last statement include?

MR. MATTSON: Severe accidents include degraded core accidentsm the set of severe accidents.

COMMISSIONER AHEARNE: I guess I missed that. Severe accidents include those that go to coremelt.

MR. MATTSON: Degraded core d[illegible] not.

COMMISSIONER AHEARNE: They include those because they cover the complete spectrum.

MR. MATTSON: I am sorry, I was talking instead of listening. Try it again.

COMMISSIONER AHEARNE: Severe accidents, then, are not restrictec to those that have complete coremelt?

MR. MATTSON: No, they are not. You can terminate a severe accident short of coremelt. But when you talk about a program to address severe accidents, you are talking about a program that includes the phenomenology associated with accidents all the way to core meltdown, and containment failure, and so forth.

CHAIRMAN PALLADINO: It can include varying degrees of coremelt?

MR. MATTSON: Yes.

COMMISSIONER AHEARNE: So rather than two separate, different kinds, one is a subset of the other.

MR. MATTSON: That is right.

Okay, that is the introduction. Now, Walt.

MR. BUTLER: Thank you.

COMMISSIONER GILINSKY: Let me ask you something. Are you going to talk about environmental qualifications?

MR. MATTSON: Yes, that will come.

MR. BUTLER: I would like to start by showing five viewgraphs, starting with page 2, which summarizes our casework experience -- our recent casework experience. For reference purposes, we listed three elements of the first Interim Rule. We will come back to these elements in greater detail later on in the discussion.

Our licensing basis for hydrogen control for the Mark I and Mark II plants are detailed in the Interim Rule. During the past year, we have issued full power licenses for the LaSalle and Susquehannah BWR plants, which are Mark II containment plants.

The only Mark I containment plant to be considered since the TMI accident is the FERMI-II plant, and the staff's review of that is nearing completion, and we will come to the recommendations for that.

COMMISSIONER GILINSKY: That is a Mark I?

MR. BUTLER: I am sorry.

That is a Mark I. FERMI-II has a Mark I containment.

CHAIRMAN PALLADINO: When you speak of inerting, you are speaking of inerting in the drywell on these?

MR. BUTLER: The drywell and the wetwell.

CHAIRMAN PALLADINO: And the wetwell. How about the containment building outside --

MR. BUTLER: The secondary building isn't inerted.

For completeness, I would like to just mention, with respect to the operating reactors, all the operating reactors were previously inerting, that is previous to the first Interim Rule, with the exception of Hatch-II and Vermont Yankee. Subsequent to the Interim Rule, those two plants are now operating with inerted containments.

On page 3, for ice condensor PWRs, our licensing bases in regard to hydrogen control were those that evolved from Commission action on the Sequoyah Unit I application. Full power licenses have since been issued for McGuire-I, Sequoyah-II on an interim basis. Others in the pipeline include the Catawba and Watts-Bar plants.

We are nearing completion of our final

evaluation for Sequoyah Unit 1.

COMMISSIONER AHEARNE: That is of the -- There you have the TVA's proposed different type of ignitors, is that what you mean?

MR. BUTLER: Yes.

COMMISSIONER AHEARNE: Can you say a few words as to why they went to a different type of ignitor?

MR. BUTLER: Yes. They elected to replace the glow-plug with the TECO ignitors primarily to simplify the system design, to remove the transformer which has to transform 110 volts to about 14 volts to drive the glow-plug. This design sort of snowballed -- I shouldn't say snowballed, but step-by-step developed. Sequoyah-I was the first unit that came up with the design, and the next unit, McGuire-I, came up with a slightly better design, and D.C. Cook after that.

Sequoyah-I being the first one felt that they wanted to improve their design beyond what they first came in with, and they elected to go with the TECO ignitors. The other ice condensor owners feel that the glow-plug ignitors are quite satisfactory and they are staying with those ignitors for their final system.

COMMISSIONER AHEARNE: So the basic difference between the TECO and the glow-plug is the stepped down transformer?

MR. BUTLER: There are other differences with respect to the design. The glow-plug ignitor is just a single heated element like a pencil. The TECO is a coil kind of ignitor, where there is more surface area.

MR. MATTSON: This led to quite a lot of retesting and --

COMMISSIONER AHEARNE: That was my next question. Have they done the same level of tests on them, so they understand the performance in steam, and the percentage hydrogen ignition. There were a lot of tests that had been done on the glow-plug.

MR. BUTLER: Yes. They have performed an extensive test program for the TECO system. However, as you will find out in our evaluation for Sequoyah, we do have some continuing question with respect to the TECO ignitor, and we will pursue that further with TVA. There are some confirmatory items that need further attention.

COMMISSIONER AHEARNE: That is what you expect sometime next month?

MR. BUTLER: Yes.

MR. MATTSON: We are really kind of getting up against a tight turnaround here. We have the information, as I understand it now, from TVA. It appears that we will have a few loose ends even when we finish this, although we will be able to conclude to our satisfaction that the system is acceptable for the long-term, pending some small confirmatory items.

We are due to go to the ACRS subcommittee on the 6th of December, the full ACRS on the 9th and 10th of December, or the 10th, one or the other, it isn't firm yet, and the plant is presently scheduled to restart by Christmas Eve.

COMMISSIONER AHEARNE: And the license condition requires --

MR. MATTSON: -- that we approve the satisfactory nature of the TECO design before restart. Our work is nearly complete in order to support the ACRS meetings.

COMMISSIONER AHEARNE: So, Walt, the remaining questions that you have, you don't see those as being ones that would block this approval. What would they be, remnant questions that you still would want them to further explore?

MR. BUTLER: I think we don't view them as being major questions, but we do believe they need some further attention in the insuing year. We will see these as things that we will have to work further with TVA and with our research people to get a better handle on what we will call "confirmatory items."

COMMISSIONER AHEARNE: The other question on this slide. You mention there that "the owners group -- "the Ice Condensor Owners Group has concluded that the deliberate ignition system," et cetera. Is that a formal conclusion that you are now reviewing, or is this just a general sense of where they have come out?

MR. BUTLER: They have early in their program examined a wide range of other alternatives. On the basis of data in that evaluation they have concluded that the ignitor approach is the best approach for the ice condensor plants, and we are inclined to concur with that decision.

COMMISSIONER AHEARNE: But as far as anything that you are formally reviewing for the Sequoyah submission, there is no Ice Condensor Owners Group final report.

MR. BUTLER: No. I see what your question is.

MR. MATTSON: They come in plant by plant. We proceed from Sequoyah to McGuire because the licensing decisions were staggered, and the same one year --

COMMISSIONER AHEARNE: There isn't something out in terms of a report from the owners group?

MR. MATTSON: There may be. Some of the test results were jointly sponsored by these people.

MR. BUTLER: Yes, they have quarterly reports, but each licensee submits his own quarterly reports.

MR. MATTSON: One question that we might get out of the way here. You are going to see in the discussion as it goes along that there has been some narrowing of the uncertainties on hydrogen by these ignitors, and the narrowing of the uncertainty on hydrogen phenomenology.

We are pretty comfortable with the design that is before us now for Sequoyah, and we will proceed then to write off on this one and McGuire. We will be down to tell you about Grand Gulf for a full power license early next year, and an interim approval.

With another ACRS review early in December, and an ACRS letter that we are going to ask for on this Sequoyah system, the question becomes whether you want to hear a briefing, before Sequoyah is restarted, on its ignitor system. There is some uncertainty among us as to whether you require one. You have never said anywhere we can find that you require one, but we thought we ought to offer, because it is going to be kind of at the last minute if we are going to give you one.

Do you have any feel that you have here today?

COMMISSIONER GILINSKY: Wasn't that a Commission approval at a second stage?

MR. MATTSON: The license requires that NRC to approve the ignitor system before restart following the first refueling outage. We feel that we can give that approval.

COMMISSIONER GILINSKY: I thought the way we had worked it was that the initial approval was given by NRR, and the second approval was given by the Commission.

MR. CASE: Did it say NRC?

MR. STAHL: The words used were the Commission reviews that.

COMMISSIONER GILINSKY: No, I think that was the --

CHAIRMAN PALLADINO: The words used where?

MR. STAHL: In the license condition itself.

COMMISSIONER GILINSKY: It was intended, as I recall, that it was actually the Commissioners. The first approval was granted by NRR, as I remember it was set up, and the interim system was to be approved by the Licensing Office, and then at some point, when a system for permanent use was developed, that was to be approved by the Commissioners.

MR. MATTSON: I wasn't here at that time, so your information is much better than mine.

MR. CASE: The terminology between the two conditions, did they both say the Commission?

MR. STAHL: The third condition, I will have to get the license, but does say that the Commission will determine --

COMMISSIONER GILINSKY: I think the first one says NRR.

MR. STAHL: No, it does not. In both instances, the interim and the final system, will be reviewed and approved really by the Commissioners. In the first instance, the interim was part of our review --

MR. CASE: Did it say Commission in that one?

MR. STAHL: No.

COMMISSIONER GILINSKY: Are you sure? Why don't you check that.

MR. STAHL: I will check that.

COMMISSIONER GILINSKY: As I remember it was that we had approved the license but within a certain number of months the interim decision --

MR. CASE: We obviously have no problem.

MR. MATTSON: We have no problem doing it, it is just a question of --

COMMISSIONER GILINSKY: I understand.

MR. CASE: It is the holiday season and the time to start operation.

COMMISSIONER GILINSKY: Obviously, there are two ways to do this.

CHAIRMAN PALLADINO: Even if we weren't to approve it, you would be prepared to present or brief us on what the resolution is?

MR. MATTSON: Absolutely, yes, at your discretion. We will be prepared any time after the 6th of December. Obviously, we have to go to the subcommittee and the full committee, and perhaps putting it in-between or as soon after that --

CHAIRMAN PALLADINO: When do you need an answer, or when do you need to give your answer?

MR. MATTSON: TVA says that they are scheduled to start up on either the 24th or the 25th of December.

COMMISSIONER GILINSKY: John, do you remember how that was phrased?

COMMISSIONER AHEARNE: No, I really don't, Vic.

COMMISSIONER GILINSKY: I wonder if the Secretary could look that up, or look up the transcript.

CHAIRMAN PALLADINO: But you would be prepared after December 6th?

MR. MATTSON: Yes. I think it would be best to let us go before the ACRS and see what their concerns are after having done a detailed review over the last couple of years, and learn from that experience, and see if we can report to you that they agree with us.

CHAIRMAN PALLADINO: This is on the hydrogen ignitor?

MR. MATTSON: The ignitor system for Sequoyah Unit 1.

Walter.

MR. BUTLER: On to page 4, for the Mark III BWRs, our licensing bases were developed from the precedent set during the licensing of Sequoyah unit 1. The first of the mark IIIs is the Grand Gulf Unit 1 case, which has been issued a five percent license.

Staff reviews on the interim system for the Mark IIIs were completed last July. Details of this review will be discussed with the Commission when the full power license is considered, now estimated sometime in early 1983.

COMMISSIONER AHEARNE: Walt, are they using a glow-plug also?

MR. BUTLER: Yes. The Mark III people are using the glow-plug ignitors.

CHAIRMAN PALLADINO: Is this one a glow-plug?

COMMISSIONER AHEARNE: Yes.

Did anybody ever go to the combine system?

MR. BUTLER: The only one that considerec it in any serious way was the Allen's Creek NTCP case, but that has since been cancelled.

CHAIRMAN PALLADINO: This ignitor system is for the drywell above the suppression pool?

MR. BUTLER: Yes, and the containment above the suppression pool. In the Mark III the suppression pool is off to the side.

CHAIRMAN PALLADINO: But now the drywell is a high pressure system, and then there is a lower pressure containment. You are not talking about any ignitors in the low pressure portion?

MR. BUTLER: Oh yes. The ignitors and most of the burn will take place in the low pressure portion, which is designed for 15 pounds gauge, similar to the ice condensor containments.

CHAIRMAN PALLADINO: But in the others, you didn't do that, or did you?

MR. BUTLER: The others being the Mark Is and IIs?

CHAIRMAN PALLADINO: Yes.

MR. BUTLER: That is correct, we did not require ignitors for the Is and IIs, we required instead the inerting of --

CHAIRMAN PALLADINO: And it was inerting only in the drywell?

MR. BUTLER: The drywell and the wetwell. However, in that case, you see, the drywell is above the wetwell connected with the downcomers.

MR. MATTSON: But not in the containment building, not in the secondary containment.

CHAIRMAN PALLADINO: But here you are requiring it in the containment building as well.

MR. BUTLER: Yes, but the containment building for Mark IIIs is the primary containment. The reactor building in the Mark Is is a secondary containment good for only inches of water pressure. This is a different concept.

CHAIRMAN PALLADINO: I see. Just because they made that outside building stronger, now they have to have ignitors?

MR. MATTSON: No. It is wherever the hydrogen gas can reach after the gases go through the suppression pool and the steam is condensed, the gases that accumulate in the space above the water can burn, if the hydrogen is there.

CHAIRMAN PALLADINO: Couldn't it do it in the old ones also?

MR. MATTSON: Yes, and they are inerted in the old ones.

COMMISSIONER GILINSKY: I think Joe looks upon the new building as just the old secondary containment.

CHAIRMAN PALLADINO: Yes.

COMMISSIONER GILINSKY: It isn't. It communicates with the inside.

CHAIRMAN PALLADINO: Only through the suppression pool.

COMMISSIONER GILINSKY: Through the suppression pool.

MR. MATTSON: Yes.

COMMISSIONER GILINSKY: The other one doesn't.

CHAIRMAN PALLADINO: The other one communicates with the --

MR. BUTLER: But the distinction is that in the old ones, Is and IIs, the suppression pool is inerted, whereas in the Mark IIIs, the suppression pool or the wetwell is not inerted and, therefore, you need these.

COMMISSIONER GILINSKY: The space above the water does not communicate with the secondary containment in the Mark I.

MR. MATTSON: That is right.

MR. BUTLER: That is correct.

COMMISSIONER GILINSKY: Whereas it is part of the containment in the Mark III.

MR. MATTSON: Yes.

MR. CASE: It is the volume that the Chairman is interested in, the difference in volume.

COMMISSIONER GILINSKY: It is not simply that they made the building stronger --

(General laughter.)

CHAIRMAN PALLADINO: I am just looking at sketches of these, and maybe I didn't sense some difference.

COMMISSIONER GILINSKY: They have expanded the containment and made it larger. What would have been the taurus or the Mark II containment is now a larger building. They have also put a lot of equipment in there, which is what makes it impossible to inert it.

MR. MATTSON: Yes.

CHAIRMAN PALLADINO: I know why you wouldn't want to inert that.

MR. CASE: We will sketch one.

MR. MATTSON: We will sketch one and bring it up in a minute.

CHAIRMAN PALLADINO: Let's go on.

MR. BUTLER: All right, going on to page 5, then, for the large dry containment. We have not imposed any new requirements to deal with degraded core accidents for large dry containments, pending completion of rulemaking.

COMMISSIONER AHEARNE: Which rulemaking?

MR. BUTLER: This would be --

MR. MATTSON: -- the second interim rule, but there is something that we want to tell you about that a little later. So it is really the severe accident rule. If that is enough answer for now, why don't you wait until we get to the second interim rule.

COMMISSIONER AHEARNE: The severe accident rule glimmering somewhere.

MR. MATTSON: I think we can show you why it is worth waiting a few months, and we would like not to wait on the second interim rule that long. But to do the large dries, there is some methods development that is occurring in Fiscal-83 that would really help cut down on the amount of analysis that has to be done by the various owners.

COMMISSIONER AHEARNE: I am sure, but do you mean that the severe accident rule is only a few months beyond some fixed date?

MR. MATTSON: The methods and the calculations that go into forming the technical basis for the severe accident decision will be completed within the next 12 months, yes, sir, that is NUREG-0900 -- Fourteen months, at the end of Fiscal-83.

COMMISSIONER AHEARNE: That I wouldn't challenge, but it is the rulemaking.

MR. MATTSON: No. The methods and calculations will be done by done by the end of December.

COMMISSIONER AHEARNE: It is the rulemaking that I was questioning.

MR. MATTSON: Yes. But the reason for putting it in that decision is a methods reason.

COMMISSIONER AHEARNE: Yes.

MR. MATTSON: We will get to it later.

MR. BUTLER: Examples of full power licenses to large dry containment plants include those issued for North Anna-II, Salem-II, and San Onofre-II.

MR. MATTSON: There is an interesting aside that can be made on this slide, if you will bear with me a minute. You will notice that the second bullet says, "Some applicants have performed calculations to demonstrate acceptable consequences without additional measures, those are both large dry containments." The first bullet says that we haven't required anything of large dry containments. Then, the question is, how come these people did the calculations.

The ACRS asked some questions beyond the design basis, and hearing boards are anticipated to allow contentions beyond the design basis. For those reasons, some mix of those reasons, these applicants chose to do analyses, make calculations of equipment survivability, and containment survivability beyond the design basis.

MR. CASE: Essentially those things that would be required by the second interim rule if and when it became final.

MR. MATTSON: Yes.

COMMISSIONER ASSELSTINE: I have a couple of questions on those, Roger. Where you say, acceptable consequences, what kinds of consequences do they describe in those calculations?

MR. MATTSON: Survivability of the safety equipment and ability to function, and survivability of the containment. The same kind of thing that we require of the ice condensors and the Mark III.

COMMISSIONER ASSELSTINE: What sort of assumptions do they make on the percentage of metal water reaction?

MR. MATTSON: The interim basis is 75 percent metal water reaction, and both interim rules state 75 percent.

COMMISSIONER ASSELSTINE: Have you looked at those calculations and decided whether or not you agree with at least those two that were done?

MR. MATTSON: Walt?

MR. BUTLER: We have not undertaken a special review of those two particular ones. However, we have seen the analyses done for the NTCP case for a large dry, the Pilgrim Plant, and we agreed with those preliminary findings. They are quite comparable.

MR. MATTSON: That was 100 percent metal water reaction for the near-term CPs, the difference in the two rules.

COMMISSIONER ASSELSTINE: Also how did they treat, perhaps, the weak points in the containment like penetrations through containment?

MR. CASE: Just like an overall calculation and say, well, it is a half for the interim rule, and not look at the penetrations, or did they look at them in detail?

MR. BUTLER: We have had our Structural Engineering Branch reviewers take a look at the design for penetrations. Basically, these penetrations were designed for a 60-pound containment. They were not modified when they were selected for installation in the 15-pound containment. So they are basically strong penetrations.

MR. MATTSON: We are talking about now?

MR. BUTLER: These are the penetrations in Sequoyah.

MR. MATTSON: Sequoyah.

MR. BUTLER: Yes.

I am sorry, it is a different issue on the penetrations for the large dries.

MR. MATTSON: There continues to be some attention to that question in on-going coremelt phenomenology work. We are doing some in the Reactor Systems Branch. There is some going on in Research. There is some going on in the Structural Engineering Branch. What kinds of penetrations can be counted on to be as resilient to overpressure of the containment; what kinds can't? Is temperature important? Those kinds of questions are still very active.

COMMISSIONER ASSELSTINE: I guess I was just trying to get a sense of how much weight we should give to the fact that at least in those two instances, at least some analysis has been done that would lead one to the conclusion that the consequences would be acceptable, without any additional measures.

MR. CASE: I guess there is a little doubt on the containment.

MR. MATTSON: For the large dries, there is very little doubt. And because of the over-design for the Sequoyah, I think there is fair confidence. The question of penetrations for the severe accidents, the ones beyond these hydrogen burn questions, are still a real question.

MR. BUTLER: The final slide for casework is on page 6, where for the NTCP and ML applications, we base the staff review on the applicable rule issued January 15, 1982.

We completed our reviews of the seven then pending CP/ML applications. At this time, all but two of these applications have been cancelled by the applicants. They are the FNP plant, the ML application, and the Staget Mark III plant.

Going on to the first interim rule now, on page 7 --

COMMISSIONER GILINSKY: Let me ask you this. Does D. C. Cook have ignitors?

MR. BUTLER: Yes. Units 1 and 2 have ignitors.

MR. MATTSON: They are more like the McGuire ignitors?

MR. BUTLER: Yes.

As you know the first interim rule is now an effective rule, and we are generally satisfied with the progress of its implementation in all respects, with one exception, that of requiring the recombiner capability as it affects Mark I BWR plants. Details of this are shown on the next slide, where I discuss the recombiner capability for the BWR Mark I plants.

MR. MATTSON: We are going to kind of move from the interim rule to this specific thing. If you have any questions on the other aspects of the first interim rule, now is the time to ask them.

MR. BUTLER: This requirement for a recombiner capability was intended to apply to all LWR plants. If a plant did not have installed recombiners, they needed to provide the capability for this installation, so that they would not have to purge as the primary means for hydrogen control.

The Mark I owners have completed an extensive re-examination of the issue and have made a pretty strong case for not needing the recombiner capability. They have supplied a substantial amount of additional information in the area to show that radiolysis rates, in fact, are substantially lower than we had expected at the time the rule was promulgated.

They provided cost information that indicated the installation of this recombiner capability is a lot more expensive than was considered at that time. When you consider these two pieces of additional information, it tends to alter the cost/benefit balance.

COMMISSIONER GILINSKY: What is our policy on purge? Do we let people purge?

MR. MATTSON: We said in very short words, so let me see if I can elaborate a little. 50.44, the regulation concerning hydrogen control, when it was issued in the '70s had two classes of plants -- new plants and old plants. There were a number of plants that were grandfathered.

The grandfathered plants were not required to have recombiners. They were allowed to depend upon repressurization and purging of the containment after an accident, long-term after an accident, if combustible mixtures of hydrogen were accumulating -- combustible mixtures of hydrogen and oxygen.

After TMI, the staff thought about it and discussed it with the Commission, and it was decided in the first interim rule to require that for that class of plants that had no recombiners, but depended upon repressurization and purge, that we would require them to install the capability, that means pipes and valves to points outside of containment, where if a need came to purge in order to control the hydrogen from radiolysis.

This doesn't have anything to do with metal water reaction. That is prompt generation of hydrogen, and recombiners don't do anything for that. But for the long term generation of hydrogen and oxygen, you would be able to call somewhere and have a recombiner flown in, hooked up to this capability that had been built into the containment penetrations, and use the recombiner in the way that it was used at Three Mile Island.

CHAIRMAN PALLADINO: For what kind of a plant was that, PWR?

MR. MATTSON: For both Ps and Bs.

CHAIRMAN PALLADINO: I thought you inerted the BWRs.

MR. MATTSON: Yes.

CHAIRMAN PALLADINO: I see.

MR. MATTSON: But over the long term, if there is a significant radiolysis in a BWR, you will generate both hydrogen and oxygen by the radiolysis. The point that has been brought to us by the BWRs owners is an interesting and good technical point. If it has been a severe accident, and there is a lot of hydrogen in that inerted environment -- There would be a lot of nitrogen from the inerting, but there could have become a lot of hydrogen from metal water reaction, then that hydrogen will act to suppress radiolysis over the long-term. That is, no more hydrogen and no oxygen will be generated.

On the other hand, if it is an accicent -- here we come to one of Ed Case's and my intermediate small window of accidents. If it is an accident just between the design basis and a degraded core accident that doesn't generate a lot of hydrogen, but does let out a significant amount of fission products, then you could theoretically generate hydrogen and oxygen in an inerted containment.

So the question really becomes one of risk. How probable is this small window? Our analyses have shown that the argument by the owners is a good technical argument. There is new information that has been brought to us. There is new safety and technical information, on the one hand, and new cost information.

If you look at the record from the rulemaking, the estimates we had made, and there was no change of those estimates in the public comment period, they were in the hundreds of thousands of dollars.

CHAIRMAN PALLADINO: Where did you get this overpressure of hydrogen? Did it come from radiolysis, or some other --

MR. MATTSON: If it is a severe accident, it came from metal water reaction. It the intermediate area between the bad accident and the design basis accident.

COMMISSIONER AHEARNE: Is this an argument which would hold for all BWRs?

MR. MATTSON: Therein lies the question that we are sort of hung with at the moment. We are debating internally whether to come to you and say, "We think we ought to issue exemptions for those BWRs who have made this case," or whether we ought to issue a rule change. We are grappling now with the extent of this information, whether it should apply to other reactors.

In the case that we have done so far, we have been concentrating on the suppression of the generation of oxygen in an inerted containment. It is a little bit different than a PWR where there is no inerting, but if there were large amounts of hydrogen, it too would suppress radiolysis long-term after an accident. Yet, large dries, whether they can maintain any significant amounts of hydrogen without being ignited or burned --

COMMISSIONER AHEARNE: But it would also hold for Mark II.

MR. CASE: It would also hold for PWRs.

MR. MATTSON: Yes.

MR. BUTLER: The Mark IIs, of course, do not purge as a primary means of hydrogen control. It would really only apply to about 90 percent of the old Mark Is, because it is only the Mark Is that rely on purging as their primary means of hydrogen control. Some of the more recent Mark Is have recombiners installed, and they would not be affected.

MR. CASE: But also PRWs, Walt, the issue can be well raised with them.

MR. BUTLER: Yes, certainly. Yes, there are a number of older PWRs that purge as their primary means of hydrogen control.

MR. CASE: I am inclined to go the exemption route because the conditions vary from plant to plant as to the probability of this small window. So in order to have a control of the situation, it is better to require it and then grant an exemption if the conditions were right, rather than remove the requirement.

MR. MATTSON: That is consistent with the way the information comes in. So far, it has only been brought in for the Mark Is.

COMMISSIONER GILINSKY: Isn't the hydrogen generation from the walls, and the paint, and the debris, and so and so forth, and it is a small addition to the other problems?

MR. MATTSON: Yes, that is true.

MR. CASE: But it is that small addition that you are worried about from the combustion standpoint because you take care of the initial amount by the inerting. The metal water amount is taken care of by inerting. It is the long-term radiolysis and other sources --

CHAIRMAN PALLADINO: Where you get both oxygen and hydrogen.

MR. CASE: Right, that you have to worry about. That depends on the so-called G value. The safety guide would read --

COMMISSIONER GILINSKY: I don't like these kinds of comparisons usually, but if you look at the plants like the Mark IIIs and ice condensors, there is loads of oxygen there that we are putting with.

MR. CASE: But you are burning the hydrogen in a controlled way.

MR. MATTSON: So far they are all required to have recombiners or else install a recombiner capability. We have not looked at whether we would use the same information to remove the requirement for a recombiner capability being backfit.

Ed is saying, that is an interesting question in light of what we think we are about to propose to you for the Mark Is. It may be an interesting question, but the technical analysis has not been done, and it is not certain that it is the generically applicable argument. We will have to study that argument. In the meantime, your regulations and our reviews are on the safe sideof that. We require such capability to be backfit, and it is up to the people, if they believe that it is an unreasonable requirement, to come and tell us bout it and make the case.

In the meantime, we are concentrating on those people who have brought the information, the Mark Is, and I am signaling to you that they appear to have made a good case. We still have it under review. You will get a Commission paper in another weeks that probably will recommend that exemptions be granted to the Mark Is, although we are reserving a little bit on which way we will recommend you to go.

CHAIRMAN PALLADINO: But they are postulating -- In order to get an exemption, you have to postulate that you have severe metal water reactions --

MR. CASE: The rule itself postulates that.

CHAIRMAN PALLADINO: Let me just go on.

MR. MATTSON: Just so you don't freeze your mind on that, it is a more complicated question.

CHAIRMAN PALLADINO: My mind is very fluid.

MR. MATTSON: Don't let the record show we agreed with that. It is more complicated than what you just said. I

CHAIRMAN PALLADINO: I was going to ask you another question. If you have coremelt, are you postulating that you would have had zirconium metal water reaction, or are you just saying that you would not have had it?

MR. MATTSON: Yes, you would have had it.

CHAIRMAN PALLADINO: So you are saying that you always get his overpressure?

MR. MATTSON: If it is a severe accident that leads to significant core damage, that is damage to the cladding and the geometry of the core, you will have gotten metal water reaction. There is a class of accidents which you could release the fission products from the core, which is what contributes to the G factor for the production of hydrogen by radialysis -- hydrogen and oxygen.

You could release the fission products and not otherwise damage the cladding. You could perforate the cladding, and lead to the release of the gap activity, but not have a significant amount of metal water reaction.

Then the question becomes, given the reasons for putting the recombiner capability on as a backfit requirement in the first place, that was the ability, if you wanted it, to avoid purging.

We didn't say that it was a safety problem from purging, remember. We said purging hadn't met with a lot of public acceptance following Three Mile Island, and if you listened to that question of public acceptance, then there was the realization that there were 40-some plants that had to purge for long-term hydrogen control if significant amounts accumulated in the weeks and months following an accident. Therefore, the consideration was that it was relatively cheap to put a pipe and a valve, and be able to pick up the phone and call for one to be flown in.

We have since learned that the G factor over the long-term in an inerted containment, say the Mark I people, is not significant, and we tend to agree with them for all, except this very narrow window that doesn't have a high risk potential.

COMMISSIONER GILINSKY: The whole notion of recombiners comes from a time when one didn't take into account accidents which involved a substantial amount of metal water reaction.

MR. MATTSON: That is right.

COMMISSIONER GILINSKY: So, when you thought about hydrogen, you thought about relatively small amounts of it coming from the various causes that Roger outlined, and the recombiner which has a relatively limited capability would deal with that over a period of a month or two.

MR. MATTSON: That is right.

MR. CASE: It is a very interesting question that we are getting to here. We don't want you to make the decision --

COMMISSIONER AHEARNE: Good.

MR. CASE: But it is a question that you can think of.

COMMISSIONER AHEARNE: Roger, you also on this chart mention that it is costing more than you thought it was going to cost. Are you saying that you thought that it was going to be relatively inexpensive?

MR. MATTSON: We thought several hundred thousand dollars, and we are now fairly convinced that it is several million dollars a plant when you consider just the capability, but it is a pro rata share of what it costs to build one and have it available to fly in.

It turns out that we had made an assumption that basically the same recombiner would work for an inerted containment that would work for a non-inerted containment. It turns out that there are some engineering costs and some redesign that has to be done in order to make it work when it is passing a lot of nitrogen in addition to the hydrogen and oxygen.

We had thought that a skid-mounted design for flying actually existed, when in fact it doesn't. There are some skids, but you can't fly them around and guarantee that they will work. So there is some redesign associated with that. When you look at the cost of all this, and pro-rate it, it comes out to be significantly higher than we had estimated on those other bases.

COMMISSIONER GILINSKY: Are they mostly for air charter?

COMMISSIONER AHEARNE: If there plants that don't have to have it, the higher the pro-rationg gets.

MR. MATTSON: That is right. We could be in a catch-22.

COMMISSIONER ASSELSTINE: Roger, are you saying that, basically, these things are not hooked up to penetrations in the containment, but they are just put in and then you just fly them out?

MR. MATTSON: Yes.

COMMISSIONER ASSELSTINE: How long does it take to get one unit hooked up?

MR. MATTSON: You don't need one for on the order of weeks or even months, depending on the G value, and you could conceive, from the way we flew things around at Three Mile Island, getting one there in hours. It is fairly easy.

COMMISSIONER ASSELSTINE: And the are all outside containment?

MR. MATTSON: Yes, all outside containment.

COMMISSIONER ASSELSTINE: How do you prevent insignificant releases?

MR. MATTSON: The design of the hook-up would be double-valves and consideration of the radiation protection of the workers, and that kind of thing. It is just an engineering problem, and fairly straightforward. You would have to consider that in the installation.

CHAIRMAN PALLADINO: Will be the operators be familiar with what they need to do?

MR. MATTSON: Yes, they would have to have procedures for that.

CHAIRMAN PALLADINO: Procedures are one thing, but that is when you usually get the inadvertent releases, when you are hooking up, if you haven't with it.

MR. MATTSON: Valve line-up and that kind of thing are important, yes.

MR. BUTLER: Let me go on to the second interim rule now.

COMMISSIONER AHEARNE: Before you go on to the second interim rule, could you tell me what the status is on high point vents?

MR. BUTLER: Yes.

COMMISSIONER AHEARNE: As far as how plants are coming in.

MR. BUTLER: They are pretty much --

CHAIRMAN PALLADINO: When you are talking about high plant vents, which plants are you talking about, any specific ones, or all of them?

COMMISSIONER AHEARNE: Not any specific plant, no.

CHAIRMAN PALLADINO: No, I meant specific types. Are you talking about vents in --

MR. MATTSON: Let me see if I can narrow the subject a little. In the case of the boilers, the argument was generally that they had a lot of vents up in the vicinity of the steamline and they didn't need any more high point vents.

I think we are still having some debates with a few boilers that had some interesting arrangements of their isolation condensors, which you will remember there aren't many boilers with isolation condensors.

COMMISSIONER AHEARNE: Yes.

MR. MATTSON: I think we have not had the continuing debate with the rest of the boilers.

In the casë of the PWRs, Walter, do you have a general statement on them, or do you want me to try that one, too?

MR. BUTLER: Go ahead and try.

Primarily, the thing is installed in most of them, okay. There are a just a few open items in a few of the plants that need some further work by the staff to get the equipment installed. But then the procedures for how you use the thing is something that we will have to work out during the next few years.

COMMISSIONER AHEARNE: There is no class of plant, then, that the basic design for it has not been done?

MR. BUTLER: That is true, yes.

CHAIRMAN PALLADINO: Where are these high point vents?

MR. MATTSON: It depends on the PWR. Some of them are just in the head and high points in the loop, I believe. In the B&W plants, they have one in the top of the candycane in their design.

CHAIRMAN PALLADINO: Why are these vent in there; do get rid of non-condensible?

MR. MATTSON: Yes, their design basis was non-condensible gases.

COMMISSIONER GILINSKY: It turns out to be a good idea to have them --

CHAIRMAN PALLADINO: I am not arguing about that.

COMMISSIONER GILINSKY: -- in the case of accidents.

CHAIRMAN PALLADINO: I am just trying to understand how they relate to hydrogen problems.

MR. MATTSON: They were intended for hydrogen. There has been some discussion about their utility for steam venting. The B&W Owners Group, in the ATOG procedures, the anticipated transient operator guidelines, or whatever they stands for, I can't remember. The ATOG symptom oriented future procedures include a reference and a dependence upon the valves for aiding the management of steam bubbles in the B&W design.

COMMISSIONER AHEARNE: If I could just make sure that I understood what Walt said. There is no class of plants for which the vent design has not been completed. It is your sense that all the plants that were to have vents put in are in the process of having them put in?

MR. MATTSON: There is still some debate about the design and its utility. There is a B&W plant in the OL process, for example, that I just reviewed the questions on this week, and there still is an active dialogue about the way the vents between the head and the candycane are connected, and the way the would be used for managing accidents.

So it is fair to say that there is a design, but it is also fair to say that there isn't final write-off by the staff on some aspects of some designs. We haven't completely written off the procedures for their use at any plant.

COMMISSIONER AHEARNE: I would understand the procedures part. I was trying to get a sense of how far along it was in the process. I think what you are saying is that it is mixed, that there are some that have them in, and there are others where there is still debate on the actual design.

MR. MATTSON: That is right, it is a mix.

CHAIRMAN PALLADINO: Roger, these high point valves would be under the control of the operator; they are not automatic?

MR. MATTSON: That is right. That is right, they are all manually operated from the control room.

MR. BUTLER: The second interim rule, on page

9, was reissued as a proposed rule on December 23rd, 1981. It basically codifies for the ice condensor and Mark III containments that which the Commission imposed as licensing requirements earlier for the Sequoyah Unit 1 plant. It also proposes to require certain analyses for large dry containments.

The status of the second interim rule appears on page 10. Detailed staff review of public comments of the rule have been completed, and we are in the process of preparing a Commission paper on the second interim rule.

COMMISSIONER AHEARNE: What is the estimate date?

MR. MATTSON: I think they are talking that they will be down in January.

MR. BUTLER: January or February of 1983.

MR. MATTSON: This slide has an important -- Again, we are trying to give you a briefing that tell you where we are going in addition to where we have been.

There has been quite a lot of discussion in the public comment period about the requirement that is in the rule for the large dry containments to demonstrate plant by plant that what we think is true for large dry containments can in fact be demonstrated plant by plant.

Those are two features, in essence -- well, three. One is that these containments have an ultimate strength of about two-and-a-half times the design strength. Another is that the burning of hydrogen, without an igniting system, which is burning by sources of ignition within the large dry containments, would not cause pressures in excess of two-and-a-half times design, or local pressures that could lead to containment failure. The third is that the important safety equipment would survive. Remember our discussion of survivability.

The expectation is, and has been since we first started talking about these things, since Three Mile Island, that for the large dry containments, that is the case. There is evidence to support that.

First, it has been fairly easy to show it for the small containments, the ice condensors and Mark III, easy in the sense of once you have got a control ignition system, but easy also in the sense of the pressures and the temperatures, that are generated when you pay attention and the do the precise calculations, turn out not to be so extreme. For example, the local temperatures from hydrogen burn turn out to be less than the environmental qualification temperatures for the steamline break used in the normal EQ process. Once you can show that, of course, you have really reduced the regulatory burden imposed upon licensees for the survivability question.

There is another point, and that is that the equipment in containment survived a fairly hefty burn at Three Mile Island. There was a lot of hydrogen produced. There was some form of prompt ignition, and apparently there was not significant damage to the safety equipment that we ended up relying on.

There is a third reason for wanting to delay, and that is the one that we were starting to talk about a few minutes ago. And that is, in the IDCOR program, to look at severe accidens, and in the NRC research program supporting our severe accident decisions, there is quite a lot of activity on survivability of equipment, containment calculations for a fair spectrum of plants.

We are going to look at 13 PRAs that are in existence, and we will update them with current information as the basis for our severe accident recommendations. IDCOR is looking at four surrogate plants, if you will, looking at these questions. It may be possible, a year from now, to handle the large dry hydrogen question for degraded accidents fairly simply, without requiring each licensee to redo an expensive set of calculations.

It seems to us worthwhile to take that year delay, given that we expect the answer to be an affirmative answer, and given that it would take them, if they did plant by plant, several years to complete them all, simply because there aren't the resources in the country to do these kinds of analyses plant by plant within a one-year period.

You put those facts together, and it is hard to make a recommendation that the rule continue to require the analysis that it had proposed for large dry containments.

Now there are a couple of exceptions on the order of what I have talked. Large dry containments at this point include a couple of peculiar plants, or unique plants. The Surry sub-atmospheric containments are in the large dry class. Well, they are small, and maybe we should do something special there. Big Rock is a boiling water reactor, but in a large dry containment. Maybe we should do something special there. We will continue to think about that and have answers to those questions when we come back to you in January with the final recommendations on the second rule.

COMMISSIONER AHEARNE: Do you have a working definition for the sense of equipment. Is that a new term?

(General laughter.)

MR. BUTLER: Roger.

MR. MATTSON: Do we really want to have a hot standby cold shutdown discussion this afternoon?

It is the equipment required to keep the plant in a stable, long-term cooling situation. It is subject to the debate of exactly which equipment is that. You have heard us have that debate with you on Sequoyah. It would help to have a final Commission vote on the environmental qualifications.

MR. CASE: I am working on it.

(General laughter.)

MR. MATTSON: I don't think you really want to go further this afternoon, or we could be here for some time.

MR. BUTLER: Going on to page 11, we mentioned earlier that there was an unresolved safety issue task A48. A draft of that action plan has been prepared and it is now under staff review. Its objective is to provide a vehicle for coordination of the NRC rulemaking and technical review efforts on issue related to the degraded core hydrogen control. It specifically excludes the coremelt hydrogen control issues.

COMMISSIONER AHEARNE: Let's see now, when you say, it excludes the degraded core hydrogen control issue --

MR. BUTLER: Coremelt.

MR. MATTSON: It includes the degraded core. It excludes the severe accident, the melt situation. It is not completely consistent with the definition I gave you earlier. It excludes the rest of the severe accident set, how is that?

COMMISSIONER AHEARNE: Can you transform that into what it includes in the sense of generation of hydrogen?

MR. MATTSON: Seventy-five percent metal water reaction.

COMMISSIONER AHEARNE: It doesn't go beyond that?

MR. MATTSON: That is right. You see, it includes the work on the Mark Is, IIs and IIIs --

COMMISSIONER AHEARNE: Yes.

MR. MATTSON: -- the ice condensor, large dries being put over to severe accident in the way I have just described. The completion of the lead plant reviews, the completion of the second interim rule, and the documentation of the results for the ice condensors and the Mark III.

CHAIRMAN PALLADINO: Where did you say that this was not consistent with your definition?

MR. MATTSON: I said something a few minutes ago that was not consistent with the definition we had tried to adopt for severe accidents. I corrected it.

CHAIRMAN PALLADINO: But this is degraded core?

MR. MATTSON: This is degraded core, that is right. It is the degraded core portion of the severe accident domain.

COMMISSIONER ASSELSTINE: What is left out is coremelts?

MR. MATTSON: Yes.

COMMISSIONER AHEARNE: When you put up, you say that it is the vehicle for coordination. Does that imply that the project manager for this has any coordination role with respect to all of the agency's hydrogen programs?

MR. MATTSON: Yes. Nelson Soo, sitting here, is the project manager. Either he or Carl can jump up if I offended them.

Nelson's job is to see that the activities in these areas go forward on schedule by the people who are working on them. In some cases, that is Walt. In some cases it is Mort Fleischman in Research. If there are research results, and there are, that need to become available in order to support these final decisions, that that all couples together; that there is management attention being paid to how the schedules are being kept, periodic meetings among the managers of NRR and Research, and that this thing continues on schedule abd stays all glued together.

You probably know that there has been some debate within the staff as to whether this is really a USI. I must say it because I am the source of the debate. You gentlemen decreed that it would be a USI. There are two ways of thinking about a USI. It is either an issue to which you don't think you have the technical answer, and I don't think this one is. Or, it is an issue, I guess, that you are worried about the way the management of all these diverse pieces get pulled together.

Given that we fairly --

COMMISSIONER AHEARNE: There is a set of definitions, or definitional statements that apply.

MR. MATTSON: And it is to the former --

COMMISSIONER AHEARNE: The question is, does it fit into that set of definitional statements.

MR. MATTSON: In my judgment, it does not.

You have a USI being prepared to come before you that is the coordination of a number of diverse activities to which I think we know the solution. It is just a matter of execution, or turning the crank in this area right now. To me that is not a USI.

CHAIRMAN PALLADINO: What do you mean? If you get a solution, you have misclassified it?

MR. CASE: A USI is supposed to have certain characteristics.

CHAIRMAN PALLADINO: One is that the Commission declares that it is a USI.

(General laughter.)

MR. MATTSON: He seemed to be leading me to something I think he knew was around, so we might as well get it on the table.

COMMISSIONER AHEARNE: No, actually, it was a much simpler question I was trying to get at, and that was, it seemed to me that there was a large number of efforts underway in this, and I was concerned that with so many different efforts, whether there was any coordination of all those efforts. This was the first sense I got out, perhaps this is it, perhaps this is where it gets coordinated. Now there is a difference between a bookkeeping mechanism and a coordination.

MR. MATTSON: Okay.

COMMISSIONER AHEARNE: Is this a coordination effort?

MR. MATTSON: This is a coordination effort.

COMMISSIONER AHEARNE: Nelson Soo is the person who is responsible for coordinating all the hydrogen efforts of the agency.

MR. MATTSON: As described here. We have excluded the severe accident.

CHAIRMAN PALLADINO: You exclude the severe accidents.

MR. MATTSON: Yes.

CHAIRMAN PALLADINO: It only goes up to the degraded core portion.

MR. CASE: Yes.

COMMISSIONER AHEARNE: But that is a very large amount of hydrogen generation.

MR. CASE: Yes, that is correct.

COMMISSIONER AHEARNE: I would imagine that if you have a program that is so specific that 76 percent --

MR. MATTSON: We have addressed that question. It is the accidents that can reasonably be intercepted and still cooled.

COMMISSIONER AHEARNE: Sure.

(Commissioner Gilinsky left the meeting.)

MR. MATTSON: You have that in the rule. It speaks of that.

COMMISSIONER AHEARNE: But as fa as the calculations that are required to handle the distribution of the hydrogen, the burning or the combustion of the hydrogen, the effects upon the containment, all those have to fit within some --

MR. MATTSON: Yes. I don't mean to diminish the technical complexity of the question.

COMMISSIONER AHEARNE: Right. And he is the individual who is in charge of coordinating all of that?

MR. MATTSON: Ye.. The work is done in various quarters, just like every USI.

COMMISSIONER AHEARNE: Yes. Since we do have, in looking through this, there is a large amount of work being done, my concern was where was it being coordinated. I think you have answered that, is that correct?

MR. MATTSON: Yes.

MR. BUTLER: The next topic would be the hydrogen research efforts as sponsored by the NRC and the industry, as well as foreign entities.

On viewgraph 12, for hydrogen research, the NRC budget is about $1.5 million per year spread over some four years. Most of these programs are being conducted at Sandia. They cover the areas of hydrogen generation, detection, transport, mitigation and control.

MR. MATTSON: Let me suggest that towarcs the end of this, we are going to get to some conclusion we would like to discuss, I think this is first time you have heard them, they are fairly significant, back on slide 20.

There are a couple of slides here on the specific elements of the research in hydrogen program. John Larkin is here to discuss them if you have questions. We could probably save some time if we bounced over them.

COMMISSIONER AHEARNE: I would rather see the charts.

MR. MATTSON: Okay.

COMMISSIONER AHEARNE: You are here this afternoon because I asked to have the Commission set up the meeting --

MR. MATTSON: That is why I asked the question.

COMMISSIONER AHEARNE: -- to let us know about what was the status, and I would like to get the status.

MR. MATTSON: We will go ahead with 13.

MR. BUTLER: All right.

On page 13, we start off with the first three of some five research areas. The programs here include those to provide a better data base on corrosion as a hydrogen source, and the effects of corrosion products on the water recirculation system.

On burn survival, these programs include tests and analyses of the response of selected essential equipment to the hydrogen burn environment.

For computer code assessment, we are looking at the RALOC, CCBRA, and HMS codes as to how useful they might be for analyzing the hydrogen transport question.

On page 14, we cover the next two programs dealing with the hydrogen combustion, mitigative and preventive schemes, such as the ignitors, the inerting, the flaring, et cetera.

COMMISSIONER AHEARNE: You did have, as I recall, programs -- That is, NRC had programs in which you were running tests in various geometries. For example, Coleman at MacGill University was doing some flame spreading tests. It that included in your combustion?

MR. BUTLER: Yes, that is under A1246, the hydrogen behavior program. Dr. John Lee is doing some contract work through Sandia.

COMMISSIONER AHEARNE: You also had a program that had to do with various effects upon containment, and containment strengths. I thought there were actually some -- There one model containment that was going to be tested.

MR. MATTSON: Yes. That is the work that Guy Arlotto manages in Research, where they are starting with the steel containments and moving on over a couple of years to the concrete containments.

COMMISSIONER AHEARNE: But that is being looked at as something separate from this?

MR. MATTSON: That is more a containment strength question, and they will put forcing functions in there representative of the various accident sequences, including, I presume, some with hydrogen burn.

John, can you help you with that?

MR. LARKIN: Yes, that is true. They are developing both experimental and analytical models to better understand the failure modes of the various types of containments, and they will look at different loadings, including the loadings from hydrogen burns.

COMMISSIONER AHEARNE: Is that program integrated with this to the extent that this program, the hydrogen behavior portion of it, is going to be addressed, as I understood it.

MR. LARKIN: The hydrogen behavior program is feeding input in terms of loads on containments into that program.

COMMISSIONER AHEARNE: And they are phased such that that can be done?

MR. LARKIN: Yes. Most of this work will be completed earlier, prior to the final comment period.

MR. BUTLER: Now on to page 15, the matter of hydrogen issues for coremelt accidents. We thought we would just touch on this briefly to indicate that the hydrogen control problem is much more difficult for a melted core situation than for a degraded core situation.

CHAIRMAN PALLADINO: This is because you are going from 75 to 100, or some other complication?

MR. BUTLER: Other complications, really. There is much more hydrogen than the metal water reaction. There is the hydrogen that comes from the basemat, the concrete reaction.

CHAIRMAN PALLADINO: You are postulating that. Okay, here you are postulating all the way to melt through.

MR. BUTLER: Yes.

MR. MATTSON: From some typical large dry

PWRs, I asked somebody to put together a couple of numbers to give you a feel, if you are interested in that. The in-vessel hydrogen can move from like 1500 pounds to 1000 pounds, and going from --

COMMISSIONER AHEARNE: That is hydrogen?

MR. MATTSON: Yes, 1500 pounds of hydrogen. -- and going from 75 percent metal water reaction to a melted core. That is the in-vessel hydrogen. This is a large dry PWR. The ex-vessel hydrogen and carbon monoxide can go from zero pounds, in the case of the 75 percent metal water reaction and no coremelt, to 1000 pounds in the case of a core that melts through and interacts with the basemat.

So you are talking about 3000 pounds total as compared to the 1500 pounds that are there with 75 percent metal water reaction. That is why you have some people who say that a coremelt is not 100 percent metal water reaction. It is a 200 percent equivalent metal water reaction. There are more combustion products to deal with in the coremelt down analysis of the type that are done for Zion, Indian Point, or what-have-you, and what you contend with in a degraded core situation.

MR. BUTLER: Going on now to page 16, to cover --

COMMISSIONER AHEARNE: Let me just --

MR. BUTLER: Yes.

COMMISSIONER AHEARNE: When you say, potential larger pressures just before just prior to the hydrogen burn, do you mean then larger pressure than will result from the hydrogen burn?

MR. MATTSON: No. What this means is that when you are dealing with the 75 percent metal water reaction, you have a core that has its geometry, essentially the original geometry, and the amount of energy has just been the stored energy and the shutdown energy that has been generated since the accident.

In the case of a melted core that has led to these additional amounts, it could also lead to pressures having risen above the design basis for the containment. It could be one-and-a-half times design, instead of right at design. Then when the hydrogen burns, it is on top of that already high pressure. That is what we meant there.

MR. BUTLER: On page 16, we describe the research activities of the industry, starting with the Ice Condensor Owners Group work for TVA, AEP, and Duke, the Hydrogen Control Owners Group, the BWR Mark III Group, and EPRI.

COMMISSIONER AHEARNE: But, as I think we discussed earlier, the only thing that you are actually reviewing is the plant specific proposals?

MR. MATTSON: That is right. He is going to tell you of the research that is going on, having already described where we stand in the review of the plant specific.

COMMISSIONER AHEARNE: I sort of draw a distinction between -- I imagine you are familiar with what they are doing, but as far as an independent review of whether you agree with the results, am I correct that the only thing that you are looking at from the sense of whether or not you agree with it, is any plant specific result?

MR. MATTSON: The use of the results on a plant specific basis is what we have reviewed.

MR. BUTLER: Yes.

MR. MATTSON: Right.

MR. BUTLER: Essentially, all of the ICCG sponsored research is now complete, and the staff's assessment of the results is in progress and should be complete by late December for Sequoyah Unit 1. The staff evaluations for the other ice condensor plants will follow soon thereafter.

MR. MATTSON: This has been a very good program in my judgment. You will remember at the time of Sequoyah and McGuire, you could go to a meeting of experts on hydrogen control by ignitors, and there was uncertainty here and uncertainty there, and a lot of questions. Now there seems to be a much convergence of the experts and their confidence.

CHAIRMAN PALLADINO: What does ICOG mean?

MR. BUTLER: Ice Condensor Owners Group.

On page 17, we describe the --

CHAIRMAN PALLADINO: What is the H2 mixing test. What is the mixing?

MR. BUTLER: The hydrogen mixing tests were those that were conducted at the Hanford Engineering Development Lab using the old containment system experiment vessel, where they bled in hydrogen at a local spot, and measured the rate at which the hydrogen mixed throughout the vessel.

CHAIRMAN PALLADINO: Let me ask you a question again. Is Mark III not inerted in the drywell?

MR. BUTLER: That is correct.

MR. MATTSON: We have a picture.

CHAIRMAN PALLADINO: I know the Mark III, the others I may have been --

MR. MATTSON: We want to show you exactly what we are talking about.

CHAIRMAN PALLADINO: But just to clear up, they are not inerted?

MR. BUTLER: They are not inerted.

MR. MATTSON: That is right. Everything inside that containment is inerted.

MR. TINKLER: That is a Mark III.

MR. MATTSON: That is a Mark III. I mean, everything inside that containment has an ignitor.

MR. TINKLER: Yes.

MR. MATTSON: To cover an area where hydrogen could accumulate.

MR. TINKLER: All regions are covered.

MR. BUTLER: Inside the drywell as well as out.

MR. MATTSON: Yes.

Does that clear up that earlier question that you had?

CHAIRMAN PALLADINO: That one I understood. It is the other ones where I think I was wrong. I think I understand now.

MR. BUTLER: On page 17, we describe the hydrogen program that is program proposed by the BWR Mark III Group. The milestone dates for this program are set --

COMMISSIONER AHEARNE: What is a Hydrogen Control Owners Group?

MR. BUTLER: That is just the acronym for the

BWR Mark III people.

MR. MATTSON: It is a different group of folks than for the ice condensor.

CHAIRMAN PALLADINO: Do the ice condensors include other than ice condensors?

MR. MATTSON: No.

MR. BUTLER: There is a separate and different program for the Mark III people because there are some significant differences in the design, and the hydrogen burn behavior.

CHAIRMAN PALLADINO: Is the HCOG only for the Mark IIIs?

MR. BUTLER: That is correct, yes.

CHAIRMAN PALLADINO: What about the Mark Is and IIs, don't they have a group?

MR. BUTLER: They have no programs because they resolved the question by inerting the atmosphere.

MR. MATTSON: These owners groups are narrowed to the question of ignitors for the Mark IIIs and the ice condensors.

CHAIRMAN PALLADINO: But I thought there was still a problem even with inerting, that there were certain window problems.

MR. MATTSON: You are right. There is an owners group for Mark Is to address the question of recombiner capability. As I said, there are narrow owners groups. They depend on the topic at hand. There is not an owners group for ignitors for Mark I. There is an owners group for recombiner capability.

MR. BUTLER: These research programs for the Mark III Group will be conducted over the next year or year-and-a-half.

COMMISSIONER AHEARNE: In your combining comments on the research program, does this carry with it any flavor that, yes, if you do these things, they will answer your questions?

MR. MATTSON: Yes. We pay attention to when we need to make licensing decisions, to give John Larkin money to substitute for staff.

COMMISSIONER AHEARNE: So it wouldn't be fair, then, to conclude from the standpoint of the utility that they have now gotten your approval of what it is they have to look at in order to meet --

MR. MATTSON: That is part of our agreeing, for example, on the interim licensing basis for Grand Gulf. We will say, "You are qualified to go to full power, but you must do the following pieces of research you have told us about, and come back in a year," much as we did with Sequoyah. It doesn't mean that we won't learn and alter it slightly, but there is an attempt to agree before the licensing as to what the research is.

COMMISSIONER AHEARNE: Right.

MR. BUTLER: On page 18, we describe the EPRI programs. Basically, EPRI has served as the focal point for much of the testing sponsored by not only the Ice Condensor Owners Group, but also the Mark III people. But in addition to that, they have programs of their own, and we would like to call you attention to the large vessel -- the 52 feet diameter vessel at Nevada Test Station that they plan to use. This vessel is a surplus item from the nuclear rocket program, and there is some $2.2 million worth of research that will be conducted using that vessel.

COMMISSIONER AHEARNE: When you say, validation of codes, which kinds of codes, hydrogen burn, or --

I guess to get to my question, what is inside the vessel? Does it have anything like the complicated geometry that is inside of some of the systems where you are worried about how does hydrogen diffuse, and the question of pockets, and so forth?

MR. BUTLER: At this time, the vessel is strictly an empty spherical vessel. It is a matter for future consideration as to whether we require compartments be placed in them.

COMMISSIONER AHEARNE: I was wondering what type of code you are going to be validating in this empty spherical vessel.

MR. BUTLER: You can collect data for not only the hydrogen mixing codes, but also for the hydrogen combustion, the pressure and temperature consequences of burns.

Let me ask if Charlie can augment that answer.

MR. TINKLER: With regard to your question about how does such a vessel validate codes which have to model many subsystems of containment.

COMMISSIONER AHEARNE: Right.

MR. TINKLER: In those instances, these tests will only serve to validate portions of those codes, where they can be used to model simpler geometries and simpler configurations. But these tests represent larger scale data, which is useful in validating codes. Because some of the models between the various containment codes are under review and there are some differences, and it is expected that this data would help.

COMMISSIONER AHEARNE: I would expect that what is important when you go to a large vessel, is the scale-size of your phenomena that you are worried about with respect to the size of the vessel. Many of the complications we were having in trying to address the calculation within any real containment is the subcompartment scale-size, and not the hydrogen free space scale-size.

So it wasn't clear to me what you would get out of this 52-foot diameter vessel that you wouldn't have gotten out of some of the smaller vessels.

MR. TINKLER: I am saying that this is an example. There have been discussions and some debate upon the relative effects of radiation heat transfer and the correlation of small-scale data.

The validation of computer codes using small-scale data and radiation heat transfer upon components of walls, especially in those cases where the elements are much different than they are inside the plant, the use of a 50-foot diameter vessel would provide considerably more information in an instance such as that.

COMMISSIONER AHEARNE: I am just skeptical about the validity of the comparison.

MR. MATTSON: It might be that we are giving a narrow licensing answer. Perhaps the Research Program would like to support the EPRI joint program.

John, is there any other thing that you would like to say about it?

MR. LARKIN: The first series of tests are open volume, but we are looking at compartmentalizing the vessel into smaller compartments.

CHAIRMAN PALLADINO: What sort of things are you going to do in this vessel?

MR. MATTSON: John, did you hear that?

CHAIRMAN PALLADINO: What sort of measurements?

MR. LARKIN: A series of several hydrogen degradation burns. We are placing safety related equipment in there, looking at the survivability of equipment, comparing with the thermal response models that we are developing.

MR. MATTSON: So it has got compartment burns, no subcompartment burns. It has got equipment survivability. The compartment thing is important because of the volume to surface ratio is not scalable, and radiation effects.

You asked the question about what instrumentation. John, can you speak to the instrumentation?

CHAIRMAN PALLADINO: What sort of measurements?

MR. LARKIN: The valves, cables, ignitors.

MR. MATTSON: But it is temperatures and pressures?

MR. LARKIN: Yes, temperatures and pressures.

MR. MATTSON: Then they pull the equipment out and see if it is still functions.

MR. LARKIN: Right.

MR. BUTLER: Then gas concentrations.

It is interesting to note that there are five foreign entities that are partners in the funcing of that EPRI program.

Going on now to page 19 for the foreign hydrogen activities, we just listed two countries here where we are aware that they have a strong interest in this area as well. We have been communicating with a number of individuals from these foreign countries in the recent past, and have learned that these are the areas of interest that they have expressed.

COMMISSIONER AHEARNE: Sweden has made a decision, haven't they, that they definitely will put in a filtered --

MR. MATTSON: Yes, they have. The French also have made such a decision. We should have, perhaps, included the French on the chart here. We didn't because, although I think they are a participant in the other EPRI study, they, like other countries who were looking at probabilistic risk assessments looking at degraded core and severe accidents, must contend with the calculation of the contribution of hydrogen.

It didn't seem to us in recent discussions that they put the emphasis on it that Germany had. We put Sweden on here because they had specifically told us that they were going to look at the effect of hydrogen burning on the filter that they were designing.

MR. BUTLER: On page 20, we provide a brief summary of the technical findings of the work during the past year-and-a-half or so. We basically believe that a well-designed hydrogen ignition system will successfully mitigate the consequences of large hydrogen releases to the containment for the more likely degraded core accident scenarios. Some further confirmatory work is warranted and is expected to be done in the next year or so.

Focusing on the principal findings, first of all, we feel that the burn pressures are below the pressure capacity for the more likely accident scenarios. We feel comfortable with this finding. We feel that it is defensible with the data we have in-hand.

CHAIRMAN PALLADINO: Those are degraded core accidents?

MR. BUTLER: Yes.

MR. MATTSON: Yes.

CHAIRMAN PALLADINO: They go as far as you intend your definition to go?

MR. MATTSON: Yes.

CHAIRMAN PALLADINO: I was wondering about the words "for the more likely accident scenarios."

MR. MATTSON: That is what I was going to talk about.

In the second interim rule -- Let me start before that. In Sequoyah, there was only one sequence used in the interim write-off, the S2D sequence, small break LOCA with failure of ECCS, the reason being that this is a slow-moving accident that moves through core degradation slowly, and there is some likelihood that an operator could take actions to interdict the accident short of coremelt, even though he had received as much as 75 percent metal water reaction.

There are other accident sequences that move so quickly that when you get to 75 percent metal water reaction, you are on your way to coremelt so rapidly, it is hard to imagine the operator interdicting. So in the second interim rule, the Commission and the staff worked together to try to find a way to tell the Mark III and the ice condensor owners how to consider other accidents. We allowed two approaches. Let me see if I can characterize them right. Walt, watch me.

MR. BUTLER: Yes.

MR. MATTSON: One was reasonable sensitivity studies about a central accident like S2D. The other was to look at a probabilistic risk assessment, to look at the dominant sequences in a probabilistic risk assessment, choose those that were slow-moving like S2D, and show that you could protect against a range of those.

Remember the discussions we had a year or a year-and-a-half ago on the ignitors was, we all understood that you couldn't prove that the ignitors would work for each and all circumstances. In the beyond design basis range, you must consider risk, which are the ones that are the most important in contributing to risk, of the thousands and thousands of permutations and combinations of event sequences, if you can conceive of ways that the ignitor system might not work.

So the idea was not to design it and build it so that it would work against every possible situation, but that it would work against those situations which are dominant, or possible, or reasonably likely degraded code accidents as Walt described in his statement. There is some judgment in that process, and it is in the second interim rule. You will get a chance to look at it again in January to see whether it still holds together. But it is not all degraded core accidents. I very carefully said that it is the ones that are the most likely, that is the dominant degraded core accidents when you look at risk.

MR. BUTLER: The second principal finding here that the temperature response of essential equipment is below the qualification temperatures.

COMMISSIONER AHEARNE: That being set by the --

MR. BUTLER: Yes.

MR. MATTSON: There was some concern that we would have to take some of that same equipment that had EQ and tell these folks that had all these massive programs, that they would have to redo some of that equipment at higher temperatures. It has turned out, when you look at local calculations, they are lower so far than the EQ temperatures.

MR. BUTLER: We find also that the probability of local detonations is very remote. We find that mixing and operation of the ignitors prevent the formation of detonable mixtures. Moreover, the ignitors have to date initiated detonations of stoichiometric mixtures. These are soft ignitors, they are not strong detonators, and it appears that you really need a strong detonator to set one of these things off.

COMMISSIONER AHEARNE: By a strong detonator, do you mean something that distribute large amounts of initial energy?

MR. BUTLER: Yes, a local, instantaneous, but large volume of energy.

Some items warrant some further --

CHAIRMAN PALLADINO: You mean another explosion?

MR. BUTLER: Yes.

CHAIRMAN PALLADINO: You can't block an explosion and bring about another bigger explosion?

MR. MATTSON: The point he is trying to make is that even if you take stoichiometric mixtures, and you use the ignitors that are being used in these plants, you can't make detonations occur.

You get burning, but you don't get detonations. In order to get detonations, you have to have a different kind of spark. You have to distribute the energy differently from what these ignitors provide.

CHAIRMAN PALLADINO: But hydrogen does explode in certain circumstances.

MR. MATTSON: Yes, it can.

CHAIRMAN PALLADINO: What did you do here, again?

MR. MATTSON: These ignitors are soft ignitors. They are not hard detonation causers. Even in these stoichiometric mixtures, we have been unable to cause detonations with these ignitors. We have purposely tried to and couldn't.

COMMISSIONER AHEARNE: Are you saying that no matter what mixture you ran through, the ignitor could not cause the hydrogen to detonate?

MR. BUTLER: Let's get some help from Charles Tinkler who is more familiar with the literature on that.

(Commissioner Gilinsky rejoined the meeting.)

MR. TINKLER: I would not say that you couldn't. One must consider the geometry of the clad, and the obstacles over which it goes, and so forth. But in the test situations in which we have used dry stoichiometric hydrogen-air mixture with thermal ignitors, and other types of ignitors, with something short of a blasting cap, we were unable to produce detonation.

COMMISSIONER AHEARNE: Just to make sure that I understand. You are saying, in the dry mixture, not with steam, in the dry mixture, the ignitor was unable to produce a detonation, independent of the mixture range that you ran through?

MR. TINKLER: Correct, in a dry hydrogen-air mixture.

COMMISSIONER AHEARNE: Right.

MR. TINKLER: Under stoichiometric conditions.

COMMISSIONER AHEARNE: No, I am just saying any mixture.

MR. TINKLER: Well, presumably, stoichiometric conditions --

COMMISSIONER AHEARNE: It should be, I understand that.

MR. TINKLER: I believe they were run at concentrations anywhere from 20 percent hydrogen, 29 to 30 percent hydrogen, and I think some richer mixtures of up to 40 or so.

COMMISSIONER AHEARNE: What about with steam present?

MR. TINKLER: Mixtures have been run with steam. A test has been conducted with steam, and the results using other types of ignitors demonstrated that the effects of minute amounts of steam make it more difficult to initiate a detonation.

CHAIRMAN PALLADINO: Are these tests consistent with experience? By that I mean, have there not been hydrogen explosions where they had similar kinds of initiations? I am not sure we know all the reasons for hydrogen.

MR. TINKLER: I understand what you are saying.

Clearly, hydrogen explosions have occurred.

CHAIRMAN PALLADINO: Yes.

MR. TINKLER: Sometimes it is difficult to differentiate in industrial accidents whether it was just a rapid burn which would do a great deal of damage, but it could occur over a second, or two seconds. Sometimes it is difficult to differentiate the damage between that which occurred over milliseconds.

CHAIRMAN PALLADINO: Have you looked at experience to see if the tests are consistent with whatever experience we have?

MR. MATTSON: Yes. There was quite a lot of talk when we started this program that we didn't need to do any research and study, there was a sufficient body of knowledge.

I think it is fair to say that the work that has been done in hydrogen burning in this industry in the last couple of years stretches that body of knowledge significantly.

CHAIRMAN PALLADINO: It will be helpful when we have a hydrogen occurrence.

MR. MATTSON: Walt has one last slide to show you, what a chart really looks like when one of these codes has been verified when all this data is run.

MR. BUTLER: Going on to the last viewgraph, if you will focus on the viewgraph that we are actually showing, since we sent that one downtown a few days ago, we found that the points really had to be lifted a little bit because the computer plotter did not follow the actual results.

We also took the opportunity here to show you the base-case rather than the sensitivity case that we sent downtown, the 12-foot per second flame speed case. The base-case is the S2D accident, where the calculation assumes a flame speed of six feet per second. We show up on the board there the design pressure for Sequoyah to be 12 pounds gauge, 27 absolute.

The pressure capacity that we have found acceptable is 36 pounds gauge, 51 absolute, and the peak burn pressure here for the base-case is 19 pounds gauge.

MR. MATTSON: Then you see the little on again/off again blips as the concentrations are burned down below the ignition point. They accumulate, and burn again.

COMMISSIONER GILINSKY: The ignitors are on throughout this entire period.

MR. MATTSON: Yes.

COMMISSIONER GILINSKY: Nature is just doing this?

MR. MATTSON: It is the burning of the concentration, diminishing it below the ignition point. The accumulation of more hydrogen, igniting again when it reaches a certain point where the ignitor can turn it on, burning briefly, and then slowly diminishing over time as the hydrogen from a 75 percent metal water reaction following a S2D sequence slowly tails off.

COMMISSIONER GILINSKY: Did you say something about the training of operators in connection with this burn?

MR. MATTSON: We didn't.

COMMISSIONER GILINSKY: Is there anything more to it than having them turn the ignitors on at some point?

MR. MATTSON: Heretofore there hasn't been. It might be useful to think, as we move along toward the final write-off on a final system, to ask the question of whether it has been factored into the training process, to be more than "turn them on/leave on/walk away from them." But if they are on, and if you get in the situation, "Here is now is the best estimate of what we think is going on."

COMMISSIONER AHEARNE: In your review for Sequoyah, in this final review, aren't you addressing what specific guidance they have got to operators?

MR. MATTSON: I believe we do. I am sure we do.

MR. BUTLER: Yes.

COMMISSIONER AHEARNE: That will include what situations they would use them.

MR. MATTSON: Yes.

COMMISSIONER AHEARNE: Okay.

MR. MATTSON: Where they go, in what situations they turn them on, and when they leave them on, and that kind of thing.

CHAIRMAN PALLADINO: Are there any other questions?

We thank you very much. That was very interesting and very enlightening.

COMMISSIONER AHEARNE: I specifically thank you. This is what I had hoped to get, Walt, and I thank you very much.

MR. BUTLER: You are welcome.

CHAIRMAN PALLADINO: We will adjourn this meeting and take a ten-minute break before resuming with the next meeting.

(Whereupon, at 3:35 p.m., the meeting adjourned.)

NUCLEAR REGULATORY COMMISSION

This is to certify that the attached proceedings before the

COMMISSION MEETING

in the matter of: Public Meeting - Briefing on Hydrogen Control Program

Date of Proceeding: November 19, 1982

Docket Number:

Place of Proceeding: Washington, D. C.

were held as herein appears, and that this is the original transcript thereof for the file of the Commission.

Patricia A. Minson

Official Reporter (Typed)

Patricia A. Minson

Official Reporter (Signature)

STATUS BRIEFING ON H_2 CONTROL FOR SEVERE ACCIDENTS

I. INTRODUCTION

II. CASEWORK EXPERIENCE

  A. NTOL & OR CASES

  B. NTCP CASES

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  A. INTERIM RULES

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V. RESEARCH

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  B. INDUSTRY

VI. SUMMARY OF TECHNICAL FINDINGS

November 19, 1982

CASEWORK EXPERIENCE

(NTOL'S AND OR'S)

- FIRST INTERIM RULE REQUIREMENTS ISSUED AS FINAL RULE (46 FR 58484) DECEMBER 2, 1981
    - INERTING
    - RECOMBINER CAPABILITY
    - HIGH POINT VENTS

MARK II

- LASALLE AND SUSQUEHANNA (OL'S HAVE BEEN ISSUED)

MARK I

- FERMI (NOT YET LICENSED)
- ALL NEW PLANTS ARE IN COMPLIANCE WITH THE FIRST INTERIM RULE
- PREVIOUSLY NON-INERTED BWR'S WERE VERMONT YANKEE AND HATCH 2 - BOTH ARE NOW INERTED

CASEWORK EXPERIENCE

(NTOL'S AND OR'S) - (CONTINUED)

ICE CONDENSER PWR'S

- ICE CONDENSER OWNERS INSTALLED DELIBERATE IGNITION (IGNITER) SYSTEMS
- STAFF APPROVAL ON INTERIM BASIS WITH LICENSE CONDITIONS TO REQUIRE CONTINUED RESEARCH ON H_2 CONTROL
- ICE CONDENSER OWNERS GROUP HAS COMPLETED RESEARCH ON H_2 CONTROL MEASURES AND CONCLUDED THAT A DELIBERATE IGNITION SYSTEM ADEQUATELY MITIGATES CONSEQUENCES OF H_2 RELEASED FROM DEGRADED CORE ACCIDENTS
    - TVA HAS PROPOSED PERMANENT SYSTEM WITH DIFFERENT IGNITER (TAYCO)
    - DUKE, AEP, RETAINING ORIGINAL SYSTEM WITH GLOW PLUGS
- STAFF FINAL EVALUATION OF SEQUOYAH PHMS EXPECTED: DECEMBER 1982

CASEWORK EXPERIENCE

(NTOL'S AND CR'S) - (CONTINUED)

MARK III BWR'S

- MP&L PROPOSED IGNITER SYSTEM FOR GRAND GULF: APRIL 1981
  - SYSTEM SIMILAR TO THOSE INSTALLED IN ICE CONDENSER
- OTHER MARK III PLANTS, E.G., PERRY, CLINTON HAVE PROPOSED SIMILAR SYSTEMS
- STAFF APPROVED GRAND GULF IGNITER SYSTEM JULY 1982 ON AN INTERIM BASIS AND IMPOSED LICENSE CONDITIONS TO INSURE CONTINUED INVESTIGATION OF H_2 CONTROL ISSUES
  - FUTURE RESEARCH THRU HCOG

CASEWORK EXPERIENCE

(NTOL'S AND OR'S) - (CONTINUED)

DRY CONTAINMENTS

- LICENSING HAS CONTINUED FOR DRY CONTAINMENTS WITHOUT REQUIRING ANY ADDITIONAL H_2 CONTROL SYSTEMS OR ANALYSES FOR DEGRADED CORE ACCIDENTS, PENDING CONCLUSION OF RULEMAKING
- SOME APPLICANTS HAVE PERFORMED CALCULATIONS TO DEMONSTRATE ACCEPTABLE CONSEQUENCES WITHOUT ADDITIONAL MEASURES, E.G.,
    - COMANCHE PEAK
    - SAN ONOFRE

CASEWORK EXPERIENCE
NTCP & ML APPLICATIONS

- IN LICENSING NTCP & ML CASES, STAFF HAS FOLLOWED REQUIREMENTS OF THE APPLICABLE RULE (47 FR 2286) ISSUED JANUARY 15, 1982
    - FNP HAS FOLLOWED APPROACH USED BY OTHER ICE CONDENSER OWNERS AND SELECTED AN IGNITER SYSTEM
    - SKAGIT (MARK III) HAS CHOSEN AN IGNITER SYSTEM
    - CP REVIEWS WERE COMPLETED BASED ON PRELIMINARY ANALYSES AND COMMITMENTS TO FILE RESULTS OF DETAILED ANALYSES WITHIN 2 YEARS OF CP-ISSUANCE DATE

FIRST INTERIM RULE
(46 FR 58484)

- INERTING OF MARK I & II
  - ALL EXISTING PLANTS ARE INERTED
  - ALL NEW PLANTS WILL BE INERTED
- RECOMBINER CAPABILITY
  - PWRs: IMPLEMENTATION IN PROGRESS
  - BWRs: IMPLEMENTATION ON HOLD
- HIGH POINT VENTS
  - DESIGN REVIEWS

    NEARING COMPLETION
  - PROCEDURES REVIEWS

    KEYED TO EMERGENCY PROCEDURES REVIEWS

STATUS OF RECOMBINER CAPABILITY - FIRST INTERIM RULE

- PURPOSE: AVOID PURGING FOR H_2 CONTROL
- BWR OWNERS GROUP REQUESTED RELIEF
- PETITIONS TO COURTS HAVE BEEN FILED AND ARE ON HOLD PENDING STAFF REVIEWS
- SUBSTANTIVE NEW INFORMATION FOR BWRs
  - RADIOLYSIS RATES ARE SUBSTANTIALLY LOWER THAN EXPECTED
  - COSTS FOR RECOMBINER CAPABILITY ARE HIGHER THAN EXPECTED
  - COST-BENEFIT BALANCE ALTERED
- TENTATIVE TECHNICAL CONCLUSION
  - NEED FOR RECOMBINER CAPABILITY AT INERTED MARK I BWRs SHOULD BE RECONSIDERED
  - COMMISSION PAPER FORTHCOMING SHORTLY WITH RECOMMENDATIONS

SECOND INTERIM RULE
(46 FR 62281)

OBJECTIVE: DEGRADED CORE H_2 CONTROL FOR OR & OL PLANTS WHICH HAVE ICE CONDENSER, MARK III, AND OTHER NON-INERTED (DRY) CONTAINMENTS

- ISSUED AS PROPOSED RULE DECEMBER 23, 1981; COMMENT PERIOD EXPIRED APRIL 8, 1982
- GENERAL ELEMENTS OF RULE
  - DEGRADED CORE ACCIDENTS WITH H_2 FROM A 75% FUEL CLADDING REACTION
  - PROVISIONS FOR CONTAINMENT INTEGRITY
  - EQUIPMENT SURVIVABILITY

STATUS OF
SECOND INTERIM RULE

- DETAILED REVIEW OF COMMENTS ON THE RULE HAS BEEN COMPLETED
- COMMISSION PAPER TRANSMITTING A FINAL RULE IS IN PREPARATION
  - MAY PROPOSE DEFERRAL OF REQUIREMENTS ON DRY CONTAINMENTS UNTIL SEVERE ACCIDENT DECISION
  - DRY CONTAINMENTS HAVE HIGHER PRESSURE CAPABILITY
  - EQUIPMENT TEMPERATURE ANALYSES FOR ICE CONDENSER AND MARK III PLANTS DEMONSTRATE ESSENTIAL EQUIPMENT SURVIVES
  - DETAILED SURVEY OF EQUIPMENT IN TMI-2 INDICATES ESSENTIAL EQUIPMENT FUNCTIONED AS NEEDED AND WAS NOT IMPAIRED BY H_2 BURN ENVIRONMENT

USI TAP A-48

HYDROGEN CONTROL MEASURES AND EFFECTS OF HYDROGEN BURN ON SAFETY EQUIPMENT

- OBJECTIVE: PROVIDE VEHICLE FOR COORDINATION OF NRC RULEMAKING AND TECHNICAL REVIEW EFFORTS ON ISSUES RELATED TO DEGRADED CORE HYDROGEN CONTROL

- SCOPE: H_2 CONTROL AND EQUIPMENT SURVIVABILITY FOR SMALL AND INTERMEDIATE SIZED CONTAINMENTS
  1) MARK I AND II BWR
  2) MARK III BWR
  3) ICE CONDENSER PWR

  DRY CONTAINMENTS DEFERRED TO SEVERE ACCIDENT DECISION AND EXCLUDED FROM USI

- TASKS
  - 2ND INTERIM RULE
  - ICE CONDENSER AND MARK III LEAD PLANT IMPLEMENTATION REVIEWS
  - GENERIC DOCUMENTATION FOR ICE CONDENSER AND MARK III PLANTS

HYDROGEN RESEARCH

(NRC - RES)

- OBJECTIVE: PROVIDE INFORMATION TO ASSESS THE RISK REDUCTION BENEFITS OF VARIOUS H_2 CONTROL SYSTEMS FOR THE MITIGATION OF SEVERE ACCIDENTS: PROVIDE INFORMATION FOR NEAR TERM LICENSING DECISIONS AND TO SUPPORT RULEMAKING ACTIVITIES

- RESEARCH PROGRAMS ADDRESS THE FOLLOWING H_2 RELATED AREAS
  - GENERATION
  - DETECTION
  - TRANSPORT & MIXING
  - MITIGATION AND CONTROL

NRC RESEARCH - CONTINUED

- COMBUSTIBLE GAS IN CONTAINMENT (A1255)
  - H_2 GENERATION FROM CORROSION (DBA CONCERNS)
  - EVALUATION OF EFFECTS OF CORROSION PRODUCTS ON SUMP AND WATER RECIRCULATION SYSTEMS

- H_2 BURN SURVIVAL (A1270)
  - TESTING OF SAFETY RELATED EQUIPMENT IN HIGH HEAT FLUX ENVIRONMENTS, SIMULATION AND H_2 BURNING
  - LOADS FROM DETONATIONS OR ACCELERATED FLAMES
  - PROGRAM COMPLEMENTS THE NRR ANALYTICAL PROGRAM

- CODE ASSESSMENT AND APPLICATIONS
  - EVALUATE CODES WHICH MAY BE USED TO ANALYZE H_2 TRANSPORT (RALOC, COBRA, HMS)
  - RECENT NRR/RES MTG TO DETERMINE FUTURE COURSE OF WORK ON H_2 TRANSPORT CODES

NRC RESEARCH - CONTINUED

- H_2 COMBUSTION MITIGATIVE AND PREVENTIVE SCHEMES (A13386)
  - EVALUATION OF EFFECTIVENESS AND FEASIBILITY OF VARIOUS METHODS OF H_2 CONTROL
  - DELIBERATE IGNITION, INERTING, O_2 DEPLETION, WATER FOGS AND FOAMS, FLARING, CATALYSTS
- H_2 BEHAVIOR PROGRAM (A1246)
  - PRINCIPALLY ADDRESSES H_2 COMBUSTION BEHAVIOR - ANALYSIS AND TESTING
  - DEFLAGRATIONS AND DETONATIONS
- ALL MAJOR ELEMENTS OF RESEARCH SHOULD BE COMPLETED BY FY '85
  - SOME INDIVIDUAL PROGRAMS WILL BE COMPLETED EARLIER
  - DEGRADED CORE ACCIDENT RESEARCH THRU MID - '84 MELTED CORES THRU 85

HYDROGEN ISSUES FOR CORE MELT ACCIDENTS

HYDROGEN CONTROL MORE DIFFICULT

- POTENTIALLY MORE HYDROGEN PRODUCED
  - IN-VESSEL
  - EX-VESSEL HYDROGEN AND CARBON MONOXIDE
- POTENTIALLY LARGER RELEASE RATES OF HYDROGEN INTO THE CONTAINMENT
- POTENTIALLY LARGER PRESSURES IN CONTAINMENT BUILDING JUST PRIOR TO HYDROGEN BURNS
- POTENTIALLY MORE SEVERE ENVIRONMENTAL CONDITIONS (TEMP, PRESSURE, AEROSOLS)

H_2 RESEARCH
ICE CONDENSER OWNERS GROUP (ICOG)

- IN SUPPORT OF THE IGNITER SYSTEMS OF TVA, DUKE, AEP
  - IGNITER QUALIFICATION TESTING
  - COMBUSTION TESTING
  - COMPLETED EVALUATION OF ALTERNATIVE SYSTEMS AND IGNITER RESEARCH CONCLUDED IGNITER SYSTEMS ADEQUATE
- ANALYSIS WITH CLASIX CODE
- ELEMENTS OF ICOG RESEARCH
  - IGNITER DEVELOPMENT TESTING
  - COMBUSTION TESTS
    - LEAN AND RICH MIXTURES
    - FAN AND OBSTACLE TURBULENCE
    - COMPARTMENTALIZED GEOMETRY
    - WATER SPRAY/FOG
- H_2 MIXING TESTS

H_2 RESEARCH

BWR MARK III H.C.O.G.

- HYDROGEN CONTROL OWNERS GROUP FORMED TO RESOLVE H_2 CONTROL ISSUES PERTINENT TO MARK III'S

- HCOG RESEARCH FOCUSED ON DELIBERATE IGNITION ISSUES
  - COMBUSTION IN H_2 RICH ENVIRONMENTS (DRYWELL)
  - COMBUSTION ABOVE A SUPPRESSION POOL
    - 1/20 AND 1/4 SCALE COMBUSTION TESTS

- HCOG RESEARCH SLATED FOR COMPLETION DECEMBER 1983

- STAFF HAS REVIEWED PRELIMINARY RESEARCH PROGRAM AND PROVIDED COMMENTS TO HCOG

EPRI H_2 RESEARCH

- COSPONSORED SOME OF THE ICOG RESEARCH
- SPONSORED EQUIPMENT SURVIVABILITY TESTING
  - ALL ITEMS OF EQUIPMENT (SOLENOID VALVE, RTD, CABLE, VALVE OPERATOR, ETC.) OPERATED SUCCESSFULLY DURING AND AFTER H_2 BURNS
- COSPONSORING LARGE SCALE TESTS ALONG WITH NRC & SEVERAL FOREIGN UTILITY ORGANIZATIONS
  - 52 FEET DIA VESSEL WITH 87 PSIG DESIGN
  - SHAKEDOWN TESTING IN LATE 1982
  - EXPECTED USES
    - VERIFICATION OF SMALL SCALE DATA
    - VALIDATION OF CODES
    - EQUIPMENT SURVIVABILITY
    - TESTING OF METHODS OF H_2 CONTROL DURING SIMULATED METHODS

FOREIGN HYDROGEN ACTIVITIES

GERMANY:

- IDENTIFIED AREAS OF FURTHER STUDY
  - ULTIMATE STRENGTH CAPABILITY OF CONTAINMENTS
  - HYDROGEN COMBUSTION/MIXING STUDIES
  - ADVANTAGES/DISADVANTAGES OF HYDROGEN PREVENTION AND MITIGATION SCHEMES
  - RELIABLE HYDROGEN MONITORING SYSTEMS
  - RELIABLE PREDICTIVE METHODS FOR ASSESSING HYDROGEN COMBUSTION/MITIGATION SCHEMES

SWEDEN:

- STUDYING ALTERNATIVE FILTER DESIGNS FOR FILTERED - VENT SCHEMES, HYDROGEN BURNING EFFECTS INCLUDED

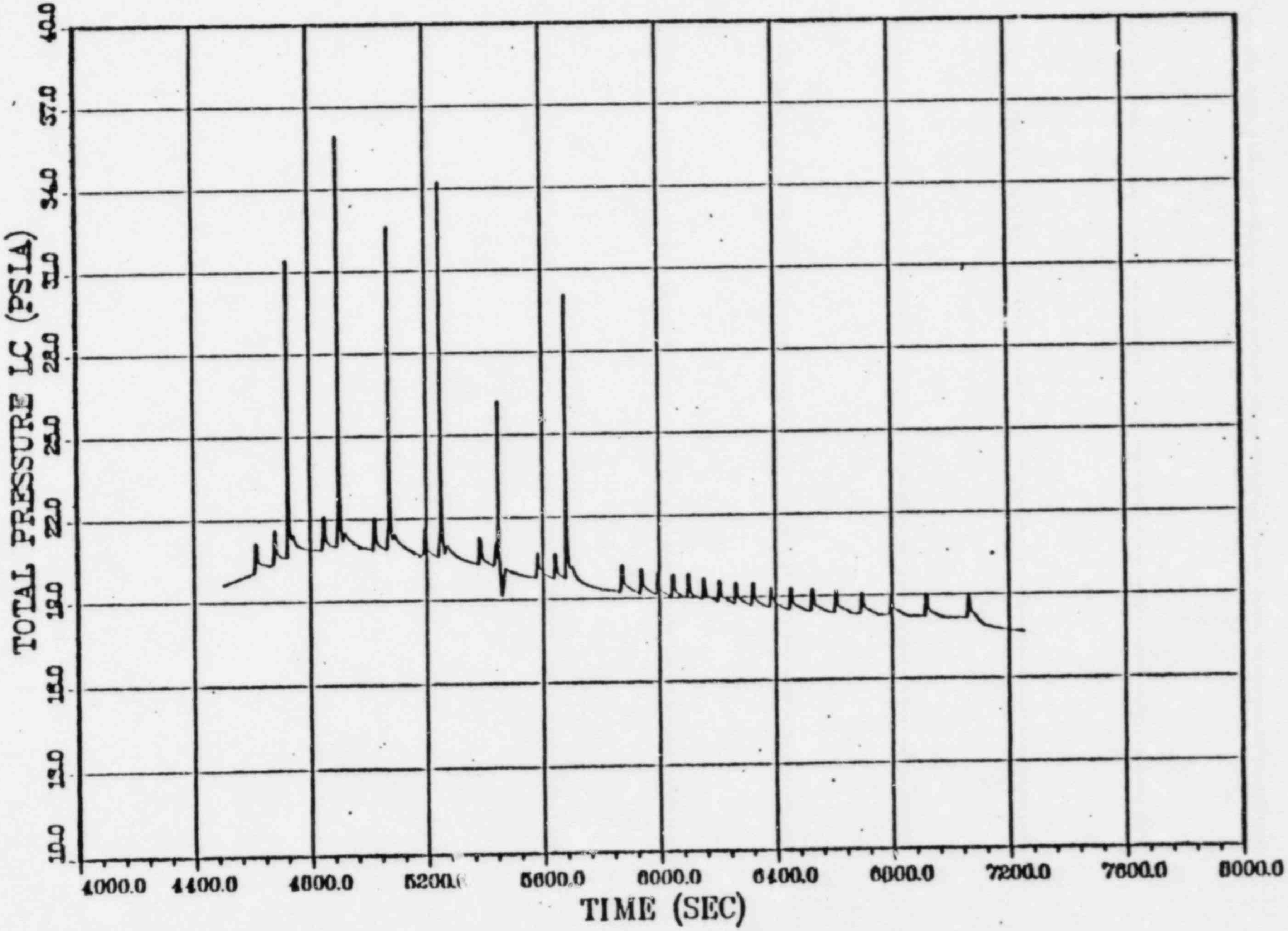
SUMMARY OF TECHNICAL FINDINGS

- DELIBERATE IGNITION ADEQUATE FOR DEGRADED CORE ACCIDENT H_2 CONTROL IN ICE CONDENSERS AND MARK III'S
  - BURN PRESSURES ARE BELOW PRESSURE CAPACITY FOR THE MORE LIKELY ACCIDENT SCENARIOS
  - EQUIPMENT TEMPERATURE RESPONSE BELOW QUALIFICATION TEMPERATURE
  - PROBABILITY OF DETONATIONS VERY REMOTE
    - MIXING AND OPERATION OF IGNITERS PREVENT FORMATION OF DETONABLE MIXTURES
    - IGNITERS HAVE NOT INITIATED DETONATIONS OF STOICHIOMETRIC MIXTURES

- SOME ITEMS WARRANT FURTHER CONFIRMATORY WORK
  - SCALE EFFECTS
  - ANALYSIS VALIDATION

LOWER COMPA' 'ENT PRESSURE

RESPONSE - - 12 FT/SEC FLAME



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Meeting Title: Briefing on Hydrogen Control Program

MEETING DATE: 11/19/82 Open X Closed ___

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