NUCLEAR REGULATORY COMMISSION

ADVISORY COMMITTEE ON REACTOR SAFEGUARDS

IN THE MATTER OF:

SPECIAL MEETING

Place - Washington, D. C.

Date - Monday, 16 April 1979 **Pages** 1-334

Telephone:
(202) 347-3700

ACE - FEDERAL REPORTERS, INC.

Official Reporters

444 North Capitol Street
Washington, D.C. 20001

NATIONWIDE COVERAGE - DAILY

67-007

7904230171

PUBLIC NOTICE BY THE

UNITED STATES NUCLEAR REGULATORY COMMISSION'S

ADVISORY COMMITTEE ON REACTOR SAFEGUARDS

April 16, 1979

The contents of this stenographic transcript of the proceedings of the United States Nuclear Regulatory Commission's Advisory Committee on Reactor Safeguards (ACRS), as reported herein, is an uncorrected record of the discussions recorded at the meeting held on the above date.

No membe' of the ACRS Staff and no participant at this meeting accepts any responsibility for errors or inaccuracies of statement or data contained in this transcript.

67-008

CR 4051
om/wbl

UNITED STATES OF AMERICA

NUCLEAR REGULATORY COMMISSION

Advisory Committee on Reactor Safeguards

Special Meeting

Room 1046, 1717 H Street, N.W.,
Washington, D.C.

Monday, 16 April 1979

The Special Meeting was called to order at 8:30 a.m., Dr. Max W. Carbon presiding.

PRESENT:

Dr. Max W. Carbon, Chairman
Dr. Milton S. Plesset
Mr. Harold Etherington
Prof. William Kerr
Dr. Stephen Lawroski
Mr. William M. Mathis
Dr. David Okrent
Mr. Jeremiah J. Ray,
Dr. Paul G. Shewmon
Dr. Chester P. Siess

Also Present:

Raymond F. Fraley, Designated Federal Employee
James F. Jacobs

wb

C O N T E N T S

67-010

ebl

P R O C E E D I N G S

DR. CARBON: The meeting will now come to order.

This is a special meeting of the Advisory Committee on Reactor Safeguards to further consider the events surrounding the reactor accident at Three Mile Island Nuclear Station. The Committee will discuss this matter with the NRC Staff of the Nuclear Regulatory Commission.

This meeting is being conducted in accordance with the provisions of the Federal Advisory Committee Act and the Government in the Sunshine Act. Mr. Raymond Fraley is the designated Federal Employee for this portion of the meeting.

A transcript of portions of this meeting will be kept and it is requested that each speaker first identify himself and speak with sufficient clarity and volume so that he can be readily heard.

I now call on the Nuclear Regulatory Staff for our initial session, and call on Mr. Roger Mattson.

DR. OKRENT: Could I ask one question? Do you have any public participation? Have we any requests?

DR. CARBON: None.

DR. OKRENT: The reason I asked is Sunday in the Los Angeles Times there was an advertisement of the Union of Concerned Scientists which spoke concerning five nuclear reactors. All of these plants have nuclear reactors and equipment designed by the firm of Babcock and Wilcox, the firm that designed the

eb2

Three Mile Island Plant. "Will they then contain the same basic design flaws and have the safety conditions that led to the near tragedy at Three Mile Island," et cetera.

Then in California there was some kind of a hearing of one of the legislative committees, and Mr. Pollard of the Union of Concerned Scientists testified, and according to the newspapers stated, for example, that "If I had been the operator, I would have shut them off," end of quote, meaning the pumps and so forth.

I thought, at least from my own point of view, I would be interested in understanding in detail what is behind these statements so that I would have a better picture, maybe a chance to ask questions, as to why these opinions were held so I could see whether there was some basis that we were not aware of, and so forth.

Is there any way that we would be able to get a technical discussion on this?

DR. CARBON: I should think we could ask them to come and meet with us.

DR. OKRENT: I believe they're located in Washington. I mean, among other things, I for one would like to understand what they judge to be the risk for the exising situation, how they quantify it, how this compares with other similar things in other similar technologies, and so forth.

So for me at least it would be useful if I had a

eb3

chance to explore this with them.

DR. CARBON: I would think, if the other members are agreeable, we'll simply ask them to come, perhaps at our May meeting if this seems reasonable.

Let's move on then, and let me call on Mr. Mattson.

MR. MATTSON: Mr. Chairman, I would like to spend a few minutes at the start to describe who is going to be speaking to what portion of the problem here today.

For one thing, because we have a number of people still at the site, some of the folks that you'll hear from today are wearing somewhat different hats than they usually wear when they're down here speaking to you, and for that reason I think it would be good to go through the various roles that are being played in a mangerial sense, and then the scope of the various presentations that you'll hear.

Steve Varga will speak to you first this morning about what we call the immediate or on-going actions connected with the bulletins to the other operating B&W plants. The scope of his work, and the people who are reporting to him at this juncture is rather narrow. And let me state that scope if I can.

It's the immediate, on-going work involved with the bulletins primarily intended to assure that the transients that occurred at Three Mile Island and subsequent accident are not repeated in that way in the near term with other operating B&W

plants.

Following right behind Steve Barga will be Bob Tedesco who will be down a little bit later this morning. Bob has a task force that he is heading with a number of Branch Chiefs and senior technical staff reporting to him. His scope is a bit broader. It covers short-term actions and long-term actions, looking at feedwater transients in the B&W plants and then somewhat broader to feedwater transients in pressurized water reactors where the short-term goal is, one, to confirm that the immediate actions taken through the bulletins are indeed sufficient for the immediate near-term and if not, to propose or recommend additional things that might be done in the near term to continue to assure public health and safety and then lay forth a plan for further actions over somewhat longer term of the nature of re-analysis of operator actions, licensing basis for transients and small loss-of-coolant accidents, and possible design changes for B&W plants or pressurized water reactors flowing from this experience.

I should caution that a lot of what you'll be hearing today and a lot of questions that you'll be asking today will fall in the area of on-going work. We may not have complete answers to all your questions. People are working hard. I think it is safe to say that the majority of the Staff are turned to this problem at this point in time. We'll do our best to answer your questions to the best of our current knowledge, but it is clear to me that we won't be able to answer all of them. But that's one of the reasons we're here, is to look for constructive suggestions as to where we go from here.

As I understand it, those two presentations are the extent of the Staff participation this morning, other than we will stay and listen to the B&W things this afternoon, and the Committee reports this morning.

Later this afternoon, starting, as my agenda reads, at about 5:30, we'll go into several other areas.

First, Vic Benaroya will give us a summary of the current status of the plant, updated through today.

Then Carl Berlinger will summarize the activities on-going at the site, and in design shops at various places, aimed at hardware modifications and contingency plans and what-have-you, for moving the reactor into, as the media calls it, the cold shutdown condition. That's a little bit different use of the word than we're used to but let me say that that has to do with the long-term cooling plans for the reactor as it exists today.

We're prepared to speak to contingency plans in general later on this afternoon and early evening at your convenience. Whether you want to talk about emergency procedures that exist in the plant today for various contingencies or contingencies on out into the future wasn't quite clear from the agenda we had, so we're generally prepared to discuss those

eb6

things with you later.

With that introduction I guess I'm ready to turn it over to Steve Barga, unless you have front-end questions this morning about the status of the plant.

I returned last night about seven o'clock and maybe I'm as fresh on that as anybody on the Staff side this morning. If there are questions on the status now, rather than wait until later this afternoon when we planned to get at it, maybe we can have those questions.

Basically it's doing what it has been doing for the last couple of weeks, and operations are stable and a lot of work is going on to get the long-term cooling equipment in place.

DR. CARBON: Let's leave that and go on to the presentation.

MR. VARGA: Good morning. My name is Steve Varga, with the Division of Project Management.

Normally, from my pleasant past relationships with this Committee when I had another job at NRC, and from my continuing respect for this Committee, I would say I'm happy to be here. But I recognize the urgency of the particular interest that you all have and, while my group is busy back there working diligently I'm here to answer whatever questions you may have after my presentation, recognizing that we're deep in the midst of this particular review, and that all of the answers

ab7

140

are not currently available nor probably yet developed.

As Roger indicated, my particular task and the group that I have reviewing the Bulletins 7905 and then that was amended by or supplemented by 7905-A. I think it's important to recognize the time frame and the intent of the bulletins that were published at that time, April 1st, and then I believe supplemented by April the 5th, based upon the information that was available then and the perception of the prudent course of action that appeared necessary in informing all the other B&W plants.

As things progressed of course additional bulletins are being prepared or have been prepared. I myself have not seen them all, but they have been prepared and probably there will be some discussion about those additional bulletins that are being issued or have been issued that pertain to other PWRs, and perhaps also to the BWRs. And I imagine that this process and evaluation, as we get further and further into the details in our own evaluation, will probably continue.

So I'm going to address particularly the response to 05-A which essentially, although clarified, really replaced 05, and as Roger characterized it, is in the time frame of immediate action or immediate response, as contrasted to short term, and then the long-term activities underway.

As you recall in the Bulletin 05-A, there were about 12 or 13 items requiring response. In a sequential time frame, Items 1, 2, 3, 4-A and 5 were required to be responded to by the Licensees by April 11th. The remaining responses are due today. We received the majority of those responses Thursday, and the last one we got Friday morning, I believe. And we are busy reviewing that and have been reviewing those responses over the weekend.

So I will confine my remarks for the moment for today to those responses that we have receieved as a result of the due date of April 11th. In one or two instances there were additional responses to some of the other items. Although we have looked at those, we wanted to get a fairly rapid cut across all the responses to those that were due on the 11th in order to get as quickly as possible a perception of those responses.

We will continue as we get the responses today and continue throughout the week in reviewing all of the responses to 05-A.

Review priority. It's fairly simple. Those that are operating are the ones we're reviewing. Those are at Rancho Seco, Oconee 1, 2, and 3, and Crystal River. Davis-Besse and ANO-1 as you know are down and we're getting some up-to-date late information on what their plans are for restart.

1.180

We anticipate that we'll be able to finish the review of these initial responses to five of the items late tomorrow.

ɔb9

If the responses come in as we hope they will and we get copies of them immediately, which I don't believe will be a problem, we hope to finish our review of all the responses by Friday.

Let me give you a perception of, or at least the structure of the review, what we're doing.

As is evident from reading the bulletin in its total context, the thrust is to be sure the Licensees understood the import of the event that happened at TMI 2, and throughout the bulletin you will see words in there about procedures and understanding the particular events, and the Licensee's awareness of the consequences of certain particular actions that have occurred.

In our review we have identified and are identifying some additional information that we believe may be required, as well as we are also identifying or highlighting some clarification that, as a result of the on-going evaluation, we have identified in subsequent bulletins. So we're factoring that into the review of this bulletin as appropriate in the responses that we are reviewing and in our evaluation.

We are also reviewing the response of the Applicant to Item 2 which was to review the transients that have occurred at this facility, particularly those transients where the performance deviated from expected performance. In one or two instances we have identified transients, or events probably may be a better word, that the Applicant, although he had notified us in other documentation, did not emphasize or did not point this out in his response. Whether this is an oversight or not, we are looking into that. But there are only one or two instances that we've identified so far.

Based upon our review to date, let me summarize generally our perception of the over-all answers to those five items.

Now let me just briefly go over those five items.

First it said-- And attached to the bulletin of course were the preliminary notifications that went on through I think to April 1st, issued by NRC, which, on a day-to-day basis, outlined the particular activities that had occurred that day, and gave a description of those events. All of those preliminary notifications accompanied the bulletin.

In the bulletin as well there was, in this item there was a delineation of certain highlighting of certain particular actions that had occurred, and bringing those -- emphasizing those in the bulletin in order that the responses also would be pointed or focused on those particular activities. That's item one.

Item two then was to review other transients or events in your facility with that item one scenario in mind, the TMI 2 event scenarios. In addition, he was to report to us whether any of these transients or events deviated from expected performance.

The third of course was the actions for operating procedures for coping with particular transients. And in this particular item there was a highlight on the voiding that had occurred in the TMI 2 incident, addressed to the prevention and recogni ion of such voids.

Item four was a four-tiered item which had to do with overriding engineered safety features.

The second part particularly emphasized the HPI activities and concerns. The third part emphasized the reactor coolant pump operational status. And the four part emphasized the reliance only on level indication in the pressurizer. And then five, item five, emphasized or described or related it to the closed valves. It requested verification of valve lineup, review of all the procedures, all the Class E equipment, valve equipment, emphasized the maintenance and training and surveillance and testing procedures that are related to maintenance -- to the operation of the plant wherein certain activities associated with the maintenance of certain valves and the interrelationships and the operational activities that are going on perhaps concurrently.

The other items along the bulletin, five through twelve, emphasized further the specific parts of various sequences with particular emphasis on containment, particular emphasis on the auxiliary feedwater trains, and items related to the over-all scenario.

67-021

12

So let me give you a perception of the review we have done to date of those five items, taking each particular response as a whole.

We believe the Applicants have understood what we were after. I believe their responses indicate an awareness and understanding and the promptness of the review that was required. In several instances the responses indicated that prior to the receipt of the bulletin they had already initiated reviews of this particular transient.

Let me take a typical response and go through in some general detail and summarize to you what our current perception is of that particular response, recognizing that this is still in the process of review and additional expertise being used to evaluate some parts of it.

In the item one, most of the responses essentially tracked the six statements or description of circumstances that accompanied the bulletin regarding item one. As you recall, those six statements of circumstances had to do with one, loss of feedwater, then the circumstances around the relief valve, then the erroneous level indication, then the discharge to the containment, then the recirc pump problem and, finally, the -- no, five was the voiding in the core, and then the tripping of the reactor coolant pumps.

So essentially the responses tracked those particular items and responded to those, recognizing in some instances

67-022

b13

that further response will be forthcoming when they answer six, seven, eight, nine, and so forth.

But, however, in our review of the responses of this one response, typical response, there was some question we had about the depth of the level that these reviews -- of the operating personnel and personnel and the management of the utility itself who had participated.

So while we do find in general a satisfactory understanding of the sequence of events and the relationship to the

1.300

facility, we are, in order to assure that all the appropriate levels have participated, we're going to require that all licensed operators and plant managers and supervisors with operational responsibilities participate in that review, and that that be indicated in the plant records.

Concerning the electromagnetic relief valve in this particular response, there was a discussion about the indication that could be given as to the status of that valve by the temperature indicator. We believe that that temperature monitor may not be a valid indication of the relief valve status, particularly after some initial operation and that other parameters such as the discharge relief tank temperature, pressure, or level, in conjunction with that temperature monitor, could assist in the status of the ERV.

Consequently, there were other instruction and procedures that we believe that could be given to the operators

b14

concerning the ERV which have been identified in these subsequent bulletins that have been provided in the last few days to the other operating PWRs, and which we have picked up and are going to require that they be addressed as well.

That has to do with identifying those plant indications such as valve discharge piping temperature, valve position indication or valve discharge relief tank temperature, pressure, or level indication which plant operators may utilize to determine that the pressurized power-operated relief valves are open.

316

And then also in our review of this particular response there was no mention of the block or isolation valve on that pressurizer, and the additional instructions or the additional directions and requirements given to the operators, direct plant operators to manually close the power-operated relief block valves when reactor coolant system pressure is reduced to below the set points for normal automatic closure of the power-operated relief valves and the valves remain stuck open.

In our review of the responses I believe only one clear indication in the response indicated that the relief -- the block valve -- the isolation valve was there and what its function could be used for, and the recognition that in this event that that could be used. However, it was not emphasized or highlighted in the other, so that's the reason for this particular one.

In the responses throughout where we have requested operating procedures there are generalized statements about the procedures, that these have been reviewed. In one or two instances the specific procedures that were reviewed have been listed and outlined.

We believe that in order to assure that there is no inadvertent omission, we believe that we need certification that all procedures have been reviewed, and then we would like a listing of those procedures, particularly those procadures that have been revised as a result of this review.

That also applies not only to operating instructions, but also to operating procedures, maintenance procedures, surveillance procedures, or operator training instructions.

In several places in the-- In fact, I think in all of the responses there was a statement about additional aids to the operator in the tracking of these events, aids provided to him in the normal course of his operations, the pressure-temperature saturation curves, for instance. Other aids are mentioned.

We would like to have a definition of those aids, a description of those aids, and where in the operating procedures they occur or are mentioned or are alluded to or defined.

The concern-- Statement four of the first concern had to do with the containment isolation of the pumping of radioactive fluids out of the containment.

PROF. KERR: Excuse me. It isn't clear to me whether

-16

you're describing something that you have as the result of the response or something that, in the main, you do not have, these things to which you refer, for example, the pressure saturation curve.

Are you saying that these are things which eventually you expect to get from Licensees but you do not yet have, or....

MR. VARGA: We do not have. The Licensees mentioned that in response to -- particularly to voiding prevention or recognition of voiding in the curve, the response indicates that these pressure-temperature curves will be provided to the operator for his input.

Of concern, beside the technical accuracy of those particular curves, which we do not have and my group has not reviewed and will probably be reviewed in the normal context of the review that the I&E inspector makes of the particular 380 procedures, but what we're concerned about is that these aids be properly identif. i and, rather than being perhaps in some computer printout that may take some time to be defined, that he has them readily available.

PROF. KERR: It strikes me that you're developing rather detailed criteria for those things that you want to have available. It seems to me that if that is the case that you would save everybody time by letting the Licensee know what it is you expect them to have available.

17

MR. VARGA: Well, certainly as the evaluation proceeds, as we get through the immediate actions and then the short-term actions, as we develop additional information and additional criteria from the work that we have on-going, we may have some specific things that we direct the operators have available.

The assumption is at the moment that pressure-temperature curves are universally accurate if they are prepared properly and that certainly is an indication of the status of the reactor system fluid, and that these be provided to the operator.

We did not direct. We just indicated the problems with the voiding in the core, and it was the response of the utilities that said this is one way in which the operator will know the status.

Now there may be others.

I mentioned the problem with one in the bulletin concerned the pumping of radioactive fluids out of the containment. In this particular review, the containment isolated both on containment high pressure for psi, as well as on the low pressure for the reactor coolant system pressure, so that either one would have isolated the containment in this particular review. That of course is not universal in the B&W facilities that we are reviewing in the five. Only one other I believe has that provision for isolation, either on containment pressure

67-027

ab18

or on safety injection or below reactor system pressure of around 1600 psi, and we're looking at those responses.

In the bulletins and in the additional instructions that we are preparing, particularly in response to that number six which addresses containment isolation, we are going to be looking carefully to see what other provisions are being made for containment isolation.

The last item on item six -- not the last item but statement four of item one --

PROF. KERR: Excuse me. Does "looking carefully" mean that you havenot yet decided what should isolate containment but that after you've had a chance to give it some thought you may develop criteria? I'm not sure what is the significance of "looking carefully."

410

MR. VARGA: In the response to the bulletins and in the bulletins themselves, particularly the ones that are -- that followed 05, there is a statement in there about isolating the pressure upon -- "review containment isolation, initiation design procedures, and prepare and implement all changes necessary to permit containment isolation, whether manual or automatic, of all lines whose isolation does not degrade needed safety features nor cooling capability upon automatic initiation of safety injection."

So that's the instruction and the requirement that we are implementing in the responses to the Applicants'

eb19

responses -- the Licensees' responses that we have to date.

So we are requiring that they review their containment isolation provisions and, upon automatic initiation, implement the changes that are necessary to effect that.

DR. SHEWMON: Isolation containment sounds like a good thing and comforting. I'm some concerned as to whether or not-- It is well-defined, agreed-upon, and unambiguous, just what should get isolated and what shouldn't get isolated so we have all the safety functions we need but don't end up doing things we shouldn't do?

MR. VARGA: Well, the thrust of the particular added clarification of requirements that we are laying on recognizes, for instance, reactor coolant pump seal, blower component, and cooling water, which in some instances requires -- is isolated upon containment isolation.

447

The instruction we are giving is to review and implement those changes, that if you will degrade the safety features or cooling capability by that particular isolation, that you not do that.

Now, the particular specific lines and the specific fluids that we're talking about we have not identified. We are asking the Applicants to identify that, although in our review, in our on-going review, that is certainly one of our very critical points we're looking at.

DR. SHEWMON: And presumably that was all spelled out

eb20

and agreed to once in the FSAR?

MR. VARGA: Yes, indeed.

DR. SHEWMON: Okay.

MR. MATTSON: If I could interrupt just to make sure that I understand the point and that we have communicated, containment isolation provisions flowed from other considerations besides the TMI accident. Now, given the TMI accident and the sequence of events, have we learned something about containment isolation initiation and what gets isolated that ought to be changed in the near term at these other operating B&W plants?

I think that's the focus of what Steve is looking at in these bulletin responses.

DR. SHEWMON: And what gets isolated is independent of what signal sets it off? Is that correct? Or what accident you think you want to protect yourself from?

MR. MATTSON: That's generally the situation today; that's right.

DR. SHEWMON: And the operator can override some of those individually if he feels it is to his best advantage, or he can't? It seems to me that's a two-edged sword either way.

MR. MATTSON: Well, he can't. He can't, of course. It requires varying degrees of action, depending on which one he's overriding, but that's part of what we're looking at:

Does he have time to override it if he needs to override it? Was it right to close all the same things, no matter what the source of the containment isolation signal, and so on?

DR. SHEWMON: Thank you.

MR. VARGA: In the last statement of item one, which had to do with the reactor coolant pump, in the review of this particular response there were words indicating that procedures will be reviewed so to preclude premature termination of the reactor coolant pump. And that is not our intent for that judgment to be made except under very specifically defined circumstances.

So we are providing a clarification, which is a point made in the subsequent bulletins that has to do with the requirement that at least one reactor coolant pump per loop shall remain operating as long as it's providing forced flow.

Finally, there was one item, an item we are requesting the Applicant to respond to which was not indicated specifically in the bulletin but it had to do with the operated modes and procedures dealing with hydrogen that may be generated during the transient, and that would remain either inside the primary system or released to the containment.

Now we're asking them to review with the same intent and the same focus and attention as the others. We're asking them to review particularly the release of -- review his procedures and modes of operation about dealing with hydrogen

22

either in the core or the containment.

DR. OKRENT: What do you have in mind for him to review in that regard?

MR. VARGA: Well, first and foremost, at least in my perception of the events that have transpired, is the location, the access, the operability of the hydrogen recombiner, it seems to me, would be a very important item to review, review it in the circumstances of highly radioactive gas being taken from the containment to the recombiner if it is outside the containment or, if it is inside the containment, what the procedures are for protection.

Another item would be the instrumentation to indicate the evolution of hydrogen within the containment, specifically redundancy, the location of the instrumentation, items of that nature.

DR. OKRENT: Do you feel that the location and availability of the recombiner is the major consideration with regard to safety questions that would arise out of the generation of hydrogen?

MR. VARGA: Let me see if I understand your question.

DR. OKRENT: When I asked you about hydrogen, the first thing you mentioned was the recombiner.

MR. VARGA: Right. That was the first thing, one of the things, yes.

DR. OKRENT: And I'm asking whether, if you have a

023

real safety question connected with the generation of hydrogen, whether you think it's the recombiner that's going to play a vital role, or whether there are other questions that will be important prior to it. In fact, if the recombiner is going to be very important, other things will have arisen earlier.

MR. VARGA: Certainly. For instance, the general question of hydrogen recombination, particularly in the primary system, is the question of the venting and whether or not procedures or means should be provided to vent the hydrogen from the primary system.

Then, when it's vented to the containment you have the problem of measuring what the level of hydrogen is and, particularly, moving that hydrogen.

Now it's not clear to me, and I do not know, although I'm sure there is someone here who may, how one measures the hydrogen content in the primary system itself. Certainly from the fluid sample you would be able to get the dissolved hydrogen. It's not clear to me how you would ascertain particularly the amount of hydrogen in the system itself.

MR. MATTSON: May I interrupt? I'm not sure when we got started on this track.

Dr. Okrent, could you rephrase what your basic interest is in hydrogen, so we can get closer back to your question?

DR. OKRENT: Sure. I'm reading something dated

eb24

April 13, 1979, from Mr. Moseley to a variety of people. And item 12 says: "Review operating modes and procedures to deal with significant amounts of hydrogen gas that may be generated during a transient or other accident that would either remain inside the primary system or be released to the containment."

I asked Mr. Varga, who brought up the subject of hydrogen just a moment ago, what the Staff's interest was, what they expected from the Applicant with regard to that question. And the first thing he mentioned was the availability of the recombiner, and frankly, that strikes me as not being the thing I'd be most interested in if I were really concerned about the generation of hydrogen, not that it is insignificant, but it is not where my primary interest arises.

In fact,-- Well, so I'm trying to ascertain just what the Staff has in mind.

Don't misunderstand me. I'm not saying you shouldn't be interested in the hydrogen.

MR. ROSS: To give the specific reference to what Dr. Okrent may be referring to, it's either I&E Bulletin 7906-A or 06-B. I think they're both the same in this respect.

During the preparation of those bulletins we discussed a number of things along the line you're talking about with respect to hydrogen gas. I don't think our list is particularly complete at this time, and we wanted the Licensee to respond.

67-034

525

But we did discuss, for example, on the recombiner, the need to add shielding that wasn't otherwise provided. This would be by way of an operating procedure, had this been considered. It had to be supplemented on an ad hoc basis at the Island.

We also had a number of --

DR. SHEWMON: Shielding what?

MR. ROSS: The recombiner itself.

DR. SHEWMON: So you could get at it and do maintenance?

MR. ROSS: Yes. And in particular, another recombiner was plumbed in and there was concern at being able to maintain the -- at other sampling valves and so on.

There was some speculation as to the response time of the reactor building pressure transducers, to what extent did they follow the spike that was observed around ten hours and how would this correlate to a true response. In the first few days of the event at TMI there was a question about stratification and the extent to which the fan coolers would or would not mix hydrogen, and were we getting stratification at the top, and to what extent the sampling lines where you sampled the reactor building hydrogen gas content represented a reasonable sample of the reactor building.

As a corollary to that, during the TMI sequence the waste gas decay tank was vented -- plural, tanks -- were

~26

vented back to the containment, adding some hydrogen gas and other isotopes that were in the waste gas decay tank. To what extent had this contingency been factored into questions of hydrogen?

This is an admittedly incomplete list and it's a broad question, and it's asking for the Licensee to consider these and other things and see if this has been properly taken into account.

DR. OKRENT: I'm not quite sure I have more than the same information I guess I had from reading the account of the event. But what about the sampling of hydrogen itself? Are there satisfactory means on all plants for getting early, prompt measurements of the hydrogen concentration displayed in the control room or available to the control room operator quickly?

647

MR. TEDESCO: As far a Regulatory Guide 1.7 and the new rule 50.44 that deals with hydrogen control, the plant would have to have the capability to monitor hydrogen levels in the containment. These are done on a continuous basis or from a sampling basis.

As far as full implementation of all plants, I don't have the information at this point, but the capability exists to sample the containment environment.

DR. SHEWMON: No matter what its activity is?

R. TEDESCO: That would be a requirement, yes. Whatever that is, you have to have the capability to--

mb27

DR. SHEWMON: No matter what the level of activity is within the containment? That is, a person can do it remotely?

MR. TEDESCO: Well, the whole design basis is based on the TID type of release, you know, so it should have that capability.

DR. SHEWMON: The answer to my question is Yes?

MR. TEDESCO: Yes.

DR. SHEWMON: Thank you.

668

DR. OKRENT: And is it your impression that there does or does not exist means of continuous monitoring?

MR. TEDESCO: On the newer plants it's more on the basis of a continuous type capability. On the older plants it would be on a sampling basis.

DR. OKRENT: How long does it take to get a sample? How many samples are involved, do you know?

MR. TEDESCO: It would be on the order of a few hours, based on the Three Mile Island experience.

DR. LAWROSKI: How many samples do you have to get?

MR. MATTSON: The samples were fairly consistent with one another so the first was as good as the second, the third, and the fourth one. And then when they got the hydrogen recombiner installed it had a continuous monitor, so I think the answer to your question, how many would you generally have to take, is not many if there's fan coolers or some kind of

eb28

circulation going on inside the containment and you get a good distribution of the hydrogen, and it's not a hard analytical kind of chemistry process co--

DR. LAWROSKI: Well, the problem is to get a representative sample for that two million or so cubic feet that's in the containment, of total volume.

MR. MATTSON: Well, if the containment air is being mixed it's not as much a problem as if the containment air isn't being mixed.

DR. LAWROSKI: You said "if."

MR. MATTSON: Yes. Fan coolers and things like that keep the containment air mixed.

DR. LAWROSKI: You have not seen any concentration gradients in the points from wherever they take samples for hydrogen content?

MR. MATTSON: We don't have hydrogen concentration gradients that we can measure, but the temperature gradient within the containment looks like there is pretty good mixing from the fan coolers that have been running since early in the accident, and it's what you would expect.

MR. RAY: As a corollary to Dr. Okrent's question on the sampling of containment gases and so on, and reactor gases to determine the degree of prevalence of and presence of hydrogen, is there any way that you can evaluate the potential release of oxygen to mix with it, and is it possible to inert

29

that in some fashion by injecting a chemical that would do so, so that you won't get an explosive mixture if your hydrogen is released?

DR. SHEWMON: And is there a way of getting the comments of somebody who knows the recom ination rate on demand?

MR. MATTSON: Well, we learned about recombination rates on demand in a period when things were moving quickly, maybe not fast enough.

I think there are two questions here. One is the recombination rate in the primary coolant system, and the other is the potential for generation of oxygen inside the containment.

Now the broad question of hydrogen control, hydrogen flammability, and hydrogen detonation inside the containment has been a subject of review with this Committee and work within the Staff going back to the late 1960s. That's why there are recombiners there today, and the technical work that was done over those many years led to a basic system of protection that provides for mixing of the hydrogen within the containment, and then controlled burning, i.e., recombin tion to keep you from getting above flammable, and certainly keeps you below detonation limits.

Oxygen generated in the sump by radiolysis in the sump if there are fission products in the sump was not chosen to be controlled in that method of containment protection.

eb30

The question of oxygen generation in the core if there's hydrogen present in the primary coolant system I think we have a pretty good understanding of today; that is, if there's a hydrogen overpressure there's no net production of oxygen by radiolysis in the absence of boiling.

DR. OKRENT: Well, I noticed that the question of hydrogen has been sent out to the BWR owners and, I assume, to all the PWR vendors, and I guess I'm not quite sure what it is you're asking. You mentioned the recombiner a moment ago.

The design basis for that recombiner is a different event than the one that transpired at Three Mile Island. I don't think we should leave the impression, even indirectly, that it was designed for the amount of hydrogen generated in this event. It was for a much lesser release, a lesser rate and a lesser amount.

MR. MATTSON: We understand that, and that's why the question, for people to tell us what their capability is, plant by plant today, for dealing with hydrogen.

DR. OKRENT: Well, --

DR. LAWROSKI: Well, Roger, just from the pressure spike that occurred, one would get some reason to believe that the mixing isn't so good as you implied at least.

MR. MATTSON: Well, there were no recombiners on at that time and, as Dr. Okrent just said, the control of hydrogen had a design basis that was somewhat different than the amount eh31

of oxidation that occurred in this core. There was more hydrogen there than was in the design basis.

That's one of the lessons learned, one of the things that we're looking at.

DR. OKRENT: Let me put it another way:

If you're asking various reactor operators to consider situations that might lead to about the same amount of hydrogen as was generated at Three Mile Island 2, then there would be other ramifications that go with such an event, and this would be only one part of a broader picture.

So I'm still I guess trying to understand a little bit better what this question means.

MR. MATTSON: Well, it doesn't mean that we've adopted a new design basis for recombiners that is the Three Mile Island accident. I think that that's a decision that you try not to be in that situation. The intent must surely be to prevent the occurrence of the Three Mile Island accident, and in the process of working to do that, get a current up-to-date summary of what the hydrogen capability is for all the plants now in operation.

DR. OKRENT: No more on that now.

DR. CARBON: Go ahead, Mr. Varga.

agbl

C2

MR. VARGA: Item Two of the response to the bulletin requested the Licensee to review transients and events that have occurred at his facility, particularly to report those that where the performance deviated from the expected performance.

We have reviewed these and the discussion, in general, in the responses and this response indicates and understanding and an awareness of the various events that occurred in the events and the transients that they're looking at.

And we have identified in this one particular typical review that we have done, this one, there was a transient or an event that had occurred that was reported to us some time in January. That was not included in the response of the Licensee, however, that event in itself is not too significantly different than what he had already looked at, and we have not uncovered ourselves any particular concern but are calling it to the attention of the Licensee.

In these responses, as well as in all responses that we are reviewing, I guess my personal perception is that I'm taking certainly a different approach or a view from a new direction about statements like "resulted in no safety significance" or "this was terminated without adverse implications and that sort of thing.

We certainly are taking a very hard look at all aspects of various events and occurrences that have occurred, and it's being factored, of course, into the short-term program

67 142

agb2

that is following.

Item Three --

DR. CARBON: A question before you leave Number Two, you say you feel they are aware of the question and so on. But have they responded, indicating that there have been significant deviations you didn't know about before?

MR. VARGA: Oh, no. All the significant deviations that have been reported in the responses we have known about before, except -- well, we have not completed our review, I cannot say that straightforwardly, we have not completed our review. In the review we have done to date, in general, across the five and, in specific, across one, we have not identified anything.

DR. CARBON: In the paragraph that says that there have been significant deviations from expected performance provide details and so on, you would ordinarily know about all those, you really don't expect them to be telling you of any new ones, do you?

MR. VARGA: I don't expect so, except that of course it depends upon the equipment and the system involved, and whether expected performance has to do something with the protection of the health and safety of the public of that particular event. I can't think of any, but there might be performance of a non-safety grade equipment that deviated from their expected performance that they may not have reported.

gb3

They have certain obligations to report to us deviations from expected performance where that deviation has the potential to affect the health and safety of the public and indicates some deficiency in the design or the operation of the plant.

There might be some circumstances outside that that they may not have reported, and I'm not sure I have a feel for the broad spectrum of that at this point.

I don't think any deviation that occurred in a safety system that would affect the public health and safety has not been reported, I don't believe that's the case. But I cannot say that until we have reviewed all of the responses.

DR. CARBON: And you have reviewed only one so far?

MR. VARGA: We have reviewed all five in a, I would say, in a read-through and a discussion. And we are reviewing 1 with our own resource investigation procedures. You know, events transpire over a significant period of time and we're reviewing our own records as well.

DR. CARBON: Thank you.

MR. VARGA: In Item Three of the bulletin, this had to do with reviewing actions required by the operating procedures for coping with transients and accidents with particular attention to forming the voids in operator action to prevent, an operator action to enhance core cooling.

And the responses were generally uniform. This agb4 particular one indicated that they were reviewing the operating procedures as well as the instructions to the operator and that, in addition to providing additional aids to assist the operator in the recognition of this situation, they were also embarking upon a training program for the operators with the simulators in order to -- and simulating to the extent, in my view, to the extent possible, the sequence of events at TMI 2 and training and instructing the operators.

In general, we find this an acceptable response. The problem we have is the length of time the Licensee has indicated for the completion of this review. He said that this review and training will be completed in approximately 120 days. We believe that that is much too long and believe that significant reduction in that period of time should be made.

Item Four --

DR. SHEWMON: Pardon me, sir, is that really realistic if you aren't sure what it is you're supposed to be retraining them to do yet, or do we know indeed what it is we want them to train them to do now?

MR. VARGA: Well, if I were the simulator, I could certainly on my own put various events in as to the capability of the simulator that I already know.

But more than just that -- and probably any knowledgeable person in this particular activity can probably do it.

But we had a meeting with all the simulator owners

agb5

last week and went into detail as to the particular events and the capabilities of the particular simulators in order to ascertain what actions could be taken, what capabilities there were, and I believe the results of that indicated that for the B&W simulator at least it appeared that that had significant capability to simulate that event, various aspects of the event.

I, myself, do not know the complete capability --

DR. SHEWMON: So you think they should be able to cope with the Three Mile Island event and have everybody trained to cope with it better after less than 120 days?

MR. VARGA: Right.

DR. SHEWMON: My impression was that you thought they should have thought up all other ramifications and contingencies, have these defined and have everybody trained to cope with them in less than 120 days.

MR. VARGA: No, I'm speaking specifically of the TMI 2 incident that we did, and I'm sorry I didn't make that clear. But certainly there may be follow-on as our review continues and we may identify other training requirements.

DR. OKRENT: I would like to understand what it is you think the B&W simulator can do. Do you believe it is able to describe the fluid conditions inside the primary system on a reasonably detailed basis for the event which transpires?

MR. VARGA: I cannot speak from personal knowledge,

agb6

and I suggest -- I'll answer you to the best of my ability, but I would suggest probably asking B&W that at their particular point might be appropriate as well.

But I believe that a simulator can simulate only, of course, it's a platitude, what is put in. I believe when you have changing regimes, I am highly suspect from now on of any statement alluding to natural circulation.

The two phase flow regime, I believe there will be always significant problems in simulating the actual phenomena in a computer -- in a simulator. You could approach it. I cannot address the question of how well does the B&W simulator simulate the accident.

DR. OKRENT: Now this meeting you say you held with the various simulator groups, is there detailed information available on what they believe their simulators can and cannot simulate?

MR. VARGA: I'm sure there will be information available, I do not know how detailed. A member of my group that is back in Bethesda now reviewing these was the person from the Operating License Branch who was, I think -- had the meeting and informed me about the detail as I have informed you.

Now as additional information becomes available, we can certainly make that available.

DR. OKRENT: Does the NRC Staff itself have, either at

agb7

Bethesda or via any of its contractors, an ability to simulate each of the four water reactor vendor plants?

MR. VARGA: I will have to defer to someone else on the Staff.

MR. MATTSON: I take your question to be in the sense of the simulator or plant computer sense, not the computer code analytical sense. Is that correct?

DR. OKRENT: Let me ask about the system behavior, not in terms of all of the controls and alarms and so forth that would be in a control room.

MR. MATTSON: Well it's my understanding late last week they were beginning to see computer runs from our consultants in Idaho, simulating or reconstructing, if you will, the pressure, temperature, flow scenarios for this accident.

So evidently the answer is yes, we have the ability to calculate what happened given the initiating events.

The Staff has no simulator under its direct control which you could then input these plant parameters and follow what the control panel or the simulator panel would do as a consequence.

Now we have other contractural arrangements for working with simulators to understand plant transients and what have you. It's conceivable we could do that, we don't have that capability today.

DR. CARBON: Go on, please.

-gb8

MR. VARGA: Item Four of the bulletin requested actions about operators not overriding automatic actuation of engineered safety features and went on to talk about the HPI, the restriction on HPI, termination of operation and (c) was reactor coolant pump and then (d), the not relying on pressurizer level alone.

The responses are due in and we are reviewing -- 2.140 essentially deal with 4(a) about reviewing the actions directed by the operating procedures and training instructions to insure that operators do not override automatic actions of engineered safety features.

We have, in general, the response to this item is indicated -- well not in general but in two instances, as I recall, the responses indicated some particular problem with this unduly restrictive -- their interpretation of this action as being unduly restrictive.

And in the one response we reviewed, we've had subsequent communication from the Applicant -- from the Licensee concerning that.

In the bulletins that have been issued to the other PWRs, subsequent to 05-A, but to the other designs, there is wording that clarifies the intent of that particular requirement about overriding.

And let me just -- it's in the other bulletins and we are going to provide that same clarification in our response

agb9

that we believe will be immediately transmitted back to the Applicants as a result of our review that this clarification is that review of the actions directed by the operating procedures and training instructions to insure that operators do not override automatic actions of engineered safety features unless continued operation of engineered safety features will result in unsafe plant conditions, an example of continued operation of HPI which threatened reactor vessel integrity, then the HPI should be secured as noted in Number Two below.

Two below also then also then clarifies the 20 minutes and the subcooling requirement that -- either that the HPI must remain in operation until either both low pressure injection pumps are flowing for 20 minutes or longer at a rate which would establish stable plant behavior or the HPI has been in operation for 20 minutes and all hot and cold leg temperatures are at least 50 degrees below the saturation temperature for the existing pressure.

The important qualification there, or clarification is the degree of subcooling beyond 50 degrees Fahrenheit and the length of time HPI is in operation shall be limited by pressure temperature considerations for the vessel integrity.

We will review then also the remaining responses to 4(b), (c), and (d) in response to you today.

Finally, Item Five, which was verify that emergency feedwater valves are in the open position in accordance with

agb10

Item Eight below and review all safety-related valve positions and position requirements.

In general, the responses track about the same. They indicate the emergency features or systems reviewed, in some instances give the list of the procedures and also list the maintenance and testing -- review of the maintenance and testing procedures.

In the review of the one particular one we have gone through in some detail, there was an omission concerning the maintenance and testing -- review of the maintenance and testing procedures, which we are requiring and have indicated that that must be done. We believe that, in our discussion and evaluation of this, we believe that this has been done but was not indicated in the bulletin.

In the one we have reviewed in detail, there was an implication in the response that the review of the valve lineups and the procedures and the requirements for ascertaining that they are all in place and correct.

The response appeared to be tailored to a short-term response, indicating that this has been done. However, certain valves could not be checked because the containment was closed.

So we're pointing out that certainly an immediate response is required and a check is required, but important as well are procedures and actions in place for the continuous operation and long-term aspects to assure that that situation

agb11

does not change.

Particularly we are highlighting where shift changes occur, that maintenance procedures or surveillance procedures occuring at a particular shift and ascertaining of certain valve lineups or certain valves out of operation, that the Licensee indicate specifically his shift transfer procedures to assure that there is no oversight in this particular review, or this particular action.

That summarizes briefly where we are and our perception to date. As I mentioned earlier, we are deep in the process of reviewing this, expediting to the extent possible this review. If you have any questions, I'll be glad to see if I can answer them.

DR. CARBON: Any questions, gentlemen?

MR. MICHAELSON: Carl Michaelson, ACRS consultant.

I believe you indicated that the reactor coolant pump would be tripped only after there was evidence that you no longer had flow. Would you expand upon that evidence?

MR. VARGA: Well let me make some remarks and perhaps some additional clarification can come from the Staff.

There are times where the indications may show that the reactor coolant pump for cavitational purposes, loss of suction or some other reason, may be approaching the situation where a temporary loss of suction had occurred and forced cooling was no longer occurring. This could be indicated by a sudden

agb12

change in the temperatures at a particular point.

It's .. ceivable to me that you would like to, momentarily, perhaps, stop to trip the pump, re-establish perhaps some head and essentially prime the pump, perhaps. That is conceivable to me that you might want to be able to do that.

However, certainly we have not given detailed definition of exactly when and when you cannot. As I said, this is an immediate response sort of action. Additional information or requirements may flow from our continuing activities.

Would anyone like to add to that?

MR. MATTSON: I don't think we have any reason to disagree with that answer.

Was there more you were looking for, Carl?

MR. MICHAELSON: Well, what I was really looking for is, what does the operator do at the present time if he should get into a similar situation, what kind of instruction have you issued?

It appears from the wording of earlier instructions that you run that pump, shall we say, to the bitter end. I assume that's been clarified somewhat.

MR. ROSS: Let me read directly from Bulletin 06-A, Page 45, the top six lines, which is paragraph C, 7C. This is the bulletin that was sent to Westinghouse plants, and a similar provision was sent to Combustion:

agb13

"Operating procedures currently, or revised to, specify that in the event of HPI with reactor coolant pumps operating, at least one reactor coolant pump shall remain operating for two loop plants, at least two reactor coolant pumps shall remain operating for three or four loop plants, as long as the pump or pumps is providing forced flow."

Now, the discussion that we had -- and there will be some of this in the minutes of the meeting that we had with Westinghouse, and those minutes have been published and supplied to the Committee as well as to the Public Document Room -- had to do with both the previous instructions given to the plant operator to trip the pump in the event of a deviation such as an action level on vibration of the pump. There are other instructions on manual tripping having to do with, oh, perhaps, excessive current as well as some automatic trips on loss of coolant flow.

Some of the analog charts that we saw for the Three Mile sequence showed variations in the measured reactor coolant pump flow rates. The intent here was, as long as it was perceived from the flow meters and other evidence that the pump was pumping water, leave it on.

MR. MICHAELSON: I gather then that what you're saying is leave it on irrespective of the vibrational levels that are indicated and so forth, or the ammeters which might be

agbl4

swaying rather severely at that point in time.

MR. ROSS: Well I think what you said, the latter statement, might be a contradiction in that the ammeter might be an indicator that it is not pumping water, but from whatever evidence available that it's puming water, leave it on, yes, sir, the vibration meter notwithstanding.

DR. CARBON: Ivan, did you have a question?

DR. CATTON: No.

DR. CARBON: Any other questions from the Committee?

(No response.)

Thank you, Steve.

It seems an appropriate time to take a 10-minute break.

2.290

(Recess.)

DR. CARBON: Let's move on. I think it would be appropriate at this time to discuss the bulletins which have gone out to the other vendors, and I believe Mr. Ross is to cover that topic.

MR. ROSS: Professor Carbon, a brief statement on this: I want to point out for the benefit of the Committee that bulletins have also been sent in the last few days. There was a generalized bulletin which we refer to as the two-digit 06 that were action for Westinghouse and Combusion plants, which was quickly followed by a specific 06-A for Westinghouse, a specific bulletin 06-B for Combustion and then a day or so

15

later, the day before yesterday, we got a General Electric -- pardon me, a boiling water reactor specific 08.

We've talked about some of the differences already this morning. The main thing we want to do at this time is just to notify the Committee of the existence of these bulletins. The replies are not due for a few more days, and our evaluation will have to come after that.

So other than point these out, we really weren't prepared to discuss them, but we can answer questions you might have on the content of the questions.

DR. CARBON: Are there questions by the committee?

DR. LAWROSKI: I have one.

In connection with the containments, have your bulletins included an admonition to make sure that there are no unopened valves, because in this case we are fortunate that the containment was apparently good and also that there were no valves left open, so that once the containment was isolated it kept the contents pretty well controlled.

MR. ROSS: I believe -- Let me use Bulletin 06-A for reference, that may come up several places on these instructions. Instruction Number Four has to do with containment isolation initiation, so that you can, if necessary, isolate those features not needed for ECCS or other safety features.

But there's also another portion of the same bulletin having to do with maintenance and tests. Point Number Eight has

agb16

to do with reviewing safety related valve positions and Paragraph 10 is maintenance and test procedures when you're taking features out of service and putting them back into service.

So I think under one or more of those paragraphs your question is covered.

DR. LAWROSKI: Thank you.

DR. CARBON: Let's move on, then.

Mr. Mattson?

MR. MATTSON: Bob Tedesco is going to tell you of the short-term long-term activities that I described earlier. Basically, Bob picks up where the immediate-term procedural oriented bulletins leave off, recognizing that procedures are effective over a period of time but with time their effectiveness decays and therefore you look in the short-term or long-term toward question of design modifications, operator training and those kinds of things that Bob will be summarizing.

end1C
1D
2.360
Slide Set 1

MR. TEDESCO: Good morning, my name is Bob Tedesco, the Assistant Director for Reactor Safety in the Office of Nuclear Reactor Regulation.

I'd like to share with you briefly this morning the status of generic review that we are now going through with regard to the feedwater transients in B&W reactors.

(Slide.)

Starting out with the purpose of our evaluation, it's 'bl

in two parts, that this generic assessment will deal with these transients in light of the Three Mile Island-2 event (1) to establish the basis for continued safe operation of these plants in the short term and (2) to determine the review areas for long term re-assessment of the designs to meet NRC regulations.

(Slide)

We've been started on this effort for about a week now and are going ahead re-looking at various plants that fall the category: the operating reactors at Three Mile Island 1 and 2, Crystal River, Rancho Seco, Oconee, the three units there, Arkansas-1 and Davis-Besse-1.

Now in addition to this effort on the generic review of the B&W plants we'll also be looking at the other PWRs of Westinghouse and Combustion, at least as an overlay, to see where we are as far as the outcome of the B&W review and what they might mean to the other plants.

We've made a survey based on the LERs of the events related to the feedwater transients that may suggest a precursor type of event to the Three Mile Island-2 incident. Now the information that we have is based onthe licensee's responses in the LERs, but there may be other types of incidents of feedwater origin where a plant has responded as designed and, therefore, it would not be the subject of an LER.

But with regard to the incidents that we're talking

wb2

about, there appear to be five related events, two of which we have found to be, in a way, similar precursors to the Three Mile Island-2 event. Back in '75 Oconee-3 during its initial program had an incident that actuated the power operated relief valve. The valve subsequently stuck open, and then the injection signal was hit, and he hit the injection as designed.

Then a year later at Oconee-2 there was another event with the feedwater where the power operated valve was actuated and the system stabilized as designed after that.

Davis-Besse in September of '77, during its initial startup program was somewhat similar to Oconee-3 in that the valve was actuated, stuck open and you had injection.

Rancho Seco had a depressurization event during 1978 which caused an injection.

Oconee-1 had a similar event that caused both the power operated relief valves to be actuated and the high pressure system actuated.

At Three Mile Island-2 we had the sequence we're talking about right now where we had the valve actuated and it stuck open and you had injection.

So based on this preliminary comparative of the LER information that we have there appear at this points two events as precursors and were similar to the Three Mile, Oconee and Davis-Besse. We're looking into these further to wb3,

to try to find out generic implications of the events, what had happened, and then to include them into our generic evaluation.

(Slide)

I'd like to spend a brief time now on the Three Mile Island-2, to kind of lay in the background of where we are in our generic evaluation, identifying the major areas that we are looking at.

Prof. KERR: Mr. Tedesco, in connection with your early slide, can you tell us whether, in those cases in which there were stuck-open relief valves, the operator was unaware of the fact that they were stuck open?

MR. TEDESCO: Let me see if I have that.

(Pause)

Let me put that slide back.

(Slide)

With regard to Oconee-3, the indication was that the operator did close the block valve at reactor trip. But then he re-opened it because of the rise in pressurizer level. So the action by the operator was to close the valve. So there was an indication in that one that the valve had stuck open.

PROF. KERR: Does your information indicate how he knew it was open?

MR. TEDESCO: Well the information-- There is a temperature readout at the valve that would indicate an increase

wb4

in temperature with the valve open.

PROF. KERR: And was information of that type available to the TMI operator?

MR. TEDESCO: That information is available. There is a block valve downstream of the power operated relief valve.

PROF. KERR: What about at Davis-Besse?

MR. TEDESCO: Davis-Besse was a--

PROF. KERR: Did the operator know then, in that case?

MR. TEDESCO: Twenty minutes into the transient the operator closed the power operated relief valve. But also remember, on Davis-Besse we blew the rupture disc on the pressurizer surge tanks. And so I'm not sure which was the indication to him, whether it was the temperature or the fact that--

PROF. KERR: But the evidence is that in both of those cases the operator was aware that the valve was stuck open?

MR. TEDESCO: Based on this information I would say yes.

PROF. KERR: Thank you.

DR. SHEWMON: One would judge from this that it seems to be the rule instead of the exception that the PORV sticks open. Do we have any sort of reliability data on those

wb5

things? Or is this the only way we can test them?

MR. TEDESCO: As I get further into my generic evaluation I'll be able to share further the equipment valve function and how we're factoring that into the program.

DR. SHEWMON: Good.

MR. MICHAELSON: Would you care to comment now as to whether or not these were identical power operated relief valves, or were they of different manufacturers?

MR. TEDESCO: I can't answer that specifically right now.

DR. CARBON: Bob, I'm confused on something. I'm under the impression that at Three Mile Island-2 there was no temperature indicator to show that the PORV was open. What's--

MR. TEDESCO: Well so far as I know on the T&ID there's an indication of it.

MR. MATTSON: Mr. Chairman, our understanding was there was a temperature indicator on that valve.

DR. CARBON: A second question, then.

This temperature indicator presumably acts fairly slowly. And I believe you indicated that maybe at Oconee-3 they closed the manual valve something like twenty minutes after the--

MR. TEDESCO: Davis-Besse was twenty minutes.

DR. CARBON: Is that a typical time, that it takes

wb6

2.520

that long to recognize?

MR. TEDESCO: On the Oconee-3 incident the block valve closed on reactor trip but reopened. That would have been earlier than twenty minutes.

DR. SHEWMON: Max, it's a thermocouple hanging in the fluid. It should respond in a matter of seconds, a minute at worst.

DR. CARBON: Is it in the fluid? And how much time lag, I wonder, does it have. I'm told it's a very slow thermocouple.

MR. TEDESCO: You should be able to tell if this valve is stuck open. You're going to start getting a depressurization indication in the control room, and you'll know-- If the valve should have reseated and you're still starting to depressurize I think it's a very reasonable, logical indication that something has happened. You either have a small break or the valve hasn't closed. The operator should then go ahead and try to secure it with the block valve if no kind of information signals are available to him in the control room.

DR. CARBON: I don't question that. But I was wondering if the lag of the thermocouple in telling the operator anything--

MR. TEDESCO: It won't be a twenty-minute lag, I'm sure, on the thermocouple.

DR. PLESSET: I was concerned about the valve hanging open. When you've got loads on it due to flow out through that valve which might have low quality then the loads can be so that even though the valve wants to close it cannot. I was just mentioning it to Darryl Eisenhut, and I'm glad to know that they're worried about this, too, about this possibility. But I think the loads may be higher than we're aware of.

MR.TEDESCO: Dr. Plesset, one of the questions we have is the adequacy of the valve to pass anything but steam.

Remember, this is also part of the staff consideration on ATWS. It's related to this.

DR. PLESSET: Yes. I think this is a rather serious question.

MR. TEDESCO: Yes, it is.

DR. OKRENT: In some future listing of these transients I think it might be helpful to have a fourth column which indicated whether the operator had a basis for knowing the status of the plant or whether there was ambiguous information coming to the operator. That's separate from whether he used all the information. --if I make the distinction.

MR. TEDESCO: I would hope that in our report when I talk a little more about it, maybe I will identify the appropriate area where this aspect will be discussed.

MR. MICHAELSON: Before you get off that I'd like to ask one further question.

You apparently have indicating lights in the control room concerning the position of the power operated valve. What position did the lights indicate?

MR. TEDESCO: Let me see if I can add some light to that.

Based on the information that we are putting together now on Oconee-3 the control room light did not show open status of the valves. At Davis-Besse I can't tell you: I don't have the information with me right now.

MR. MICHAELSON: On Three Mile Island?

MR. TEDESCO: Roger, do you know?

MR. MATTSON: I'm sorry; I didn't hear the question. Could you repeat the question? We have a valve line up back here.

MR. MICHAELSON: The question was, What position was indicated for the power operated relief valve on Three Mile Island after the event started?

MR. VARGA: I have a list of the instrumentation available, presently available, to sense opening or a leaking PORV. On Three Mile Island-1 there's a thermocouple indication but no alarm. On Three Mile Island-2 there was also a thermocouple indication but no alarm.

Crystal River has a thermocouple with an alarm.

wb9

Oconee-1, 2 and 3 have position indicators, thermocouple location, quench tank level, pressure and temperature. I'm not clear yet whether those are all alarmed. But indications are available.

Rancho Seco has a thermocouple, not alarmed, quench tank level, temperature and pressure. I don'tknow whether those are alarmed.

On ANO-2 it has position indicators only, not alarmed. Davis-Besse has position indicator and thermocouples.

MR. MICHAELSON: I guess I have to ask my question again, then.

Is there a position indication at Three Mile Island? They do not have one, or you don't know?

MR. VARGA: The review we have made, which is subject to checking, indicates they do not.

:3

(Slide)

MR. TEDESCO: Going back to my slide, it really forms the basis for our generic review. We have feedwater concentration at Three Mile Island. The sequence that followed was that we challenged the plant design in certain areas, namely, pressurizer level indicator, the one-through steam generator, the feedwater control system, and the configuration of reactor coolant system.

In addition to that, there were operator procedures

wb10

were available. Based on the information I'm looking at now, it looks like it was the wrong operating procedure for that particular situation, namely, in regard to what the operator did with the high pressure injection system and what was also done later with the reactor coolant pumps.

As far as equipment malfunction, we did have the power operated relief valve stick open. And then the operator failure falls in the category of the aux feedwater system being blocked out.

Now collectively these sequences are being reviewed in our generic program, and we are constituting what we call a short term program to see what these are, to assess their significance and impact on the other B&W plants.

So with that as background, we then went ahead and said, All right, we're going to look the plant design features, the operational aspects and the licensing basis of where we are. And then, with the I&E bulletin as our action point, to make this assessment for the short term program.

The three categories we'll be talking about are design, the operation, and the licensing that we'll be emphasizing in our review.

(Slide)

We recognize that the review is really very early in this progression. We don't have all the answers yet. But

wb11

I would like to at least share some of the areas that we are considering for our evaluation.

DR. OKRENT: Before you leave that last slide, you mentioned something about the operational procedures were not appropriate for that transient. And I assume that relates to whether or not the RCP should stay on or off, and so forth.

MR. TEDESCO: Yes, sir, that's one of the questions, yes.

DR. OKRENT: And do you have any knowledge yet as to whether the operator was very worried about overpressurizing the primary system? Was that a factor in his thinking?

MR. TEDESCO: Well, that would be on the high pressure coolant injection system, when he went from an ECCS mode of operation to the level control mode. And I would share on that that it was a concern about overpressurizing in this instance.

DR. OKRENT: Have interviews established that this was the case?

MR. TEDESCO: This is speculation. We were at the initial exploratory stage of asking what did he do and why with respect to this question.

DR. MATTSON: Could I interrupt just a minute, please?

The initial stages of the investigation of the accident by the Office of Inspection and Enforcement were

wbl2

undertaken last week. And the kind of information that you're looking for to remove the need for this sort of speculation should be coming in relatively soon. But the staff here in Bethesda doesn't have it yet.

DR. PLESSET: What kind of review of operator training, operator background, will be made?

MR. TEDESCO: That falls in the category of our licensing basis and the operational aspects. And the people in the Operator Examining Branch are going through the whole area. They are re-assessing operator training, operator licensing requirements in light of the accident that happened at Three Mile Island. That will be part of our report.

DR. PLESSET: It will be a searching re-examination?

MR. TEDESCO; All the areas -- design, licensing basis, the operational -- they are all open now, all subject to a complete re-assessment on our part.

(Slide)

Now in the area of plant design, here are some of the matters thatwe're looking at.

We realize that during the incident the pressurizer level started to indicate a rising pressure. The question is, Why was that so when we knew we were voiding in the core?

So we went into three areas. We asked questions of ourselves about the instrumentation itself, was it behaving

wbl3

as designed?

No. 2, we asked ourselves the question about the loop seals in the pressurizer surge line, could it have affected the reading of the pressurizer level?

No. 3 was the effect of the thermodynamics on the whole system.

We came up with the following preliminary tentative finding, that we believe the level indication was proper, that the instrumentation was responding as designed, that it showed a rising level in the pressurizer. And from the event that we had at Three Mile Island, wherein you had a - qucte - small type of break in the pressurizer, the loop seal manometer effect did not contribute to this indication.

No. 3, as far as the thermodynamics go, we made some preliminary calculations at Idaho using Three Mile Island-type of input scenario with the RELAP run, and the preliminary results are showing that you would, for this type of event, with a rising level in the pressurizer, with a decreasing system pressure, would suggest strongly a thermodynamic process during ::depressurization.

Westinghouse and Combustion, and even now B&W, have all made similar analyses and are coming up with similar types of findings.

So we believe the instrumentation was recording right; we don't feel as strong at this point as to the

wbl4

contribution from the loop seals, and thermodynamics appear to be predictable for it.

We're looking at the power operated relief valve, its malfunction history, what type of valve it is, the manufacturer, and so on. That will be part of our generic review.

The primary coolant system configuration. We do have for the B&W plants the once-through steam generator causing the loop configuration into a candy cane type of configuration. We're looking at that to see what possible kind of design aspects exist with regard to the Three Mile Island-2 event. Also what effect it might have on entrained gases and the natural circulation capability.

The once-through steam generator is unique to the B&W plants, recognizing that it has a much smaller heat capacity compared to Westinghouse and Combustion Engineering. We have tried to assess its impact on the whole sequence.

The feedwater system malfunction: the principal components, the history of it, will be included. And then also the control and safety systems.

The B&W plants have an integrated control system between the primary and secondary loops for control. We'll be looking at that.

The safety systems, as far as their actuation goes, what differences exist on B&W compared to the other pressurized plants, and establishing the basis of whether or not we would

515

have to do more on the basis of comparison.

DR. OKRENT: What do you really expect to look at with regard to the control system for the B&W plants?

MR. TEDESCO: If you look at the control systems with regard to the once-through steam generator, how these things are coupled, realizing that with the smaller heat capacity that you have and the smaller size of the heat generator, the control system has to respond in a lot faster way. It also involves the auxiliary feedwater system.

We found at Three Mile that the steam generator went dry very early in the whole transient.

Now recognizing that for all these events, for a small break, all pressurized water plants need auxiliary feedwater systems.

And how does that tie into the control system? The control system on these plants are generally not safety grade. What effect does that have? That's just a kind of a characterization of what we're looking at at this point.

DR. OKRENT: I guess I'm not quite sure what you think you'll do with regard to your look at the control system.

MR. TEDESCO: The role of the control system for all these transients really hasn't been considered in great detail. They've been considered to be normal plant operating features where one has not had to rely upon their function.

67-072

Does the transient consider the anticipated event? I think we have to re-think our whole process on that, what role does the control system have. It may have to be upgraded.

DR. ORRENT: Okay.

MR. TEDESCO: I just want to give you an idea of the areas that we're looking at. Some of them may just not be consequential, other ones may. We may have to add to it and modify it as we go along.

DR. CARBON: A different question with respect to Item 2 and your comment on natural circulation. Could you summarize briefly what sort of calculation is done for each of the different B&W plants to show that natural circulation is feasible? And would you also comment on how much testing is done at each of the plants to demonstrate natural circulation capability?

MR. TEDESCO: Let me take the latter question.

Our preliminary review has shown that natural circulation tests have been run at Oconee and at Davis-Besse. They have been included.

DR. MATTSON: I might remind the Committee of the discussion we had down here on RHR and the need to go to cold shutdown on safety grade equipment. It must be two or three months ago at this point. Where we talked ab[illegible] state of requirements for natural circulation testing and spoke to the

17

need to do additional natural circulation testing for that safety grade decay, or RHR concern. I think we summarized that for you at that point. That is, there are tests done but they haven't been done on all plants.

Does that help?

DR. CARBON: It helps.

And specifically with regard to the plants under discussion here, they have been run on Oconee and Davis-Besse?

MR. TEDESCO: That's my understanding, yes.

DR. CARBON: And not on the others?

MR. TEDESCO: I don't know about Three Mile. I haven't checked.

DR. MATTSON: The B&W side of the room is nodding that that information is accurate; those two plants have natural circulation tests and the others do not.

MR. TEDESCO: Your first question about the analysis, Ivanhoe is in the process of performing an evaluation of the Three Mile Island situation for natural circulation. I don't know the results. Maybe later on when Carl Berlinger comes down he can share it with you. But I know we initially had an evaluation of this matter.

DR. CARBON: Let me go back to a further question to either you or Roger. Some of the B&W plants have the steam generators quite high and some of them quite low. Are the two tests that have been run, natural circulation tests, are

wbl8

they believed to cover both the situations, the high steam generators and the low?:

DR. MATTSON: Our answer is Yes, from over here. We think it does. Let's see if B&W can confirm that so we have the right information.

Yes, they indicate yes.

DR. TEDESCO: Oconee is representative of low steam generator, Davis-Besse the high steam generator.

DR. PLESSET: Does the operator get adequate preparation for going to natural circulation from full power condition? And is it at all made aware of the importance of the pressure in the reactor and its effect on natural circulation?

DR. MATTSON: I think that's a little bit different question. I don't believe these kinds of tests are conducted starting from a full power, going through--

DR. PLESSET: I don't mean that. But I mean, is the operator aware of the things he might have to go through to get to natural circulation from full power?

DR. MATTSON: To my knowledge that is not a design consideration in setting up these procedures. But it's subject to check.

Does anybody over here have it?

MR. TEDESCO: We do know for loss of flow that they have to track through. That would be loss of power or

wb19

tripping of the pumps. So that is an effect that's analyzed.

DR. PLESSET: Well "analyzed," of course, is one thing. It means that some sophisticated engineer -- let's call him sophisticated -- has analyzed it. Does that mean that the operator understands what he's going to have to go through?

MR. TEDESCO: I really don't think at this point I could give you a specific answer. As far as the detailed operating procedure--

DR. MATTSON: We can get a specific answer pretty quickly. Let us step out and make a call and we can get your question answered on the record.

MR. MICHAELSON: I believe you indicated some preliminary findings concerning the question of pressurizer level. Would you clarify that these preliminary findings pertain both to the short term -- and by that I mean maybe the first thirty minutes -- versus the long term, meaning the next 10, 15 hours?

MR. TEDESCO: Dr. Michaelson, I was speaking to the initiation, the initial part of the transient.

MR. MICHAELSON: Well, do you have any comments or preliminary observations concerning the longer term?

MR. TEDESCO: I guess as long as you are pressurized, voiding in the system, you would indicate a level. Once you started with a simulated break up in the top side of the pressurizer I think you're going to have -- you will equalize somewhere in this time frame, and the level should show a decrease. That would be in the long term.

PROF. KERR: Mr. Michaelson, let me in on what it is you're driving at. What are the significant differences between short and long term?

MR. MICHAELSON: Well, I was really searching just for a clarification on a statement concerning the effect of the loop seal on the pressurizer. I would fully agree that the loop seal is immaterial in the short term, meaning while the system is still essentially filled with water. I would not necessarily agree with it being immaterial in the long term.

PROF. KERR: Thank you.

DR. OKRENT: During the recent interchange of questions and answers there was mention of loss of offsite power as a possible way in which you could lose feedwater, and so forth. And I was wondering whether in either your analysis of what you're doing and, even moreimportantly, in your questions and advice to those who have operating reactors, whether you have included the examination of that transient as something that the utilities should give attention to, and whether you have thought in that regard.

MR. TEDESCO: In Bulletin 79-05, appended to it is a summary write-up on the Davis-Besse incident where they

21

experienced a loss of offsite power, and the concerns about loss of equipment affecting the core are described in that attachment.

The next step of where we are today on the generic review, when I get further into the licensing aspects I'll be indicating that we do have to open up the whole approach on the evaluation of feedwater transient. We have not made specific evaluations yet ith or without offsite power questions. But it will be part of our effort.

DR. MATTSON: Let me try to answer that the same way but in little bit different words.

The bulletin's immediate on-going action is narrowly looking at the event at Three Mile Island to avoid its repetition. What Bob is saying is that the short term study tht he's doing would include an assessment of other possible initiators of this kind of event for study over the long term, or for an identification of need to do something if there's a need to do something in the short term.

We understand the importance of offsite power as (a) an initiator of this kind of sequence, or (b) a contributor to the difficulty if you have some other initiator of this kind of sequence. And both of those thoughts will have to be factored into the broader question that Bob is addressing.

End 1D

bl

3.250

DR. OKRENT: But you haven't asked the utilities to review their procedures with regard to that specific initiating event; is that what I understand?

MR. TEDESCO: Let me get the bulletin out and read right from it.

DR. OKRENT: It may be there. I was looking at 79-08.

MR. TEDESCO: Inclosure 2 is an evaluation of feedwater transients in 79-05. And it says: A loss of off-site power occurred at Davis-Besse -- and so on. And we're transmitting this information. And the bulletin says: to review the evaluation by the Staff of the postulated severe transient related to B&W PWRs as described in Inclosure 2.

Do you have it?

DR. OKRENT: Well I was looking at 79-08 and I didn't see so specific a reference to this.

I mean, we've been talking about whether the primary system pumps should be turned or something. They'll be turned off automatically in that case. And you have a rather different transient and you are rather quickly under other circumstances. And if all the effort and thinking is aimed in one direction it might lead operators to be sort of directed down one road, as they may in fact have been here worried about overpressurization from lots of discussion about overpressurization a year ago.

wb2

If I can ask just two other short questions:--

In your opinion is there a difference with regard to the probability of a transient like a feedwater transient or a control transient, or so forth, if the reactor is load following or if it is running base loaded?

MR. TEDESCO: A base loaded plant is a stable plant. You're just producing a certain fixed power level and just balancing for short maneuvering type adjustments. I guess in my opinion a plant that's a demand type of plant it probably would affect the probability. That's just an opinion. I don't have the hard data in front of me.

DR. OKRENT: I didn't notice anything in the discussion about operating plants, whether one wanted to consider whether they should stay in the load following mode if they were so, or not. And I was just trying to ascertain whether you had given the matter consideration and arrived at a judgment or not.

MR. TEDESCO: Not at this point.

DR. OKRENT: All right.

And just a question that relates really to the previous discussion. I didn't seem to see anything that related to trying to make more available temperature information from the core in any of the bulletins. Did I miss it?

MR. MATTSON: No; it's not there. I think that's part of the broader questions that we're looking at. The

wb3

whole question of instrumentation to follow the course of an accident is one that we view has to be relooked at. The question of qualification of equipment not normally called safety grade equipment is of higher importance today than it was two weeks ago. Certainly within those two categories falls a question of the sort you just phrased, that is, temperature instrumentation from the core. It's not in a bulletin, but it is in our minds and it is in our scope of inquiry; yes, sir.

While we're pausing a moment, if I could go back to Dr. Plesset's question, and I think, Dr. Okrent, your line of inquiry was somewhat related. The thrust of it was, a lot of these things are analyzed by sophisticated engineers, I believe they were described as, and safety analyses and safety evaluations, but are there procedures. But certainly for something like loss of offsite power, which is something that happens and you lose reactor coolant pumps and you depend upon aux feedwater, there are procedures for bringing that plant into natural circulation and cooling with auxiliary feedwater, and training of operators to do those kinds of things is done, and operators are examined on their capability to bring a plant into natural circulation following those kinds of initiating events.

Now whether the question of-- Well, that's enough. Does that get to your point?

4

DR. PLESSET: I think so.

But what I was in particular concerned about, would the operator appreciate the significance of getting to saturation pressure in the core, or even close to it, what that might mean for the condition within the core. I think that's-- I don't know; it might seem subtle to some operators.

MR. MATTSON: I think he would appreciate it. I think it's also safe to say he'd appreciate it better today than he might have before. And that's part of the review that's going on.

DR. PLESSET: Thank you.

DR. CARBON: Steve?

DR. LAWROSKI: In connection with the question that Dr. Okrent just raised about following some of the temperatures in the core, in the plants that have been in operation somewhat longer and perhaps have been refueled, are all of those thermocouples present in those plants? As I understand, sometimes they're not included upon refueling.

MR. TEDESCO: Do you know if the thermocouples are also in the older plants that have been refueled, Roger? Do you know?

DR. MATTSON: I was led to believe that this instrumentation was, the in-core thermocouples were pretty good in this plant compared to some others.

I think maybe B&W could answer that better than us

wb5

at this point.

Recall that this instrumentation is not required for safety purposes according to the way we normally do business. This is plant monitoring informatic

DR. LAWROSKI: Could I get an answer to my question?

DR. MATTSON: I'd have to turn to B&W to see if they have that information. I don't have it off the top of my head.

MR. McMILLAN: I'm John McMillan from Babcock and Wilcox. We do have in-core thermocouples in all of our operating units. In not all cases are they connected directly into the computer where the operator would have an immediate readout. But there are thermocouples installed in each of the operating units.

DR. LAWROSKI; Thank you.

DR. CARBON: Bob, in your review of loss of offsite power, will you carry this further to include a case where maybe the diesels don't start up?

MR. TEDESCO: You're talking about a total blackout situation? At this point that's one of the generic matters that we're looking at from the overall, you know, Category A safety items. Not at this point is it a specific requirement. The generic review on this particular event, -- Remember, it's a short-term approach we're taking from the vb6

learning experience on Three Mile Island and what it means right now. But the generic review on the longer term, we want to acknowledge the loss of power incident as an initiator. But at this point I do not see a total loss of power as being involved specifically.

DR. MATTSON: It's important to remember also that steam driven aux feed pumps do exist in all of these plants, all the PWRs.

DR. CARBON: Steve.

DR. LAWROSKI: In how many of these are they not connected to the computers?

MR. McMILLAN: There are fifty-two thermocouples in all of the units. They connect to the plant computer on the three Oconee units, Three Mile Island-2, Rancho Seco and Davis-Besse. They do have them at Crystal River as a computer input through a multiplexer, so that you can't read them simultaneously. It's a little different configuration.

At Arkansas Nuclear-1 the in-core detectors can be read from the in-core detector tank. But that's inside the reactor building and not accessible to the operator.

DR. LAWROSKI: Thank you.

DR. CARBON: Roger, could I go back to your last comment here.

Have you ever put probabilities together for plants like these on loss of offsite power and the diesels

wb7

don't start, and this single pump -- which I understand really aren't very reliable sorts of pumps. Just in general the sequence here.

DR. MATTSON: As I recall, that's Task A under General Issue A-44, which is one of the unresolved safety issues. It is to do just exactly what you're asking for.

DR. CARBON: To try to put some probabilities together?

DR. MATTSON: Yes. That is, to assess the reliability of aux feedwater from just the view that you propose.

Saul reminds me that the Reactor Safety Study locked at that aspect. But, of course, that's only one plant.

DR. CARBON: Yes. Do you have any idea what kind of timing this particular generic item will receive?

DR. MATTSON: I'd suspect that that kind of information in the normal course of events we'd see some time next fall. Whether the Three Mile accident adds or subtracts from the capability to meet such a goal is unclear to me at this point. It's going to depend in large measure on the results of Bob's work in which he is, in essence, going to say, These are the important things to do now, and here are the things that can be left to do a little later. And I don't know where that one comes out for sure.

wb-8

DR. CARBON: Thank you.

DR. LAWROSKI: With respect to, I think it was Dr. Okrent who asked about maintaining the offsite power, some of the helicopters that were flying around this plant were not all required in connection with monitoring this plant, it's plumes, and so on. How long did it take to get the others out of the way so that at least they wouldn't be there to jeopardize that offsite power which might have been needed?

DR. MATTSON: Dr. Lawroski, I can say that by the time I arrived at the site on Sunday that I was told that the plant had been placed in some sort of special status with regard to assurance of offsite power from the grid if there were difficulties with the grid. I was told that there were five separate offsite power lines into the facility, so that if one were lost it didn't mean you were necessarily in difficulty.

I also saw helicopters flying there. I don't believe there were any at that time that were not connected with monitoring efforts either by the government or by the licensee. By Monday they had moved the landing pad to a better location relative to one offsite power line. And I think that situation is under control.

DR. LAWROSKI: That was some time after, your arrival was some time after.

·b9

DR. MATTSON: Yes. I would suspect it's fair to say it was under control by Saturday. I don't think it was too far out of control ever.

DR. PLESSET: Can we move on, then?

(Slide)

MR. TEDESCO: This slide is the second part of our review, which deals with operational matters.

The equipment malfunction history. We are looking at the LERs to see if we cannot assess the malfunction history as far as the power operated relief valves. We're looking at the operator actions during this event. We're looking at the probable response to feedwater transient. Plus the human factor in the whole situation, how he follows procedures, why he did certain things. We'll see if there are not generic conclusions that one might be able to establish from the operational experiences that we derive from the Three Mile-2 accident.

(Slide)

The other part has to do with our NRC role on the licensing basis that we follow in the evaluation of feedwater type transients. We're looking at the vendors' message, their models and capabilities, the general approach that one follows in the evaluation of these types of transients.

We're reviewing the staff approach to transient evaluation, namely, the general design criteria and the Standard

wb10

Review Plan that describe the review areas, the review criteria and the findings that we make in our reviews.

We certainly now have to go back and re-look at the whole process to see what's going on in the light of the Three Mile Island-2 accident.

Along with this is involved a review of technical specifications, What are we putting in as requirements on these plants? Are some areas perhaps too refined? Are we being too specific in certain areas? And in other areas are we not being specific enough with regard to pressurizer, pressurizer level, aux feedwater systems and the reactor trip system. And then folding that into the operator procedures to try to better understand what the operator follows; What is he told to do in these type of transients, and how does that fit into the Three Mile Island situation?

The last category will deal with the operator training itself. What is the training that he gets to cope with transients of the type we've just had, and others as well?

So we're expanding our look into the whole area on the licensing basis, what our regulations tell us to do, what are the areas of weakness now which we could perhaps beef up. That is part of our generic review.

So when we put the three parts together: one about the design, one about the operational aspect, and the other about the licensing basis, then in the short term we'll be looking at the I&E bulletins, confirming the action taken there, their adequacies: we may have to add to it in certain areas depending on what we find out. And then launching into a long term generic program that will look at all the aspects that we're considering.

(Slide)

Right now where we are in regard to the three areas: As far as design of the B&W plant, our preliminary review indicates to us that we find no apparent major design deficiencies on the B&W plants. This would not preclude serious consideration of areas where improvement might be accomplished to improve the safety capability of the plant.

As far as the operation goes, we certainly agree that greater attention is needed on the plant safety equipment with regard to its operability and availability, and greater assurance has to be placed on this matter.

With the licensing aspect we certainly need more emphasis on what we had earlier believed as a regular anti-cipated event. We have to look harder at operational transients, especially the feedwater type of event: what our tech spec requirements are, the areas where they have to be augmented or modified. And in conjunction with this whole review that we are going through, we will be folding this into the I&E bulletin action to confirm the actions that are being required.

wbl2

We are working toward an action date of something like the end of this month to try to get our preliminary report put together that will speak to the areas that we have talked about right now.

That's the conclusion of my presentation.

DR. SHEWMON: If you ever got there, I missed just what the testing procedure is on these relief valves on the pressurizer.

MR. TEDESCO: Right now there would not be any tech spec requirements for testing, periodic testing. That question was folded into my tech spec review. We perhaps have to rethink that requirement.

DR. SHEWMON: Have you ever got to whether a meaningful test could be done without having pressure, a significant amount of steam be released at the same time, or without it being tested at 2200 pounds pressure in two-phase flow?

MR. TEDESCO: I indicated earlier that a lot of this concern that's being expressed with regard to ATWS, it's the same type of question.

As far as the testability goes on the plants, the safety valves and so on, they're all tested in accordance with the ASME requirements, which means bench type tests for actuation.

DR. SHEWMON: And they do that once, and that's good

wbl3

forever?

MR. TEDESCO: I'm not sure what the frequency is, whether it is only once, or after a certain modification or maintenance procedure. I don't know specifically what it is.

DR. SHEWMON: Who in the organization is responsible for this?

MR. TEDESCO: This would be in Engineering under Jim Dyke.

DR. SHEWMON: Thank you.

DR. CARBON: Chet?

DR. SIESS: Bob, will you be looking at the possibility of whether the use of evaluation model analyses, say for small break LOCAs, can lead to inadequate or incorrect accident scenarios, and, thus, to inadequate guidance to the operator?

MR. TEDESCO: At this point, yes. I can say we just made some preliminary calculations at Idaho on this type of test and it did reveal the thermodynamic behavior that was experienced. So I have to say yes to your question.

PROF KERR. Are these models being used in the conservative mode or a best estimate mode?

MR. TEDESCO: Right now, Dr. Kerr, the evaluation that we are in the process of doing is based on the Three Mile Island input parameters; in other words, what happened at that plant.

PROF. KERR: If one uses an evaluation model that conforms, for example, to Appendix K the emphasis is on conservatism rather than realism. Is the evaluation model being used that kind of model?

MR. TEDESCO: Up until March 27th the evaluation model was used on small breaks. It was not coupled to transient type events. We just have to re-look at the whole procedure, the process. I understand what you're saying about the conservative model passing out because of some of the subtlties that happened. It's a precaution that we will consider.

DR. PLESSET: It may not be entirely pertinent for what they were trying to do in their analysis, I believe, whether it was evaluation or best estimate. I think that in a best estimate mode they've gone beyond in trying to describe what happens, I think. Isn't that right?

MR. TEDESCO: Yes.

I have a curve, if you would like to see it.

DR. PLESSET: The only concern they would have would be what the decay heat would do, and probably there they would take the best value they would have.

DR. MATTSON: They took the parameters measured at Three Mile Island and input those to the code to see if they could reproduce the transient. And that, in effect, removes

wb15

the conservatisms that are there for a loss of coolant accident analysis that's done under the more traditional framework.

(Slide)

MR. TEDESCO: Here's a comparison of the Three Mile Island event and the transient that's calculated by the Idaho people. It's a preliminary thing. In the lower part here--

DR. LAWROSKI: Could you use the pointer and stand to the right, please?

MR. TEDESCO: All right.

Here we go. The solid curve is our RELAP run. As indicated down here, the dashed line is the Three Mile transient. There are phasing differences. This plot here is the peak saturation during the process, and following along until we reach somewhere about this range.

This spike appears about in the eight-minute point at which the aux feedwater system went on, eight minutes into the transient. The other curve I'll show you is related to this, it's the pressurizer level. This pressurizer pressure is falling during this period.

C4

(Slide)

Here we put the level on with the same type of nomenclature. You see the solid means the RELAP-4 run and the dashed means it's the actual transient. And during this period here we're showing a rising level, and the other curve

wb16

shows the pressure going down.

Let me see if I can't put the two together. It's a kind of a messy configuration, but let me see if I can walk through it with you.

(Overlay)

This one here is pressure, showing it going down during the transient, and then showing the level going up in the pressurizer. And that's what the operator was responding to. He thought he had plenty of water in the system and that everything was well under control. He was following procedures in the shift over to maintaining the level.

These are very preliminary runs. We haven't gone through a thorough evaluation. They're running up to about 12 and 20 minutes into the transient.

DR. SIESS: Is RELAP-4 an Appendix K approved licensing evaluation model?

MR. TEDESCO: Yes, that's what we used.

DR. PLESSET: That's not quite the understanding, Chet. It's not used for evaluation model analysis.

MR. TEDESCO: I think it is.

DR. PLESSET: But that's not what was used here?

MR. TEDESCO: No, not here. This is the RELAP-4 code that was used to mock up Three Mile Island.

DR. PLESSET: It looks as though it's doing fairly well.

7

MR. TEDESCO: Trend-wise I think it looks pretty good. There's a little shift on time sequences that we haven't ironed out yet. But for a quick run to get some quick sense of what happened, I think it's pretty good.

DR. CARBON: Dave?

DR. OKRENT: Bob, I think you made a comment that as of now you don't see any basic design deficiency.

MR. TEDESCO: I used the word "major."

DR. OKRENT: Major design deficiencies.

MR. TEDESCO: Yes.

DR. OKRENT: In what context are you making that statement? Is it in terms of the specific transient or accident at Three Mile Island, or is it a general one where you consider response to small breaks of all sizes, or a range of transients, or what's the context of the comment?

MR. TEDESCO: The initial attention is on the Three Mile Island event, on what experience we've derived from that. Folding that into the design of the plant, do we see anything basically wrong with it? And as far as we can tell at this point, from a short term look we have found no major design deficiencies.

DR. OKRENT: How do you plan to ascertain whether there could be, or may be design deficiencies, if there are any, for other kinds of transients, including small breaks or intermittent breaks or whatever?

wb18

MR. TEDESCO: I have to rely on the outcome of our generic program for that. I tried to indicate our short term approach. It clearly focuses on Three Mile. And then we have to shift into the more generic aspects. The outcome of our report will be a set of findings and recommendations from whatever we learn, and not to be so narrow that we don't look at other aspects of it.

d 1E

1f eb1

DR. OKRENT: Has the Staff initiated a long-term program concurrently with the short-term program, or does it have to wait?

MR. TEDESCO: That's what we're trying to do now. That's part of our effort.

MR. MATTSON: Part of the goal of the short-term program is to define the long-term program.

MR. TEDESCO: We're only a part of the whole effort

4.040 on this thing. You know, if anything has taken priorities, if it's one, two, three or A, B, C, it's one and A, believe me, on the whole thing.

MR. MICHAELSON: Bob, I have just one question and that is I'm having a little difficulty yet sorting out the short-term events at Three Mile Island and the longer-term events. You addressed here the computer calculations and observations and also drew a preliminary conclusion concerning I guess the short-term situation.

Would you care to surmise or at least indicate what you feel concerning the longer term, and also indicate perhaps when you really think the damage occurred. Is is a short-term effect or a long-term effect, and if it is a long-term effect, then that's the one that appears to be the desirable one to concentrate on.

DR. SHEWMON: By "damage" do you mean core damage?

MR. MICHAELSON: I mean when did all the activity appear to be released? Core damage of course is the thing of major concern here.

MR. TEDESCO: When I contrast long term and short term I do not include such things as the containment isolation, dealing with hydrogen, dealing with highly contaminated fluids, and stuff like that.

I'm in short term looking at initiating events and how it propagated in the system, up to the time we had the core damage which was, you know, within the two-hour period when the went off, and just seeing what the reactor responded to.

060

As far as the long-term accident recovery, that's another type of generic program that we'll be following.

MR. MATTSON: Maybe I can try.

Bob, I think two hours is about the time that Carl is starting to get interested. It's between two hours and 15 hours that damage occurred, according to the information we have today.

Bob is saying he's looking at the transient up to that point that got you into the situation where damage did occur, and that's the kind of thing that we want to concentrate on in the sense of the short-term for deciding what are the proper things to do from a procedure standpoint or a design modification standpoint or an operator training standpoint to not get in a situation where such damage would result.

3

Clearly there has to be a good look at the mechanisms of damage, how the system was behaving once you got into the box that could cause damage. A lot of that is going on right now, trying to characterize what the core looks like for long-term cooling purposes, trying to understand the mechanism of damage, the extent of damage; that sort of thing.

I suspect that that may in fact be finished before Bob has got his long-term program underway. We're not ignoring it. But Bob is saying he's concentrating on the safety of operating plants.

MR. MICHAELSON: Maybe I can make one more comment in clarification then.

I would have to conclude from what you have said I believe that you have strong reason to believe the problem developed in the first 20 minutes and that that was kind of the end of the analysis. Is that right?

MR. MATTSON: I think the sequence of operator actions and equipment performance in the first 20 minutes is very important and over the next two hours it is also important. By the time you finish the first two to three hours, you're in a position where the core is being damaged, extensively damaged. And the goal here is to avoid getting beyond that first two hours.

It's certainly important to understand what happened after the two or three hours but with the idea being that you

b4

don't want to repeat that, then the focus right now, in our judgment, has to be on how do you prevent the first two hours from occurring.

MR. MICHAELSON: Are you intending to carry the analysis out further than 20 minutes, say for the first two hours?

MR. MATTSON: Oh, yes. I think eventually there will have to be an analysis that extends not only the first two or three hours but tries to reconstruct the physical situation within the reactor vessel over the whole accident, right up until today.

Sol reminds me that a lot of that is not done with computer calculations. Once you get steady-state and stationary, stable, a lot of it is done by hand calculations. Computer calculations of the sort that Bob has shown won't go that long.

DR. SHEWMON: I think we're all concerned that one doesn't get too enamoured about how well one can get the computer to fit the irrelevant part of the curve, the marginal irrelevant.

MR. MATTSON: Yes, sir.

DR. CARBON: Are there other questions by the Committee?

(No response.)

Does that then conclude the presentation?

MR. MATTSON: Yes, that's all we had planned this

$.LL)

xzxzxz

morning. And the other things I mentioned we will be prepared to discuss later this afternoon.

DR. CARBON: Let's then take a ten-minute break.

(Recess.)

DR. CARBON: Let's move on to the next part of the agenda. I would like to call on Mr. Etherington to lead off discussing the status of the Three Mile Island Station.

Harold, will you present your report?

MR. ETHERINGTON: Mr. Chairman, I spent two and a half days with Dr. McCreless of the ACRS staff at the site, from April 10th to 12th, observing the offsite activities across the river from the plant, attending meetings, and talking to personnel.

Other Committee members and Committee consultants attended at various periods and I presume they have also made their own observations.

My observation is the two organizations, the Three Mile Island Recovery Organization and the Industry Advisory Group, comprise an exceptional assemblage of high-level talent. It would be difficult to get together an organization better qualified to steer the recovery.

THe chain of events has already been described by Mr. Michaelson to the Committee at a previous meeting, and I believe he proposes to update his conclusions.

We have also heard from the Staff and expect to hear

eb6

further complete statements on the chain of events, and the recovery procedures from others during this meeting.

With your permission, I would like to forego a statement that would be fragmentary and prove repetitive, and I would like to focus the attention of the Committee on two basic, if obvious, requirements for natural circulation, one of which appears -- and I emphasize "appears" -- from the record -- Let me restate that -- one of which appears from the record -- and I emphasize "appears" -- not to have been met at the Three Mile Island Plant, and this could well have been the prime cause of the seriousness of the accident.

4.135

If I may go into that description, Mr. Chairman?

The heat sink in the steam generator must be at a higher level than the core of the reactor. Obviously, if the heat sink is at the same level as the core, we have a hot leg which is balanced by a hot leg, a cold leg which is balanced by a cold leg, and no driving force to promote circulation.

If the core is much below the heat sink or let me say it the other way: If the heat sink is above the core, then we have a balanced hot leg here, a balanced cold leg here, and a cold leg here, which is also offset by a hot leg here, and the driving force is the height of the one-inch square column of cold water minus the weight of a one-inch-square column of hot water.

Now clearly the first requirement is that the heat

b7

sink must be higher than the heat source. A conservative interpretation would be that the heat sink should be as high as possible in the steam generator.

Now, let us look at the actual conditions. During steaming operation at full power, the level is 42 feet high in a total cube length of 52-odd-feet. At full power the level in the steam generator is about 42 feet.

At low power, down to 10 percent, the level is only about 7 feet way down here.

Tom McCreless and I looked hard to find a statement of what the condition would be during operation of the auxiliary feedwater system. We found the statement in either the SAR for Three Mile Island or in one of the PSAR -- I forget which it was we found it in. We looked in both. And the statement was that when the auxiliary feedwater came on, the level is to be maintained at an unspecified high level.

However, the record appears to show that following dryout after the loss of feedwater, the level remained extremely low, about one foot, way down here, about 20 minutes

170

and at the time the recirculating pumps tripped, the level was only about five feet, still way down here.

One obvious conclusion which one would be tempted to make is that there could be no possibility of a natural recirculation occurring at that time. Now I will qualify that statement later.

b8

Obviously another conclusion-- The first conclusion would be that the level control appeared not to function as stated in the SAR.

After the pump was tripped, the water level rose slowly in the steam generator and the secondary pressure dropped to about 300 psig. This clearly suggested a continuation of inflow of feedwater but with loss of heat sink inasmuch as the temperature -- pressure in the steam generator didn't rise at

183

all. It was actually falling.

At the time the satisfactory level was reached, and this was very late in the transient after the pumps had been tripped, the second requirement, which I will mention now, could not have been met, and therefore, natural circulation couldn't have been promoted at that time.

The second requirement is that the pressure of the reactor coolant must be high enough to prevent breaking of the circuit by gas accumulation at the top of the loop. If we have an accumulation of gas here, clearly it will be a problem in establishing recirculation.

A conservative interpretation of this criterion would be that there should be no release of gas.

I believe -- and I think if I'm not correct I would like the physical chemists to correct me -- if we have a gas bubble in the system and the free service of water, the pressure here we'll say is P, and we'll give that a saturation

eb9

199

temperature, CP_{sat}, then the pressure here will have to be P_{sat}. The saturation pressure corresponds to the temperature of the water plus the partial pressure of the hydrogen in the bubble.

Now for a bubble to exist the pressure must be equal to P_{sat} plus PH_2, partial pressure of the hydrogen.

We can see what would happen. Let's suppose we increase the pressure here and keep the temperature the same. The saturation pressure of the steam would have to stay the same. To balance this, the pressure of the hydrogen, the partial pressure of the hydrogen will have to increase. For the partial pressure of the hydrogen to increase, the hydrogen will have to pass into the water in order to maintain the equilibrium between the water and the gas phase, and that means the bubble will shrink.

And ultimately when the total pressure exceeds these two, there will be no longer any gas bubble.

Now I'm not a physical chemist, but I think that's appro imately right.

Steve, can you tell me what your opinion is?

DR. LAWROSKI: I think you're very modest.

MR. ETHERINGTON: This is now a presumption. By the time the level rose in the steam generator to where you could conceivably maintain natural circulation, there had been so much damage to the core that there was a very large quantity of hydrogen generated, and the loop that I erased at the top

eb10

of the steam generator is completely filled with gas, and there is no possibility of recirculation.

Now please understand what I'm saying is not a statement of what occurred. It is something which I think the Committee might want to think about in its deliberations of the over-all problem.

I should say something about the possibility that there might have been some recirculation in spite of the very low heat sink. There are two ways heat can get over.

The first is the spray. In the auxiliary feedwater mode the spray is right at the top of the steam generator. It's spraying on the tubes. I don't know to what extent it penetrates the tube bank. I don't know how much water was spraying, or how much heat could be removed; that is, what temperature could be established in the cold leg.

The evidence, however, does seem to be that there was no recirculation established. So whether this mode was effective or not, I think we would have to leave it to B&W to give us an analysis of the degree of penetration that they could expect into the tube bundle.

The second possible mode of -- if I may call it a degraded means of heat transfer to the steam generator. Shortly after the pump trip the hot leg was at or above saturation. We had hot water in the leg above the reactor vessel. There would be bulk boiling, presumably, in steam, a crossover at

11

that point and steam could pass over, condensing in the water in the cold legs and give you some mode of heat transfer which might establish recirculation.

This doesn't look like a very strong mode of heat transfer. Whether this would be an effective means of establishing natural circulation, I don't know, but the evidence is of course that there was no natural circulation.

Now with these comments, it does appear important that for all pressurized water reactors there should be a precise instruction concerning t.e conditions necessary before transferring from forced circulation to natural circulation, and secondly there should be a clearly specified means of verifying the natural circulation has in effect been instituted.

These apparently were lacking and I say again "apparently" only as an inference.

I don't know how fast the steam generator can be filled with the auxiliary pump. That also might be a factor. If the reactor was operating with the water in the steam generator at a low level, then we would have to have a means of filling it fairly fast in order to establish the circulation.

Mr. Chairman, I think I will-- Well, let me see.... I think the Committee might want to have this in the back of their minds as context material in considering the effects of the early abnormalities. We could conclude that the early abnormalities had no bearing at all on thesubsequent events, 2 that in any case, as long as the transfer to natural circulation was made, it was made with a low heat sink it could not have been established, or we might conclude that the early abnormalities did in effect contribute to what developed later, possibly by gas generation.

t.280 I think that's all I have to say, Mr. Chairman.

DR. CARBON: Thank you, Harold.

Are there questions for Harold?

DR. PLESSET: I don't see quite how you can suppose, if you had a fair amount of hydrogen in there, that it would disappear. Certainly the vapor will disappear if the pressure is above--

MR. ETHERINGTON: If you get the pressure high enough so that the concentration of the hydrogen in the water is greater than the partial pressure that you would have in the steam space, then of course there would be no gas bubble.

DR. PLESSET: But the hydrogen is going to have to dissolve.

MR. ETHERINGTON: It would have to dissolve.

DR. PLESSET: And it might be a very slow process.

MR. ETHERINGTON: Oh, yes. Excuse me, this is strictly at equilibrium.

DR. PLESSET: Vapor condensation is rapid but the hydrogen dissolution, that is--

MR. ETHERINGTON: You're absolutely right. I should

b13

have made it clear I'm talking about an equilibrium process and the dynamics of it is something quite different.

DR. SHEWMON: To make sure I understand what you said, on the first part you said not only do you need a solid primary system for natural convection, you also need the water level in the secondary side high enough--

MR. ETHERINGTON: -- to provide a heat sink which it at a higher level in the core. You need a cold leg on one side that more than balances the hot leg on the other side by the greater density of the water.

DR. SHEWMON: A different one, though.

Do you have any evidence that says there was a significant amount of hydrogen generated before, say, one and a half hours, which was after both the pumps had been turned off?

MR. ETHERINGTON: No, I haven't. But the water level in the steam generator remained low for a long time.

DR. SHEWMON: Long? You mean before and after the--

MR. ETHERINGTON: Before and after. It rose gradually after the pumps were tripped, but it didn't reach a really high level until hours, I believe, into the transient.

DR. CARBON: Fine. Let's go ahead then.

Carl, would you present--

MR. ETHERINGTON: Could I ask whether the Staff has any rebuttal to what I said?

DR. CARBON: Surely.

67-109

1G agbl

The question was raised, do you have any rebuttal to what Mr. Etherington has said?

MR. MATTSON: I think Harold understands the situation quite well from the discussions he's had with the people up there.

If I could try to summarize what I think the message is, Mr. Etherington, then we can make sure we've understood what you've said, because I think we agree with you.

I think you're saying that the success of putting this machine on to natural circulation at the time the reactor coolant pumps were tripped several hours into the accident would have been a function of where the thermal center was in the steam generator.

MR. ETHERINGTON: That's right.

MR. MATTSON: And the higher the better for that thermal center.

MR. ETHERINGTON: Yes.

MR. MATTSON: But because the steam generators had been through a transient where they boiled dry because of no feedwater and then were refilled, that thermal center at the time the pumps were tripped was low in the steam generator. And had it been higher, natural circulation may in fact have been achieved in time to prevent serious damage to the fuel.

MR. ETHERINGTON: That sounds right.

MR. MATTSON: That is more succinctly said today

b2

than I've heard it said before, but I have no reason to quarrel with the technical facts that go into that kind of statement.

MR. ETHERINGTON: It doesn't seem to be very much factored into the discussion of the chain of events, does it? It hasn't really been discussed very much, this particular phase of the accident.

MR. MATTSON: WEll if I go back to Carl's point about making sure that you look at the two to three hour portion of the transient, I think the emphasis has been on early in the transient, where the loss of feedwater and the stuck open relief valve were very important controlling parameters. I have not heard considerable discussion of what you're talking about. I think there ought to be more.

DR. CARBON: Dave?

DR. OKRENT: Since this is not my field and I'm trying to learn as I go along, I have to ask questions. And I earlier asked questions about the loss of off-site power and whether you were thinking about that, and what you were suggesting operators be prepared to deal with.

What I can't tell is whether, in the event of loss of off-site power, you might be in a position where your steam generator level was low and where, when you hoped to go into natural circulation, for example, you met one of the conditions proposed by Mr. Etherington, a no-go condition, in other words, too low a level in the steam generators.

b3

MR. MATTSON: I'm not sure I can answer a question of whether we have confirmed that that's the case for the loss of off-site power analysis. But certainly that would be an important consideration in the loss of off-site power analysis transient. Where you lost the reactor coolant pumps, you would be on natural circulation in the primary system, you would have a small transient in the secondary system where you went from normal feedwater to aux. feedwater and the movement of the sink or the thermal center, as we've been talking about it, would be an important consideration in that analysis.

But these plants are analyzed for that event, and shown to be capable of sustaining that event without fuel damage.

The question I think you're phrasing is that event as normally treated in the safety review is not compounded with some of the failures that were observed early in the transient at Three Mile Island and so how would some of those factors, compounded with this normal transient, affect the course of that transient.

DR. OKRENT: I guess I can't tell whether the short-term program described by Tedesco earlier might benefit from a little bit of broadening in what he's thinking about.

MR. MATTSON: Your question is, is this kind of effect to be included in Tedesco's program? The answer is, it is.

DR. CARBON: Dr. CAtton?

agb4

DR. CATTON: I'd like to make a couple of more comments along the same line as Harold.

I don't think you could ever reliably establish natural circulation with saturated fluid, I think the head is just too high from the top of the steam generator down into the core. Also, if you once bare the core and start to generate hydrogen gas, I don't think your condensor is going to work. Even if you have the surface available in the tubes of the steam generator, I don't think you're going to get much condensation. There will be blanketing by the hydrogen gas.

DR. SHEWMON: But the operator presumably could have been able, or hoped he was able to go to natural circulation when he turned the pumps off, which was before there was any hydrogen generated.

DR. CATTON: But the fluid was saturated by that time. He was boiling at that time. I think if the operator knew that you can't get natural circulation with saturated fluid, he might have done something else.

DR. SHEWMON: Saturating to you implies certain areas which are super-super-saturated and thus it's boiling, is that right?

DR. CATTON: Right.

DR. CARBON: Let's go on then, Carl.

?A agbl

4.440

MR. MICHAELSON: What I wanted to do this morning was to go over the data that is now made available to us for the event at Three Mile Island and discuss just a few of the curves with you. The handout has 19 curves. I'm not going to discuss all of them because of the limitations on time, but certainly if you have a particular problem, I'll pull that particular curve.

I'd like to keep this kind of informal now, so just interrupt as we go.

(Slide.)

I'm afraid some of this will be repetitious from what you might have discussed on other occasions, but I would like to go through with you, just to be sure we're all together.

The first slide shows the --

PROFESSOR KERR: Excuse me. Would you comment on the difference, if any, between these curves and the ones we saw earlier, aside from distinctness of them?

MR. MICHAELSON: These are essentially the same curves, the earlier ones were received by Thermofax or electronic transmission, so some of the scales got stretched out, I noticed. You can't overlay them too well.

These are pretty good curves, and they have a few corrections already made on them. Keep in mind, of course, they are still preliminary curves and may have other corrections required. But this is the best we've got, and I think it is

agb2

appropriate that we work with these until we get something better.

PROFESSOR KERR: Thank you.

MR. MICHAELSON: They have been redrawn and data points have been plotted and you can tell now the difference between strip chart data and computer data so they are much more useful than that first set which were quite difficult to read.

I didn't have time to cover these up so it's still a little hard to follow these, but basically here's the pressure transient that was observed. As the feedwater system was lost and the turbine tripped, the pressure proceeded to rise on the primary side until the relief valve opened, which was in the vicinity of about 2250.

The reactor scrammed at about 10 seconds more or less, and the pressure proceeded then to go at a very rapid drop, which is to be expected. However, the drop is somewhat more than is expected in that it appeared to go down continuously, and I will show you later on the curves that have just kept on going down, which was a little unexpected and perhaps indicative of

4.490

an in-progress loss of coolant accident.

While observing the level, you can see again the level did a rapid turnaround. In fact, it turned around in less than a minute which, for some people, was surprising in view of the fact that the high pressure injection pumps were not

agb3

scheduled to come on until 1600 pounds was reached, which was in the neighborhood of 2.5 minutes into the event. And you can see from the curve here that there didn't seem to be any change in shape when the pumps came on, which might be a little surprising.

There is a fair indication -- and this is strictly hearsay, I guess you would say -- there is a fair indication that the first pump, of course, was running, the B pump was running at time zero because it was used for normal charging.

The operator has instructions, apparently, at Three Mile Island to manually start the A injection pump upon a reactor trip in order to assure that you don't lose track of where the level is in this transient, it helps to turn it around much quicker. However, it isn't a safety requirement, since that is only required at 2.5 minutes.

There's a possibility that he might have even turned on the C pump, but we have no way to establish that at this time.

But at any rate, there's nothing on this curve to indicate pumps came on. There is an indication when the first pump was tripped. You've got a nice little discontinuity.

This might have been the B pump, I don't know. If it was, it was probably well throttled back because the B pump was operating a level control off the pressurizer and wouldn't have been delivering much flow at that point anyhow.

gb4

Interrupt me now if you have any questions. I'll just go on, because there's quite a bit to cover.

(Slide.)

This is a plot of the temperature during the first eight minutes. The temperature peaked at about 611 degrees on the A loop on the primary side. It came down very quickly as the cold leg temperatures rose and we see within one minute we're establishing very small delta Ts through the core, which is what's to be expected with all the reactor coolant pump flow, and only reactor heat now to deal with.

4.530 It's also interesting to note that the temperatures really didn't rise a whole lot for the first four to five minutes. They started rising very rapidly when the first HPI pump was tripped at about 4.5 minutes. Then they took off on a pretty good slope here until about 8.5 minutes, at which time the steam generator auxiliary feedwater was flowing and a new heat sink was established.

Up to this point, the only heat sink that would be apparent would be the open relief valve itself.

(Slide.)

This curve extends out into a little further time to again show the pressure now coming down and reaching the 1600 pound setpoint somewhere in the neighborhood of 2.5 minutes. And dropping on down to this point.

Now this is the point at which the system has

gb5

depressurized to the saturation conditions corresponding to the T exit of the core. At that point, the system proceeded to reheat because, as you recall from the previous drawing, this is where the HPI pump was also tripped, and so the system started to reheat and you're just seeing a saturation line here which I will show you in a minute.

As soon as the steam generators became effective as heat sinks, it turned the temperature right around and -- pardon me, it turned the pressure right around and it came down again. The temperature was doing the same thing.

DR. CATTON: Was this following a saturation curve during the last portion?

MR. MICHAELSON: I'll show you the curve in a moment. It'll be easier to talk about it then.

(Slide.)

This is just a brief rundown of what happened to temperature during the first 32 minutes. Again we see this period of time when the temperature was rising rather rapidly until the steam generator became effective and it turned it around very nicely and you can see the hot leg temperature on the A and the B loop.

Now the reason for differences here are probably related to the steaming rates out of the two steam generators, they were probably not steaming at the same rate for both generators therefore one was running with a little larger

agb6

delta-T on it than the other.

DR. SHEWMON: Is there any evidence of when pressure -- steam generator B opened up? There has been repeated talk about leaks in that steam generator.

MR. MICHAELSON: I did not follow the leak situation, but I think I have some curves that might give some idea.

DR. SHEWMON: Thank you.

(Slide.)

4.590

MR. MICHAELSON: This is the saturation curve you were asking about. Here's the plot of saturation, pressure, and here is the plot of the real system pressure. Of course, it tracked very nicely until the steam generator became a heat sink. At that point, there was a slight overpressure again available on the system for up to about 15 to 16 minutes.

I would surmise that this overpressure was probably available because there was quite a bit of heat remaining in the pressurizer yet because of hot walls and, of course, perhaps, the heaters were on. I do not know yet when the heaters were lost to the event, but there was an overpressure, a very slight one, during this period of time.

As you can see, it started losing at about 17 minutes.

DR. SHEWMON: Carl, is there any way that the operator has of knowing where he is relative to saturation in something like this, any practical way?

agb7

MR. MICHAELSON: The operator knows his pressure, which is this curve, he knows his system T exit temperature, which is measured up on the hot leg partway up, near the flow elements, so he knows what the saturation pressure is according to what temperature he reads and there's a set of these kind of curves for each possible condition he could be in, I guess.

DR. SHEWMON: Well I guess my question is how does he know it? He could go back and look at a chart on the wall and figure it out if he has time and inclination, is that it?

MR. MICHAELSON: That would be it. If the chart was readily available and it had been plotted up in a useful form, he can pull the steam tables out and derive one. It's not a difficult operation.

DR. SHEWMON: For an operator.

MR. MICHAELSON: Yes.

DR. SHEWMON: With three things going on.

MR. MICHAELSON: I don't think he would do this, very likely, but he could.

Now we should keep in mind that this is not a real fast transient, although it isn't exactly slow in terms of all the kinds of things the operator is required to do.

DR. OKRENT: This is the sort of thing you could easily teach a computer to do, I would think.

MR. MICHAELSON: You could easily read into a computer the conditions and it will keep plotting the saturation

agb8

curves for you on a cathode ray tube or something, it would be real handy.

(Slide.)

This is the auxiliary feedwater discharge pressure. This is primarily simple evidence to show when the auxiliary feedwater was likely to have started. The auxiliary feedwater started up automatically, both the electrical and the steam-driven.

Now there is a bit of conjecture yet as to whether the electric-driven are automatic. But I have it on reasonably good authority that they are automatic, but I'm not positive. The steam-driven is automatic.

But at any rate, within 30 seconds or so they were all up and running. And then they just sat along here at a certain discharge pressure which is set by the pump characteristic and the amount of minimum flow that might have been falling back to some tank, enough flow to keep the pumps from boiling.

And they will set at a constant pressure until you start to open up the valves, at which time the pressure will drop commensurate with the increase in flow.

So you can say here, I guess, at eight minutes he started to do something to increase flow on both the steam- and electric-driven, and at about 10 minutes he did some more.

This is not real clear to me as to whether that was an operator action or some kind of an automatic action, but clearly something more was done to increase flow at around 10 minutes. And then it was backed off again at around 11 minutes, and I assume from then on they just got the flow he thought he needed to put his steam generator wherever he wished to keep it.

DR. OKRENT: Do you know if the valves that were opened were opened from the control room or from another point?

MR. MICHAELSON: I did not talk with the operator who was in the control room at that point, so anything I could say would be purely hearsay.

So would you rephrase the question and I'll give you the hearsay.

DR. OKRENT: At eight minutes the valves that were closed and preventing auxiliary feedwater flow were opened. From where were they opened? Was it a manual or a remote procedure?

MR. MICHAELSON: It's my understanding only from hearsay that they were opened from the control room by simply pushing a button and putting it back in operation. But that's not an established fact yet.

DR. OKRENT: Is there anyone here who can give me a different impression of that? In other words, were those valves opened from the control room at eight minutes?

MR. MATTSON: I'm operating on the same hearsay that

agb10

Carl is, that's my understanding.

DR. OKRENT: Does B&W know anything different?

MR. MC MILLAN: I don't know anything factual that would be different from that.

DR. OKRENT: Thank you.

(Slide.)

MR. MICHAELSON: This is the curve that's showing what's happening in the once-through steam generator during the first 32 minutes.

And it's kind of interesting also because you can see that, of course, as is characterized by once-through steam generator -- and I'm sure B&W can give us more information on this -- when you essentially isolate the generator, which you do when you trip the turbine, the level of fluid in the system which is really originally running at kind of a froth, it will collapse and settle down very quickly to some relatively small level.

Here apparently it was something of the order of 10 to 15 inches in the steam generator which seemed very low, but it may have to do with where inches are measured from. And I'm trying to get the data now on what the instrument was really reading. Zero on that instrument does not necessarily perhaps mean the steam generator is empty. I don't know yet.

But at any rate, it settles down to a very low level. And according to this plot, the actual level was not changed bll

for 20 minutes.

Now this is only the level at the bottom, it has nothing to do with the spraying of the tubes. This is only a reflection of the accumulation of water at the bottom.

And it remained relatively fixed for 20 minutes, at which time it started coming up and you can see from other curves that the operator was starting to raise this minimum level.

However, the real action that occurred was somewhere -- after a couple of minutes, the steam generator could no longer hold pressure. The reason most likely is it was running out of water and the automatic circuitry which attempts to control pressure could no longer hold it up, so the pressure came on down without control.

And it proceeded to come down to around 800 pounds or less. And I'm sure when the operator noticed this condition developing, he recognized the need for getting water back in the generator, which he did at the eight-minute point. And this is another very nice check on the other charts to show that yes, indeed, at about eight minutes certainly something rather dramatic happened.

DR. SHEWMON: This is secondary pressure?

MR. MICHAELSON: This is the secondary side of the once-through steam generator, the steam side.

DR. SHEWMON: Okay. Why is it when he turned the

agb12

pumps on -- and the bottom line here is indicating the level on the primary or the secondary side.

MR. MICHAELSON: This is the secondary side water level on the bottom.

DR. SHEWMON: Now Harold earlier was talking about where you wanted your level to get, I guess it is technically called the thermal center, up in a nice high place. Is this bottom line here a reasonable indication of what is called the thermal center?

MR. MICHAELSON: I would not think so. I'll show you a picture here, maybe it will help clear up your question.

(Slide.)

This is a once-through steam generator, and the level we're talking about is this water at the bottom, as opposed to the water which is spraying in near the top of the steam generator.

I would expect -- and I'm not qualified to discuss these generators in detail, but I would expect the thermal center is being controlled by the spray of the auxiliary feed-water on the tube bank being up in here at some point. It wouldn't convect too well if this were the only cool section, it wouldn't even work. It's not too likely, at least, to work, but thats what we're talking about -- is the situation we're in.

This water level is probably immaterial, I believe.

b13

I think it's the spraying of the tubes that is really the effective part, although this could also be an effective cooler so long as you have reactor coolant pumps running, which we did in this case.

DR. OKRENT: Could the delay of the increase in water level be due to evaporation of all of the water being sprayed in because of an initially warm primary system?

MR. MICHAELSON: I'm not sure I track your question.

DR. OKRENT: In other words, what you see there is at eight minutes water started coming in but none was reaching the bottom. And I'm asking, could it all evaporate before reaching the bottom or what?

MR. MICHAELSON: I believe that would be a likely conclusion, yes. I'm assuming that this steady level here might be indicative of the fact that whatever was being sprayed early in the game, for instance, was -- well, pardon me, early in the game is over here (indicating).

This early in the game, the beginning first two or three minutes could only have been controlled by water remaining in the bottom of the steam generator, because there was no auxiliary feedwater flow for that period of time.

DR. OKRENT: Let me put it this way. If you had had full flow from the auxiliary feedwater system at eight minutes, would you expect to start accumulating water at the bottom at eight minutes?

gb14

MR. MICHAELSON: Yes, I would have expected it unless it were being heavily evaporated to the extent of, perhaps, all of it being evaporated. Yes, I would expect the water level to start to rise because now you're spraying.

This was the condition at the beginning, there was no spray here. There is some water here that could have been effective as cooling, perhaps, but you will also note in the drawing it didn't seem to change in elevation.

So I said Well, gee, I guess we didn't boil this dry either. Maybe it didn't even communicate somehow with the heat source, because this should have, I would have thought would have dried out because you are in forced circulation.

But that sort of thing is among many loose ends which need to be tidied up.

(Slide.)

DR. SHEWMON: The steam that is -- the turbines shut off and tripped, this goes directly into the condensor and that's our heat sink ultimately?

MR. MICHAELSON: The steam that might have been generated here goes to the --

DR. SHEWMON: No, on the right.

MR. MICHAELSON: This steam is going through the bypass valves to the condensor, yes. The bypass valves open up the control pressure and he appears to be on pressure control here which is about the right range where he might want to

agbl5

operate.

You remember the B generator was doing some earlier strange things and he controlled it lower down. I cannot at this time explain why these two were always consistently different. It had to do perhaps with operating mode but it may have had to do with a whole lot of other things.

(Slide.)

This is the information relative to when the reactor coolant pumps were tripped. This shows the, presumably the mass flow in the reactor coolant loops, both the A loop and the B loop.

The B loop was secured at about 75 seconds -- I'm sorry, 75 minutes. It was secured because there was apparent problems with it.

Again, this is only subjective but the indications I have were that the ammeters started to oscillate, and they were receiving alarms on vibration. The ammeter oscillation is a real good indicator if the pump has decided to go into surge. And the vibration, of course, is a good confirmation of it as well.

As I understand it -- again from hearsay -- it was that the B loop got in trouble first in terms of vibration and surge, possible surge. The A loop then proceeded to operate until about 100 minutes, after which it started doing the same thing that the B loop had done earlier, and so the operator cut

agb16

it off at 100 minutes.

MR. MATTSON: Carl, could I interrupt just a second? Does the behavior you were noting in the B steam generator on the previous slide coincide with the time of the trip of the B loop pump, or are those totally different in time?

MR. MICHAELSON: Well, we'll have to find out.

(Slide.)

There's a lot of good information in these things, if we'd just have time enough to sit and think about it.

MR. MATTSON: I can't read it from here, but it looks like it's earlier in time.

MR. MICHAELSON: I'm not sure now your question, at what point in time are you concerned with?

MR. MATTSON: Well you were pointing out that the B steam generator is apparently doing something different than the A steam generator and it's unclear whether that was operator control or some normal behavior of the system. But that looks like, if I can read it, like about 20 minutes. Is that the scale now?

MR. MICHAELSON: Well out here, this is 20 minutes out here.

MR. MATTSON: But you said that continued over a fair length of time.

MR. MICHAELSON: That's right. And I didn't attach too much importance to it because -- when looking at a bunch

agb17

of curves that are in the handout, but I just didn't want to talk about -- he apparently just decided to keep different levels in the generator and so forth, so perhaps there's a lot of illogical explanations, maybe not. I think it's a good area to look at for whatever information you can glean from it.

MR. MATTSON: Well lower level in that steam generator would coincide with quicker reaching of conditions in the B loop, saturation or what have you that caused the pump to cavitate or oscillate and hence led to the securing of the B loop before the A loop.

MR. MICHAELSON: Yes, but the B loop was running at a lower temperature than the A loop, which you will recall was --

MR. MATTSON: That's contradictory.

MR. MICHAELSON: Yes.

(Slide.)

There may be other real good explanations but this situation was here you ran along on the B loop, it's somewhat cooler.

DR. SHEWMON: Let me stay with that. The last one doesn't have to go back on, but as I look at these various curves the thing is that the reactor continued to be bled -- of the primary system continued to bleed. And ultimately, we then ended up with inability to pump water or things which made the pumps cavitate -- or at least they couldn't pump

b18

enough water, I guess that's what the last figure showed, isn't that right?

MR. MICHAELSON: What I was going to do was, I'm going through what I consider the facts first, and then I was going to spend just a little bit of time on possible guesses as to what is happening and how they might relate to the facts, just so I don't -- you know, I don't want to make that part sound factual because it's not, it's just an idea.

DR. LAWROSKI: Do you know if before the accident there was this difference in the behavior of the two steam generators?

MR. MICHAELSON: I don't know, I just haven't had time to sit down and look at it carefully. I don't know. I just don't know how much importance to put on it. It may be very important, but right now I'm not -- my guess is that it's not the thing we're looking for, but it may turn out later that one would want to look carefully. I'm sure that all of this will get worked over very hard. These are just first looks at it without a whole lot of time yet to do it in detail.

(Slide.)

This is a curve of what happened to the reactor coolant system pressure versus time. You can see the initial depressurization curve coming on down and it dropped to a relatively low level at about 2.3 hours into the event, and you'll recall that that was a little while after the reactor

gb19

coolant pumps had been tripped, which was right along in here. And the pressure just kept on coming down.

At this point, as I understand it from the chronology of events, the relief valve was closed. And of course, as one might expect then a very rapid, a relatively rapid repressurization occurred. This isn't really all that fast when you look at the time scale. It was fairly slow as this part of the event goes.

But it went back to full pressure. And after this there is a large number of operations that were performed for which I have little or no information yet and I would be purely guessing as to what all this is about until we get some information on when pumps are turned on and off, when relief valves were opened or closed or when the steam generator situations were changed or whatever.

But clearly it went through quite a number of operations all the way out to somewhere around 15 hours more or less, at which time, as I understand it, they finally went to the full flooding and turned the transient around.

I am soliciting information out here to 20 hours because I could not conclude that the event terminated yet on this chart from looking at the numbers.

MR. MATTSON: Carl, a question, have you tried to correlate the indicators from the self-powered neutron detectors in-core with the first ramp in pressure there? I think you say

agb20

that that corresponds to when the valve was isolated.

My chronology says that's about 2.3 hours. The self-powered neutron detector strip chart shows that they indicate erratic behavior beginning at about 2.5 hours.

MR. MICHAELSON: I thought it was earlier than that.

MR. MATTSON: My technical people tell me that what they're probably seeing is voiding in the core, gamma indication rather than neutron indication.

And that's a little difficult to understand with that pressure ramp going on at the same time, unless we haven't fully understood the timing yet which might put it out with the pressure decrease after that initial peak.

You haven't looked at that and compared it with this chart?

MR. MICHAELSON: The data, as I understand, is available. I haven't seen it yet. Maybe Mr. Catton would want to comment on it because he was looking at some of this and was telling me a little about it last night.

DR. CATTON: Are you referring to Kaufman's exercise?

MR. MATTSON: I was thinking of the strip chart recorders from the self-powered neutron dectectors.

DR. CATTON: I think he looked at those and he felt between 126 minutes and 176 minutes, the core was essentially dry.

MR. MATTSON: But the self-powered neutron detectors

agb21

give the, I think, probably the best indication of when it voided and you ought to be able to key the time of those indictions to the time of these pressure indications.

DR. CATTON: I think that's what he was doing, between 126 minutes and 176 minutes, he felt the core was dry and that that's when all the damage occurred.

PROFESSOR KERR: You're interpreting that increase in pressure as to mean that the core was not seeing voids. It seems to me that depends a lot on how much water was in the total primary system. One could have had an increase in pressure like this just because of heatup, without very much change in voiding, I think.

MR. MATTSON: That's why I bring it up. The increase in voiding could be read to say that you're collapsing voids when, in fact, really what was going on was increasing voids causing the increase in pressure.

5.260

DR. CATTON: I think you're right.

MR. MICHAELSON: I was going to do that part of the subjective material at the end, and maybe we can comment on it some more at that time.

DR. SHEWMON: Before you leave that, will you read the fine print down there "around two hours" to me again or tell me what happened? The pumps came back on --

MR. MICHAELSON: That's what was filling the steam generator to try to start natural circulation. I don't --

that's on the graph.

DR. SHEWMON: The primary pumps came on again, then, after two hours, is that correct?

MR. MICHAELSON: No, they never came on again. It was somewhere around 16 hours.

DR. SHEWMON: What is the other --

MR. MICHAELSON: This was closure of the block valves.

DR. SHEWMON: Okay.

MR. MICHAELSON: Which would then bottl the system back up and permit it to repressurize. During the repressurization process now you might ask, of course, what's happening to levels and what's happening to void formation and you'll see some other interesting things in a couple of charts here which give you more food for thought.

(Slide.)

This is the history of what the operator was seeing on his level indicator as a function of time throughout the event. And, again, it's pretty interesting.

The period of particular concern, which seems to be now related to other data that we're giving, is the period from two to three hours, where it is possible that that's where most of the damage was done but we really don't know yet for sure. But there are some pretty good indications that interesting things are happening during this period of time.

agb23

Now on his level indicator he was holding what is ordinarily a very comfortable level, since the normal operating level is somewhere down in the 220 range. So he had plenty of water in the pressurizer if he wished to believe it.

He did know though he was having a decreasing pressure. He was also seeing a decreasing level with time but not a disturbing one, this is a very slow disappearance of water from the pressurizer, and since there is so much level I guess he wouldn't get real excited over it.

Now, when we get to the last part of the discussion, I'll point out what I think might be happening in here. But for now, I think we can say that as far as his apparent level indication, it went back to off-scale or very near off-scale. Off-scale, as I understand it, being about 400 inches.

You can see he is allowing it to wiggle back on scale occasionally, I suspect just to derive comfort that it's working and things were looking all right.

Again, I don't have any good history really beyond this 2.3 hour point where things -- in terms of operator actions and equipment operations. I just don't know when they turned things on and off, so there's an awful lot of guessing until you get better data as to what caused the shapes that you see.

DR. SHEWMON: Is there a log for this or are there continuing strip charts?

MR. MICHAELSON: There are logs for this. There is

agb24

some amount of computer data printout. There are some strip charts. A lot of what you see, of course, are off strip charts, but some of it is off the data logger.

I think the information will become available as to the certain values on these parameters, although some of them are only printed by the computer when the computer is asked to follow them and, of course, nobody ran downstairs to ask it necessarily to follow all of these. So we'll have to do with what we have got, but it is still pretty good information. There's quite a bit to work with.

The real key though is when did he turn things on and off and some of that is logged, some of it is not.

..d2A
2B

(Slide.)

As you can see, then, the last pump was tripped about 1-2/3 hours into the event. And before that, the temperature rise through the core and so forth was very nominal. The situation appeared to be well stabilized.

Then he had to trip his last reactor coolant pump. The first pump trip occurred a little over an hour into the event and it didn't seem to create a big problem, just a few little wiggles.

The last trip, though, seemed to precipitate something very strange. He proceeded to begin to see very high temperatures measured up near the flow meter in the vertical hot leg, which is where these loop temperatures are instrumented,

gb25

C6

as I understand it.

And these very high temperatures, when you look at the pressure existing in the system at the time, are indicative of superheating of the steam and not the saturation temperature.

So he was clearly into some kind of a heatup situation which is not altogether understandable in view of the fact that there was water in the pressurizer throughout this entire event.

These proceeded to go off-scale and stay off-scale for several hours, until they finally started -- one of them started coming on-scale off out here and during the latter part of the event.

Again now what the model is for this, I guess we'll just have to think about and guess at. There are some good possibilities, but I am sure there are many good possibilities and I will discuss at least one in a moment.

You should notice here also that the cold leg temperatures proceeded to drop to very low values. Now this cold leg temperature is right underneath the bottom of the reactor coolant pump, and these low temperatures then are indicative of the fact that the fluid is no longer circulating through the system because you are seeing enormous delta-Ts between hot leg temperatures andccold leg temperatures and you don't need anything like that to remove the:heat in the steam generator.

67-138

agb26

So the situation is indicative of some kind of a loss of circulation situation.

MR. STRATTON: Were these temperatures immediately available to the operator?

MR. MICHAELSON: I really can't say. I would think that they were available, but I can't -- maybe somebody knows whether these were reading out in the control room at least.

MR. MATTSON: Certainly all of these are on the computer and some of these are on the control panel. T-hot and T-cold are on the control panel, pressure is on the control panel, level is on the control panel. I suspect most of what you have up there is on the control panel. Certainly it's all on the computer.

MR. MICHAELSON: I think they have on the computer a few more points than they have on the panel, but I had assumed that they read these out in the control room but I never really asked.

So that's it.

Now there are several more in the handouts, but I won't go into them unless somebody is really interested.

MR. ETHERINGTON: Would you show Figure 17, Carl?

MR. MICHAELSON: Okay.

(Slide.)

MR. ETHERINGTON: That figure shows the extremely low level in the steam generator at the time of the coolant pump

agb27

trips.

MR. MICHAELSON: Yes, right.

MR. ETHERINGTON: On the extreme left. And then you can see as soon as the trip occurred, they started to fill.

MR. MICHAELSON: I asked the operator about this, and he said there's nothing unusual about operating at those low levels as long as everything seems to be all right.

But at this point he was starting all the desperation moves, I would imagine, and one of them was to Let's get more water in the steam generator and see if that helps some. And then later on he appeared to do the same thing with the B generator, except he set it up to control at a lower level. These are percent of range, I believe.

MR. ETHERINGTON: Right.

MR. MICHAELSON: And I believe, as I recall, 50 percent range was -- I've forgotten now -- 200 or 300 inches in the steam generator, a very high level.

MR. MATTSON: Carl, I can't read your graph again. Is the B steam generator the one whose level comes up second or the one whose level comes up first?

MR. MICHAELSON: It goes up second. He waited 'till 2.5 hours to bring the level up. The A generator, which was where he had his operating reactor coolant pump just shortly before, was brought up apparently about the same time the reactor coolant pump tripped.

MR. ETHERINGTON: It remains a question of whether he brought it up or whether it just climbed when he lost the recirculation.

MR. MICHAELSON: These are on level control, though. I don't believe he has to change to setpoints to bring the level on up. He can set these where he wishes to control level in terms of percent of operating range. I assumed he turned his level controller up to set a new range here, 50 percent. And then he fiddled with it a little bit and finally over here he decided to go full range.

MR. ETHERINGTON: That was long after the trip.

MR. MICHAELSON: That's right, yes.

Initially on trip, about coincident with the trip, he decided or perhaps it's automatic, I don't know. The fact is it's possible that it's automatic, I'm not sure because I think it has to do with some characteristics of this generator that makes it desirable to start filling it if you lose the pump on that loop.

At any rate, the level popped on up.

Are there any others you would like to see?

MR. STRATTON: How does he control the level, Carl, is it by means of -- does he change the pumping action?

MR. MICHAELSON: The level of the steam generator?

MR. STRATTON: Yes.

M' MICHAELSON. It was my impression in talking with

agb29

the operator that it's sort of like a dial indicator, you dial the level you wish, the percent of control. But that's only an impression I got.

PROFESSOR KERR: It's probably valve controlled, isn't it?

MR. MICHAELSON: I think there's some automatic control of this as well relating to some number of pumps that might still be operating. I think he told me and I just don't recall, but I believe he was saying that if you tripped certain combinations of pumps then he would want to bring this level up to certain values and that may be what we see.

DR. OKRENT: But is it your impression that before an hour and two-thirds or whatever it is, the point at which the level started rising for a steam generator, that the flow into the secondary was the maximum possible or that it was throttled?

MR. MICHAELSON: I'm assuming that the auxiliary feedwater control was throttling to whatever you needed.

Now keep in mind, looking at all the temperature charts, there's no reason to believe that there's any problem with heat removal. You remember the previous one I showed you, the temperature, there was only a few degrees through the core between the hot and the cold legs and there was no -- I, at least, could find no reason to believe there was any trouble at one hour, you know, from looking at numbers on charts.

agb30

MR. ETHERINGTON: Carl, the pool of water at the bottom of the steam generator does seem to be sufficient for removing small quantities of heat. At 10 percent power, the SAR gives the level as three feet, and that is the normal supply, so apparently they're getting enough heat transfer at 10 percent of power with seven feet of water at the bottom of the steam generator. And in this case we're talking about 1-1/2 percent of power, so it shouldn't take much.

MR. MICHAELSON: That pool of water down there should be an effective means of heat removal so long as the reactor coolant pumps are operating. Once they stopped operating, of course, then it was lost. However, the spray power at the top was still working, but now we have to go into the subjective part about what all this might mean.

DR. CATTON: Shouldn't they have been a little bit suspicious when the saturation pressure was greater than the actual pressure, and that occured at 17 minutes? In fact, from 17 minutes out to about three hours.

MR. MICHAELSON: The saturation pressure based on what temperature now?

DR. CATTON: Your curve.

MR. MICHAELSON: Which curve are you looking at?

DR. CATTON: Number 12.

DR. OKRENT: In the primary.

DR. CATTON: Yes. That tells me you've had boiling

agb31

from about 17 minutes on.

(Slide.)

MR. MICHAELSON: Is this the figure you're looking at?

DR. CATTON: Your Figure 12.

MR. MICHAELSON: It is eradicated on here, I can't read it.

DR. CATTON: You must have a different one.

MR. MICHAELSON: That figure didn't have a number on it.

PROFESSOR KERR: The superposition of the actual pressure of the --

MR. MICHAELSON: Oh, you want the saturation curve, all right.

(Slide.)

And now your question?

DR. CATTON: It seems to me that at 17 minutes you should have known you had a problem.

MR. MICHAELSON: Yes, I would agree. But he wasn't tracking any -- he wasn't tracking something that was printing this out for him necessarily. The information was available as it is now. He knew his temperature and he knew his pressure and he maybe had a steam table.

DR. CATTON: You made the comment there was nothing you could see that would lead you to believe there was a problem.

agb32

I can see this and it leads me to believe there's a problem at 17 minutes.

DR. SHEWMON: But he couldn't see that.

DR. CATTON: The operator couldn't, no.

MR. MICHAELSON: If he looked at what he normally would monitor, namely, the level of the pressurizer and cold leg temperatures and hot leg temperatures, he didn't seem to be all that bad. -- and pressure. Unless he went back to think about where he was on this curve here and he was, I believe, riding a saturation situation probably all this time.

MR. MATTSON: For what it's worth, the drain tank ruptured at about 16 minutes, so there may have been a lot of things on his mind at that time.

DR. CATTON: I'm sure there were.

MR. MICHAELSON: I believe you're referring to this figure here.

(Slide.)

MR. MATTSON: Right.

MR. MICHAELSON: Early in the game, we believe this is the relief valve opening to try to relieve the pressure, but the pressure continued to build up. I'm not quite sure whether this is a change in system pressure that caused the dump tank pressure to drop for a while or not, but at any rate something happened at about 12 minutes and the pressure took off and very shortly thereafter ruptured the diaphragm. This must have gotten him -- gotten his attention, although I don't know how, in alarms or readsout or whatever, maybe none of this information is brought readily to his attention, I just don't know.

(Slide.)

At this point, I would just like to go through a little discussion now of the subjective part of the business.

What I'm trying to do is to guess at, from the data we see, what the possible model of this situation might be. To do that, I first looked at time zero, which was the condition wherein there was no auxiliary feedwater in the spray on the tubes. The reactor coolant pumps were running, fluid was circulating properly. There was a level in the pressurizer. There was considerable flashing in the pressurizer because we are assuming that the relief valve was stuck open.

So this was the early first few minutes situation in which there is say proper heat removal out here -- well, excuse me, there is no proper heat removal out here except as might be a contribution of the water in the bottom of the generator, and I'm not sure whether it was really doing any cooling or not.

But for the first several minutes safety injection was available, and it was adding cold water to the otherwise warmer water. And this situation was riding along for a while.

(Slide.)

b34

The next thing that one sees, then, is the addition of auxiliary feedwater to start an effective cooling job which I tried to sketch up here.

The water is now pouring out of the auxiliary feedwater sparger and presumably properly cooling the fluid in the tube, so it is not immaterial what is happening, I think, to the level in the bottom. That's on the assumption, of course, that this spray up here is more than adequate for decay heat removal.

Now the level in the pressurizer is coming on up. It's still flashing up here, it's still losing the water out through the pressurizer. And I believe on this plant, the block valve is prior to the heat relief valve, but there seems to be some question about that. I think this is the correct one, according to the SAR, at least (indicating).

So he was still rocking along fine here. But the pressure was coming down very quickly, as you recall, to saturation. And when he reached the saturation pressure, his pressurizer was no longer really controlling the events in the system.

Wherever there might be a higher elevation and associated with a higher temperature, it is possible that he starts to get void formation in such location, perhaps. At the top of the steam generator there was a void forming, although there probably it was getting swept out for a while, at least.

agb35

The reactor vessel is a real good candidate because it sees T-exit of the core but it is at a somewhat lower elevation so if T-exit of the core is a degree or so higher than the rest of the system, of course, it can form a very nice void there and support all the other columns.

So this seemed to be the next situation. Again, still quite adequate core cooling, and probably this situation existed for maybe 20 minutes or so into the event.

(Slide.)

The problem, though, that he didn't perhaps appreciate was he was losing mass from the system perhaps faster than he was making it up to the system because he wasn't really monitoring his inventory but, rather, watching level, so he could get in trouble if he was losing water faster than he was making up and he was watching the inventory and he held a very fine level in the pressurizer, which he could do, there was plenty of pressure to support this column of water. But in the meantime, he was losing a net amount of mass from the system, so the void in the reactor had to grow larger and larger.

At this point, the pumps were beginning to work harder and harder, trying to somehow find sufficient suction head down here to force the fluid around the system and at least splash it over the top of the steam generator connection.

Now I think this is what happened out at 100 minutes into the event. It was working very hard to try to find

agb36

sufficient suction head.

Now, I don't know how these pumps behave in a situation like this, I don't know how far you can draw this elevation down before this pump would simply cease to pump. I'm surmising here for the moment that it was able to draw a fairly low elevation in the steam generator and still somehow shove the water over the top.

If you assume that that is the case, you can still draw -- you can still adequately cool the core, because the heat rates are getting quite low so you could even trip a pair of pumps and be all right, because the other pair of pumps were still working.

Now it's when you trip the last pair of pumps that things begin to happen. And one of the reasons is that, at that point, when the pumps are tripped, that this negative -- this low elevation in the steam generator is no longer the case. This whole leg acts as a monometer and the water from the higher points of the system want to come down here and settle out and fill the lower part of the steam generator, so that pulls a lot of water out of the system pretty quickly and stores it in the steam generator.

He did the same trick, I believe, when he tripped the first set of pumps and stored some of the water in the other steam generator. And by the time he tripped these, he had stored even more water.

Now it depends upon what the elevation is here. There's more than enough capacity between the pump elevation in the bottom tube sheet to store all the water in the upper part of the system according to a little quick and dirty calculation.

So now it's a question of where was really the elevation in here? I think he pulled a fair amount of the water out of the system, and that is the reason then he started seeing things happen pretty quickly thereafter.

DR. PLESSET: Carl, could I ask you a question about this? You've kind of described a small LOCA.

MR. MICHAELSON: That's right.

DR. PLESSET: And a small LOCA, I guess, is about like 200ths of a square foot.

MR. MICHAELSON: That's about right.

DR. PLESSET: And you mentioned that he was very possibly not realizing that he was losing coolant faster than he was able to make it up.

MR. MICHAELSON: Faster than he wanted to make it up, yes.

DR. PLESSET: Yes.

Now has this kind of thing been adequately analyzed? I think you have studied this.

MR. MICHAELSON: Yes. That doesn't make it adequately analyzed by any means. But I did look at the possibilities of

agb38

this happening, yes, and it does appear that you could get into such a situation with very small breaks.

DR. PLESSET: But it seems to me that this should have been more strongly emphasized to the designers of this type of plant, or any kind of plant.

MR. MICHAELSON: Well the situation is not identified by the normal ECCS type analysis that was performed. The ECCS analysis shows for this type of plant that something around 0.05 square foot is the largest -- the smallest break at which you still may uncover a small portion of the core. As you go to smaller breaks, the core coverage is equal to or better than that critical break size which, as I understand it, is about 0.05 or thereabouts.

MR. MATTSON: But wouldn't those analyses have inventory being made up by the high pressure coolant injection system while you're reducing the inventory from the small break, isn't that the reason the core stays covered?

MR. MICHAELSON: Yeah. The key question of those analyses, of course, is whether appropriate credit has been given for the effects of repressurization that occur during the period of time when you do the analysis, keeping in mind that for an ECCS analysis you do not assume the pumps are running, you have to start with natural circulation to begin with and you have to go through some little gyrations trying to communicate with the heat sink.

agb39

And all those factors need to be in the analysis to be sure that you have appropriately tracked the pressure history, because the injection rate is a function of the pressure history. The higher the pressure the lower the rate.

MR. MATTSON: It's not just the pumps, either. It's the overriding of the ECCS because of a perception that the level is okay, rather than letting the ECCS do its makeup function all by itself, independent of what the level says it's doing.

MR. MICHAELSON: Right. It is important, of course, to make sure that one performs the software analysis that verifies that if you don't intercept the safety injection and if you lose off-site power and so forth, that this thing will ride through properly.

It is important to do that analysis and presumably the analysis showed that you do ride through properly. And you only might get in trouble if you come and intervene, for instance, and adjust the safety injection rate to a value other than used in the analysis.

MR. MATTSON: Well one of the early things this kind of thinking says to us is that there needs to be a coupling between the normal transient analysis and the normal loss of coolant accident analysis which brings to bear the two kinds of thinking.

Some of this thinking had gone into the transient

agb40

analysis, a lot of it has gone into the LOCA analysis, and the coupling between the two seems to be the interesting thing to study at this juncture.

MR. MICHAELSON: Yes, I think that's right.

And what makes this unusual, of course, is that it's all going on so slowly that you can do it, you know, on the back of an envelope, you don't need a large computer to study what's happening, but you do need to appreciate what's happening to be sure that you have proper communication to your heat sink, keeping in mind that a hole this size cannot take out the heat as fast as it's being generated for some period of time.

DR. PLESSET: I don't think this was explored sufficiently, Carl, this situation you've described as a small break LOCA.

MR. MICHAELSON: Well, I've looked at a few of these small break LOCA analyses that are turned out by the NSS suppliers. I did not find this sort of thing as a part of the analysis. Perhaps it was done by the people and discounted on some basis, I don't know.

PROFESSOR KERR: Carl, when you say "this sort of thing," what do you include?

MR. MICHAELSON: You simply have to be sure that in the very slow moving events, that you know where the water is and where the levels are and whether or not you communicate with the heat sink, since the hole in itself is not adequate

agb41

to take out the heat for a rather prolonged period of time.

PROFESSOR KERR: But if you have a pool water makeup flow that is more rapid than the water outlet, or at least equal to the water outlet, at least you aren't going to have void formation, are you?

MR. MICHAELSON: Yes, you'll still have void formation, if the break is large enough to drop the pressure down to the saturation conditions for the system, yes.

PROFESSOR KERR: No, but that can't happen unless the water outflow is greater than the water inflow, can it?

MR. MICHAELSON: Yes, it can happen. For instance -- a hole in the pressurizer will do it. It drops the pressure very rapidly .

The pressure dropped all the time.

PROFESSOR KERR: But that pressure drop we saw initially was occurring before the -- or at least apparently before the HPCI system came on.

MR. MICHAELSON: Would you repeat that? I didn't hear it.

PROFESSOR KERR: It's my impression from your earlier statement that that initial rapid pressure drop was occurring before the high pressure injection system came on. From your comments that may not be altogether clear and there may have been a pump running or something but at least before the full flow came on is where you got the big pressure drop, isn't it?

MR. MICHAELSON: Yes, and that's to be expected. It's to be expected, to some extent, and was shown in the earlier analyses today on the basis of the transient alone, without necessarily a hole even.

If you look at the FSAR analysis for Three Mile Island, you will see -- you'll find such a curve in there for loss of feedwater with one auxiliary feedwater pump.

PROFESSOR KERR: In this particular incident, isn't the indication that one did not get into a flashing situation until after the HPCI pumps were turned on?

MR. MICHAELSON: The flashing started about the time the first pump was shut off, yes.

PROFESSOR KERR: Right.

DR. SHEWMON: Carl, a different way to phrase that question, could one say there would have been no flashing if the operator had controlled on system pressure, or controlled his HPCI flow on system pressure instead of by water level in the pressurizer?

MR. MICHAELSON: No, I think it was just a coincidence, but I'm guessing a little bit here. I believe it was a coincidence that he happened to reach the saturation point at the exact same time he decided to trip his pump.

DR. SHEWMON: That was not my question.

He could have kept his pumps on and kept the pressure

agb43

above 1400 psi or something, could he not have?

MR. MICHAELSON: Yes, if he had kept his pumps on and if the pumps were making up fluid in the system faster than it was being lost from the system, then he would proceed to refill -- he would proceed to pump the system back up, essentially, with the high pressure pumps.

DR. SHEWMON: If you keep the pressure up, then you could do what you said, Bill, but if you don't, then --

MR. MATTSON: But that makes it the traditional small break LOCA analysis. You've got the pumps on and they're larger than the break sufficient to keep the pressure up and keep the core covered, even without the pumps.

MR. MICHAELSON: I have to disagree with you. If you look at the small break analysis, you'll find that the level drops with these kind of breaks all the way down to the top of the core, at least that's true for the B&W plants.

MR. MATTSON: That's all I was saying, that it keeps the core covered.

MR. MICHAELSON: It keeps the core covered, but it doesn't keep overpressure on, they aren't able to keep up with the break so there is no overpressure. They're following the saturation pressure on down. There's no overpressure on it. But they are keeping the core covered, which is really all that's necessary.

This event is of no serious consequence if you keep

agb44

the core covered. It's the uncovering, and that's thé last picture.

(Slide.)

Again this is subjective, but here's a possible situation late in the game.

Auxiliary feedwater is still working fine. After tripping the last pumps, then there is some equalization of level and loss of inventory by storage in the steam generator. Safety injection is still coming in. Condensation, to some extent, is still perhaps occurring out here, in which there's a small return of water.

Again, though, for a while yet he was still worrying about control on inventory, as indicated by level in the steam generator -- pardon me, in the pressurizer.

At about this point in time, of course, then he closed the block valve and now you have to go into some other things which -- we did see some amount of changing in the level.

And one of the things that one has to keep in mind here is that, although you could readily support a water column of this sort with only steam pressure over here, provided that it has got a degree or so higher saturation temperature, if you do lose inventory from here, you can't make it back up again unless you somehow raise the level back in here at some time during your story and get some water back in there.

You can lose it but you can't get it back without

agb45

flooding, at least as I see it, without flooding the entrance or alternatively doing a whole lot of condensing over there, and that doesn't seem likely.

But after that point of closing here, then one needs to go back now and I think you might have a backward way of telling how the water might have been going up and down in the core, depending on what they were trying.

Now, a puzzling thing to keep in mind is the temperature, that off-range temperature for about 10 hours was measured up here on the hot leg. If their reflooding efforts from time to time ever reached that temperature indicator, I'm sure you would have seen it. We saw nothing on it for 10 hours to indicate that it was being quenched.

So perhaps the whole game was being played in here. And on occasion, I suspect the occasion was at first two to three hours, it was when the uncovering occurred in the very higher temperatures at least -- occurred in the top of the core.

DR. SHEWMON: The cold leg indication is taken where?

MR. MICHAELSON: My understanding -- I'm getting the drawings but I haven't gotten them yet -- it's not very far from the bottom of the suction of the pump. It's supposed to be right along in there.

67-158

2c ebl

Now we saw on occasion these temperatures rising and I believe that occurs when you bring the water level on up and you start backing the hot water into the pump, and I should see these temperatures going up again for a while, and then coming back down, and there is nothing to stir it around. And there was quite a bit of that sort of thing going on here, too, on the cold leg side.

6.400

So my own initial opinion is that there was a preliminary core uncovering which is further evidenced by some of the monitoring work they did, perhaps of the order of -- something of the order of less than an hour. And after that time there may have been occasions when the water was going up and down, but it appeared that the water never got up very high into the hot leg until some time way later. And I'm trying to get the strip charts on out to 20 hours to find out when they did appear to quench these thermocouples.

So that would be one possible model of what happened. There are other possibilities, but one thing to keep in mind is we must decide whether the level indicator is really working up there or not. If it is, then you've got to explain somehow water being up there and working its way around.

PROF. KERR: When you say preliminary damage may have occurred in less than one hour, this implies that it may have occurred before the first pump was turned off.

MR. MICHAELSON: If I said less than one hour, I

-b2

didn't mean it. I think the damage occurred somewhere after the last pumps were shut off.

PROF. KERR: Thank you.

MR. MICHAELSON: At one and two-thirds hours, or later.

DR. CARBON: Dave?

DR. OKRENT: A little earlier Roger Mattson indicated that he thought there could be value in looking at situations which involved a coupling of small breaks and transients, and I agree. I think we should also keep in mind a second question which has been raised by Mr. Michaelson about whether there is a class of small breaks for which you have a problem maintaining core inventory and adequate cooling of the fuel for some significant period of time, aside from other complications.

So I just don't want you to lose sight of that question. It may or may not turn out to have significant application.

DR. SHEWMON: Could somebody convert the size of leak we think we had into square feet, which seems to be the argot of the ECCS people?

6.449

DR. PLESSET: .025 I think.

DR. SHEWMON: And the numbers I've heard bandied around here are that .05 is usually the lowest analyzed because that's what the pumps will keep up with if they're operating, or something like that?

eb3

MR. MICHAELSON: The pumps won't keep up if the break-- For this type plant, I don't know what the break point is; generally of the order of one-half to one inch pipe break is about the largest hole that the pumps can keep up with, assuming only one pump of course operating.

DR. SHEWMON: And that's less than .01?

MR. MICHAELSON: Oh, yes.

Now I'm sure B&W has the numbers on what the small break is. Breaks larger than that are defined as LOCAs then because the pumps cannot keep -- the normal makeup system cannot keep up with it.

DR. SHEWMON: I'm talking about the HPCI.

MR. MICHAELSON: Well, the normal makeup system for a plant of this type is the charging pump which is also the high pressure injection pump. There are three such pumps in this plant. One is running normally for charging. One is-- And the other two are on standby for high pressure injection. So the normal charging is the operation of one pump.

If you exceed that ability-- If you have a hole which exceeds the ability of that one pump, then it becomes a LOCA, as I understand it.

DR. SHEWMON: .025 is the generally agreed-on size of the leak?

MR. MICHAELSON: No. I got the drawings on the valve and it is somewhat smaller I believe than .025. It is a two and

eb4

a half inch relief valve, but the port opening, as I recall, appears to be more like about one and a half inch, and it would be the port opening of the valve that you would look at.

DR. SHEWMON: And we're talking about the valve which is either open or shut. If it is stuck open it didn't come back halfway and hang up someplace?

MR. MICHAELSON: Well, you'd have to guess. I'm assuming that it was stuck wide open. Anything in between just varies the hole -- the break size.

DR. PLESSET: Did you communicate your concern with these small breaks to the vendor?

MR. MICHAELSON: Yes. We had some discussions and correspondence from time to time, yes.

DR. PLESSET: Were they responsive? That's a term we like to use occasionally.

MR. MICHAELSON: Well, these are kinds of events which have not necessarily been looked at carefully by the Regulatory Commission as well, the reason being because they seemed to be of such a size that they are already covered by the present ECCS analysis, keeping in mind that the analysis shows that as you go to smaller breaks, the core is always covered.

So it's a little more difficult then to get people interested in very small breaks when they look at the calculations and it says Well, the core is covered, and there's nothing to worry about.

DR. CARBON: Let's move ahead with Dr. Catton's report.

DR. CATTON: Actually what I would like to do is make a few comments about where it's at now, and I'd like to start by having read the newspapers before I got there, I thought I was going to see a disaster. The combination of the 513 industrial associate group, GP, and NRC really comprised, as far as I could tell, an exceptional pool of talent. I was really amazed by the way things were going.

I'll start with cooldown.

A couple of days ago they decided they were going to bring it from 280 degrees down to 230 degrees by just changing the steaming rate. It turns out all they've been able to reach is 250, and at the present time the heat transfer is limited on the secondary side. I personally really see no problem with this. I'm not sure why they felt they had to get to 230 before they could go to natural circulation anyway.

Another thing, I really think that if the operator knew that going to natural circulation with a saturated system meant that he would have very little cooling he would have done something differently.

The present or the next series of events that are going to occur is the first thing, the B steam generator is out because of leakage problems. I don't think they are serious.

I just think that with the highly contaminated water they feel they'll get into a problem so what they're going to do is to use the turbine oil coolers and a little bit of replumbing and that system will be taken to solid water.

At that time they will switch off the A steam generator onto the B steam generator which is now solid water. They are then going to take the A loop and modify the routing into the condenser so that the condenser will act better as a liquid-liquid heat exchanger.

They then will bring the A loop solid water so they have both the A loop and the B loop solid water through the steam generators sitting at 1,000 psi.

THey'll go to natural circulation, then they're going to drop it, the pressure in the primary system, down to somewhere between 20 and 50 psi.

The question about gas content has been checked. The results that came back from Idaho show that at the low pressure they could have a hydrogen bubble of 350 cubic feet and at those low pressures that's not very much.

The final step in this aspect is they will build another cooling system that will be designed to 650 psi. This will replace the two steam generators, the reason being is that if they get into a problem and they have to come back up and pressure, they'll have a secondary side that can withstand it.

DR. SHEWMON: I'm lost here someplace. You talked

eb7

about 1,000 psi. That's your secondary system pressure.

DR. CATTON: No, the primary system is now at 1,000 psi.

DR. SHEWMON: Yeah, but you talked about-- And I've heard 20 or 30, which I thought was where they wanted to take the primary.

DR. CATTON: Yes.

DR. SHEWMON: Now we come back to 650 and that 650 applies to what?

DR. CATTON: To the secondary. You see, the intermediate part of it in the near term, the secondary will be a low pressure system, and so you have high pressure in your primary and low pressure in your secondary, and that's not a good situation to stay in. So they're bringing the 650 psi for the secondary system. The primary will be at 50, hopefully, but if something happens to get out of line they can bring the pressure back up and still have the high pressure on the secondary side.

DR. SIESS: You said there was a leak in the B steam generator.

DR. CATTON: I believe so, yes.

DR. SIESS: How do they know?

DR. CATTON: I think they were picking up very high levels in the secondary side.

MR. MATTSON: Could I add a couple of points that

eb8

might clarify two or three things here?

First on that one, there was evidentally leakage on the B steam generator early in the accident before it was isolated. Indications are now from radioactivity measurements in the secondary that the leakage has not continued. One explanation for that might be that it leaked because it dried out and then as it cooled off, being isolated and getting down to these cooler temperatures, it doesn't leak as bad at colder temperatures as it did at higher temperatures.

600

That's encouraging because it means when they go to the water solid B steam generator the amount of fission products carried to equipment they'll be pumping with will be smaller.

Two other brief comments.

The Idaho analysis showed an amount of gas currently existing in the primary coolant that would expand to something like 300 cubic feet at 20 to 50 psi. It didn't show that it was all hydrogen, however; it showed that it was mostly nitrogen, a little oxygen and a little hydrogen. It's just what you would expect in a normal degassed system of this type during normal operations.

Now we're confirming that first analysis. One was done at Idaho and there was a second pressurized sample taken of the primary cooland. I believe it's being analyzed at B&W right now. There are several more planned, and they will go to

b9

different laboratories also, so that we get a check of the veracity of the measurement. Early indications are quite good.

One final point.

The modification of the B steam generator to take it solid that was just described is one of two alternatives actually being pursued right now. The other alternative would be to do the short-term and long-term B steam generator modification all at once.

They've been analyzing the PERT charts for the construction process and it looks like you can actually achieve both of them on the same time scale. If that's true then you can go to the pressurized B secondary side in the first step rather than having to wait for a second step.

I think those kinds of decisions are being made at the site today. In the meantime, construction is going ahead with piping and piping drawings and things like that. It's not on the critical path. You'll hear more of this this afternoon from Carl Berlinger.

DR. OKRENT: You indicated that that amount of gas didn't seem to be a problem. In what sense?

DR. CATTON: There's 1500 cubic feet I believe in the upper dome of the vessel.

DR. OKRENT: Do you know that that's where it will go and not into the candy cane?

DR. CATTON: Not for sure.

~b10

DR. OKRENT: If it is in the candy cane is it a problem?

DR. CATTON: I think it could be, yes. That many cubic feet might be able to vapor lock--

MR. MATTSON: It's going to be on the basis of these analyses that the pressure is chosen for the primary system in natural circulation. There is nothing that says it has to be 20 pounds or 50 pounds or 100 pounds. I think it's preferred to be lower but if the gas could expand and give you

666 difficulty and you can calculate that, then that's how you choose your eventual pressure.

What is clear is that the system has been degassed to a pressure of 300 psi, which means that anything that would expand at 300 psi already has, and it has been brought into solution out of the control rod drive housings or where-have-you, high in the system. And that was the purpose of the de-

674 gassing operation for a period of some days last week.

c7

DR. SHEWMON: What evidence do you have that you're beginning to get outgassing? I mean there are two sorts of questions.

One, let's say you do fill the candy cane. Is it just a matter of increasing the pressure to get yourself back solid again?

And B, what evidence do you have before all of a sudden you've got a large delta-T someplace and you're getting

eb11

into trouble?

MR. MATTSON: Those kinds of troubles are being worked pretty hard. Essentially what you're asking are what are the indicators of successful achievement of natural circulation and maintenance of natural circulation.

You've got temperature indicators. You've got pressure indicators. You've got core thermometry. Those kinds of--

DR. SHEWMON: I'm asking about the unsuccessful attempts.

MR. MATTSON: I'm sorry, I'm saying it in the same sense. What would you be looking at to tell you first and quickest that the natural circulation wasn't working?

MR. ETHERINGTON: Are the flow meters off-scale?

MR. MATTSON: Now, or in natural circulation?

MR. ETHERINGTON: In natural circulation.

MR. MATTSON: I would think they would be. Much too low a signal is what Steve Hanauer is saying for the low flow rates of natural circulation.

MR. ETHERINGTON: There'd be no difficulty in putting in a monometer or something that would register it, would there?

MR. MATTSON: I won't say there's no difficulty in installing post-accident monitoring equipment through sample lines outside the containment. It is difficult. That is the kind of thing people are looking at now, and designing and putting in place.

For this natural circulation process to work you must of course keep the primary system full and pressurized. There is a system being designed and constructed for solid primary pressure control from outside of containment. That will be constructed and installed in the same time frame as the modifications to the steam generator.

MR. ETHERINGTON: Well, of course "difficulty" is relative. Do I understand that people are looking to the possibility of using the flow meters for an indication of flow?

MR. MATTSON: I think they decided that they won't work.

MR. ETHERINGTON: No, I meant with-- Oh, not even with the more sensitive....

MR. MATTSON: I see your point. The transmitters are inside the reactor.

MR. MC MILLAN: And there's no way to get access to those.

MR. ETHERINGTON: I see.

DR. CARBON: Go ahead, Dr. Catton.

DR. CATTON: I might just mention some of the contingencies that have been mentioned in case natural convection doesn't work, and I guess there are three or more.

The first was just to turn back on the reactor coolant pumps.

eb13

And the second was to use feedwater in and bleed it out of the pressurizer system.

The final one that I've heard is the reflux boiler. I frankly don't think the reflux boiler will work with all those gases; the non-condensables are just going to shut it off.

Also, Westinghouse is in the process of building a residual heat removal system that's going to sit outside the building on skids and sit in a Quonset Hut that's all properly controlled. They're also, as I understand it, checking out the existing residual heat removal system and doing things like trying to figure out how to remote the lubrication so that if it gets kind of messy in there they won't have to go in.

I understand they are also doing something with all the drains and so forth so that if there is any leakage it can be pumped and put back into the system.

That would give them three systems, each one of which I believe could take care of the heat load.

They are also designing a permanent system that would go in a building outside that itself would have to be drained.

So that means there would be five methods, five different drains, each of which could do it itself.

MR. MATTSON: I'd add one more to that.

It is always possible for a short period of time at least, on the order of days, to feed and bleed. You use low ᵃb14

pressure to prime high pressure.

DR. CATTON: I mentioned feed and bleed.

MR. MATTSON: I didn't hear it. I'm sorry.

DR. CATTON: I mentioned the reactor coolant pump, feed and bleed, and the reflux boiler, which I don't believe --

MR. MATTSON: Okay.

DR. CATTON: -- and then the Westinghouse systems of which there will be eventually five.

050 The time scale in all of this stuff is really amazing. Of course the days keep slipping, but it's always that in five days away it's going to be running.

I'd just like to finish by mentioning-- When I talked to the Westinghouse people Saturday afternoon, they indicated next Friday which is pretty soon, I think.

I'd like to just mention the status of the core. It does feed back onto the natural circulation in that you have to circulate the fluid through the core in whatever state it's in. Koffman from LOFT did a very nice analysis I think. What he came up with seems to agree with everybody else's. I guess there's been an analysis done by B&W, one by the Staff themselves, and then Koffman's, and then there was another group with the Industrial Associates.

And basically what they-- The conclusion they come to is that 30 to 45 percent of the zirconium is gone, it oxidized, and that the central portion of the core which is `b15

about one-half radius and maybe a half down into the core is pretty beat up and is probably in particles of a size that they're unsure of. I've heard arguments all the way from dust to each pellet being six pieces laying on a grid spacer. I'm not sure where it's at.

Some of the work done by Ed Zebroski, I think from EPRI-- He tried to make some calculations that would tell him what temperatures are reached. And based on the xenon release, he felt that the temperatures that were reached in the fuel were like from 1600 to 1800 degrees Centigrade, or 2600 Fahrenheit to 30000 Fahrenheit.

The interesting thing is that Koffman's analysis was based on in-core instrumentation. I don't know exactly what he did but he was able to interpret it as if it were a densitometer, and from this he concludes that between 126 minutes and 176 minutes, the core was dry, or pretty dry. And it was in the middle of this period when they saw the big radiation spike in the effluent coming out of the relief system.

And so it was his conclusion that most of the damage was done during that period, and in the subsequent period there was actually some boiling in the core so it really wasn't really fully dried out.

MR. MATTSON: I would like jus. to add to that description of the core that there is a spectrum of opinion on what its exact configuration is. We've been pulling together ıb16

here in Bethesda work done by the Industrial Advisory Group in Middletown, the work done in several national laboratories, and the work done here in Bethesda, trying to draw down that spectrum of opinion and make it consistent with all the facts as they are becoming available.

I think the description that has been given here is probably toward the more extreme end of the possibilities. The lesser end of the spectrum certainly doesn't have dust.

This is important from the standpoint of projecting what the indicators of successful natural circulation should be, and we expect to have that information pulled together this week some time, and of course would want to provide it to the Committee for your review and consideration.

DR. CATTON: As I understand it, the measurements show that the resistance to the flow in the core has increased by a factor of nine. And I believe the B&W study with regard to whether circulation would work assumed a factor of 60, and

103

they came to the conclusion that natural circulation would be okay.

So it seems to me that if it is only nine, that there's plenty of margin. I do believe you may get local boiling in the debris beds but I don't think that's any significant problem. You'll just condense.

One other thing. In talking to some of the people, nobody seemed to know how long-- There was some question as to

>17

what you should do first. Maybe the Staff can clear this up.

If you decide you have to go on one of those RHR systems, and Westinghouse's system is sitting out on the skid and you've got the one inside that probably works, which one do you choose first?

MR. MATTSON: The ones inside.

DR. CATTON: Well, that's not the opinion that I got from some other people that were at the site. They felt that the one inside, you had no way of knowing how long it was going to run and further, that the grit in the water would burn out all the mechanical bearings and you may only run for eight hours.

MR. MATTSON: I think that's a severe speculation. I don't know who you're talking to, but that's being looked at very hard. Clearly the choice is the one inside.

DR. CARBON: Let me interrupt here. I would like to try and stay on schedule, or close to it if possible.

Can we go to Steve? Do you have a report that you would like to make?

DR. LAWROSKI: I think relative to what the agenda says I don't have any, because I visited much earlier than Harold or Michaelson or Catton.

I would like to ask, however, a question with respect to the most recent -- the more recently taken primary sample.

b18

Is there evidence of much suspended zirconium oxide that would suggest problems of blockage?

MR. MATTSON: It is my understanding that there is not evidence of zirconium oxide.

DR. LAWROSKI: I had heard there is not much uranium, if any, but I didn't know with respect to the zirconium oxide which is a lighter material and would be more easily suspended.

DR. SHEWMON: Is there any evidence of suspended uranium oxide?

DR. LAWROSKI: That's a lot denser material, Paul.

DR. SHEWMON: I know.

MR. MATTSON: The answer is yes, there is some indication of uranium, small, small amounts and -- correct me if I'm wrong -- lesser amounts than have been found with other local damage situations in the past. The signs from the primary coolant sample of what kind of particulates are involved and what the extent of uranium involvement and zirconium involvement were are encouraging signs in the sense of material outside of the core.

DR. LAWROSKI: And how about with respect to fission products which, at the pH's we have here, would be more soluble, as an indication of what might have h· pened in the core beyond the severe high temperatures but short of any melting?

MR. MATTSON: I'm not sure I understand your question.

eb19

DR. LAWROSKI: In the most recent sample of the primary, are there fission products detected which would be easier to identify and quantify than uranium, because all the concentrations will be low pH's involved here, strontium, for example?

MR. MATTSON: They're looking at--

DR. PLESSET: Fission products diffuse very slowly. That's I think what Dr. Lawroski was concerned about, in part.

MR. MATTSON: If the question is are we going radiochemical analysis, looking for all these fission products, the answer is Yes.

If you haven't seen the piece of paper that summarizes them and from which people are drawing conclusions about the extent of fuel involvement in the temperature transient, then we'll get them to you. They are available.

But the correlate well, the first sample to the second sample, lab to lab, a fairly good radiochemical characterization of the core involvement.

DR. LAWROSKI: I haven't seen them.

MR. MATTSON: We'll get them to you.

DR. LAWROSKI: I know they had problems getting additional primary samples out within the time they had hoped to get them out.

MR. MATTSON: That problem has been solved and samples are flowing rather routinely at this point; not many,

eb20

because it's a hot area, but as many as we need when we need them.

DR. LAWROSKI: When I was there, which was Saturday and Sunday -- Friday and Saturday, I should say, there was concern about having enough volume for the liquid waste particularly. Has that problem been alleviated?

MR. MATTSON: Yes, two ways. One was to stop some leakage in the auxiliary building of non-contaminated fluids that were being used in secondary cooling systems outside of containment. They shut those systems down for a brief period of time, repacked the valves, repacked pump seals, and so that non-contaminated leakage, which of course picks up some of the contaminated fluid which came into the auxiliary building early in the accident and spreads it around, that problem has been put under control now.

In addition to that, there is work going on to add liquid waste storage capacity in the plant, a significant addition of tankage, a tank farm in the spent fuel storage pool for Unit 2. Those tanks were being installed yesterday and should be piped up and ready to go in another few days.

DR. LAWROSKI: Because they were somewhat handicapped as to what they could do at that time with the additional quantities of effluent.

MR. MATTSON: That was a management difficulty, a liquid waste management difficulty a week or so ago, and it

521

seems to be under control at this point.

MR. ETHERINGTON: There was an indication of silver, presumably from control rods in the water. Any indication of how much?

MR. MATTSON: I'm not sure that's correct. There may have been a misimpression from the first primary coolant sample done at Bettis. What was said was they looked for silver from the control rods and the detection capability of the equipment and with this kind of sample would mean that they couldn't see anything less than three control rods involved in the coolant; that is, if there were less than three they couldn't detect it.

They didn't detect any so they said there certainly weren't more than three, is what I understand the results of that sample to be.

That's not the same thing as saying there is silver in the coolant, and I don't think anybody has detected silver in the coolant yet.

DR. CARBON: Shall we move ahead then to Jerry, your report?

MR. RAY: A couple of very brief comments due to the shortage of time. The gentlemen before me have covered quite thoroughly the situation out there, but I do have to repeat in all justice the observations of Harold and Ivan in tribute to the organization that was set up here and the participants

xz..xzx

b22

in it that were participants, as you know, from all the reactor vendors, several of the utilities, and of course all components of the NRC organization, and GPU also. And their concentration appropriately was on the control and cooldown of the plant, and maintaining it in a safe condition.

And do think that their work was outstanding and we all owe them a tribute.

I was interested in the continuity of service of the electrical facilities and I was very much impressed that so many of the thermocouples were still in service. I think as of Wednesday when I left there were 49 or 52 thermocouples still in service, which was quite an accomplishment recognizing the extreme environment to which they had been exposed. And similarly for the rest of the facilities.

Dave Okrent raised the question of offsite pow_ and while I was there, Roger, I had the impression, as you stated, that there was an understanding with the PJM interconnection management and operations that this site would get preferential service.

And I might comment that you couldn't be in a better position insofar as PJM's 230 Kv network is concerned for good, reliable offsite supply. It's a very well-integrated, very closely-coupled system, and you have lines coming into the Susquehannah Valley from north, south, east and west, so it's ideal from that standpoint. And the Susquehannah Valley is

228

eb23

very well sprinkled with generation capacity so that you're not going to -- you're not likely to be isolated.

And having a multiple series of channels of transmission into the site, it's in very good shape from that viewpoint.

The real --

MR. MATTSON: Could I interrupt just a second, please?

The problem with offsite power we ought to also mention, that auxiliary power supplies have been brought to the site and are being hooked up, so this question of reliance on onsite power is rapidly coming to a conclusion. I'd expect within this week that most of the backup power supplies are being hooked up, and that that kind of problem will cease to be one.

MR. RAY: I understand they're going to have their own drive. They are either diesels or small diesels or gas turbines and that sort of thing. It will be divorced ultimately from reliance on offsite.

MR. MATTSON: That's right.

MR. RAY: The decentralization of those supplies is good, too, because then you're less vulnerable to on on-site incident that would take out a transformer.

Steve mentioned concern about the helicopter traffic pattern. Carl Michaelson and I discussed that while we were there and I didn't see it, but he said he saw one helicopter

24

flying over the island.

My observations were that the traffic in and out of the paths was from the east and northeast and really what they were doing was staying clear of the 500 Kv substation and they were staying clear of the island and they were going off at an angle and going north to get away from the site. And it looked like someone had gotten to the pilots and they understood where their channels were to get in and out.

DR. LAWROSKI: That was the situation later.

MR. RAY: Yes. That was Wednesday, yes.

So that from that viewpoint it seemed to be well-organized.

I did get a chance to discuss with several of the NRC people this question, in view of the operating incidents that precipitated this and developed during the incident, their impressions of the capabilities of the operators of MetEd. And incidentally I was told that at least two NRC personnel, and sometimes three or four will be in the control room at all times, three shifts a day.

The preliminary impressions that had been formed as of then by the NRC people who were in close touch with these operators was that there was no really basic lack of competence. Of course the incidents that developed here, being an exception to the situation, but it seemed-- The impression was that they

eb25

knew what they were doing. They were well familiar with their plant and were able to perform.

There may be changed in that respect in the mean-while but I don't know. That was as of Wednesday.

Also the NRC people indicated that there had been immediate attention to the need for fire protection and that steps had been taken by the operating personnel to insure that all the alarms and all the hoses were in position, and that there was a 24-hour fire watch with personnel on duty around the clock, all of which indicated to me that they had addressed themselves to the really urgent situation, and with good responsiveness.

I was very much interested in B&W's presentation on Wednesday afternoon as to their studies of what had happened in the core with respect to fuel damage, and also their concern about the transition to natural circulation. They obviously had analyzed it quite thoroughly, and I would hope that you're going to tell that story this afternoon in your presentation.

They had gone to the point of establishing benchmarks to guide operation in the course of the transition and while on natural circulation, so it seemed to me that it was quite thoroughly addressed.

One last point was that they had considered, in view of the disarrayed condition of the fuel elements, the question of criticality, and I gathered from the story that they gave us

299

eb26

that with the proper boron content -- and they've indicated the quantitative measure of that as of then -- you were in good, safe condition for all possible fuel configurations including a total core slump.

And I hope, Mr. McMillan, you're going to tell us that story this afternoon.

That's all.

MR. MATTSON: I might just add some further elaboration of that.

In engineering analyses sometimes you take things to the limit to make sure you can't be in a situation that gets you in trouble. And one limit, a hypothetical limit, is to assume that the rods are gone, as you've described. There is no evidence to indicate that they are, or that they are not -- are in any way different than where they started.

Even if they were all gone and even if you took theoretical packing densities and things like that, borated to the extent you are borated now you would not have criticality. That has ceased to be a concern.

DR. CARBON: Dr. McCreless?

DR. MC CRELESS: I just wanted to bring this to the Committee's attention, the report you have on the site visit, which then devotes some written detail, everything I think you've heard today, but the current status of the plant, the recovery organization, and recovery plan, and the answer to ɘb27

several questions that various Committee members have asked before that we were able to get the answers for while we were there.

DR. CARBON: Any last questions from the Committee?

(Nc response.)

Let's recess for an hour for lunch.

(Whereupon, at 1:40 p.m. the meeting was recessed to reconvene at 2:40 p.m. the same day.)

:nd WRBloom
ioffman fls.

67-185

AFTERNOON SESSION

(2:40 p.m.)

DR. CARBON: Let me bring up an extraneous topic before we get into the afternoon session. We're having some difficulty scheduling a common time for the Commissioners tomorrow afternoon. Their schedule doesn't fit ours and vice versa.

I'd like to check and ask what time are people leaving tomorrow afternoon? Specifically, who needs to leave by 4:00 o'clock?

(A show of hands.)

DR. CARBON: One, two, three, plus Dr. Kerr will leave this evening. So that after 4:00 tomorrow, we would have two, three, four, five, six of us.

DR. OKRENT: How do you define "after 4:00"? I have a 5:40 plane from Dulles, and can you tell me?

DR. CARBON: I'm not sure.

MR. FRALEY: They have proposed a meeting from 3:30 to 4:40 instead of 2:30 to 3:30. I'd like to know how many can be here at that meeting?

(A show of hands.)

DR. CARBON: The three of us, I guess. Okay.

Let's go ahead, then, to the afternoon session. I'll call on Mr. MacMillan.

MR. MAC MILLAN: Thank you, Mr. Chairman. As I look around the table, I've seen many of you in the last two weeks at Three Mile Island as you've been visiting the site there. I'm pleased to hear the reports that you've brought back and reported this morning.

I'm going to read a prepared statement. I believe you all have copies of that statement. I understand that there may be some logistical problems in the sequence in which the figures are attached to that statement, and so I will be showing slides, overhead slides, as the appropriate time in the statement comes up, and you may have to be working backwards through your figures rather than forwards.

My name is John MacMillan. I'm Vice President of the Nuclear Power Generation Division of the Babcock & Wilcox Company. The Division is responsible for marketing, engineering, project management and related services of the nuclear steam systems supplied to the utility industry by Babcock & Wilcox.

Today I will discuss the incident at Three Mile Island 2, with special emphasis on B&W's activities which we have currently underway or shortly will have underway as a result of that incident.

I have with me today a number of support personnel, many of whom are familiar to the Committee, to assist in answering questions. These people are arrayed around the table there on the other side of the room.

From the time that B&W was first notified of the

TMI-2 incident, B&W's number one priority has been to provide support and assistance to bring the plant to a cold shutdown condition. Closely paralleling that have been efforts to assure continued safe operation of the other B&W operating plants. As the situation at Three Mile Island continues to improve, we will be strengthening our efforts related to the other plants.

On the basis of what is now known about the factors affecting the incident, we believe that appropriate measures have been taken by the utilities, B&W and the NRC to ensure the continued safe operation of those plants.

My remarks today will be prefaced by: One, an overview of the B&W nuclear steam system, with emphasis on those plant features of relevance to the incident; two, a summary of the specific actions taken by B&W to support and assist the licensee in connection with the TMI-2 incident; and three, our preliminary views on the six factors identified by the NRC in its I.E. Bulletin 79-05A as significantly affecting the course of that incident.

In that context, I will then proceed to address: First, the immediate actions taken by B&W, the utilities and the NRC to ensure continued safe operation of the other B&W reactors; second, our planned near-term and long-term actions to provide further assurance of continued safe operation.

For the purpose of our discussion today, I will provide a brief overview of typical B&W design features.

(Slide.)

You'll see this attached figure to the prepared testimony. Shown here is a reactor vessel and the reactor core is located in that vessel. There are two steam generators, one shown here and one here, each served by two reactor coolant pumps. The flow comes from out of the bottom reactor steam generator into the reactor vessel, through the reactor core, out of the reactor vessel and back into the steam generator.

On the A loop of the Three Mile Island unit is located a pressurizer. And this is a schematic. This does not show the elevation of the components.

In the top of the steam generator, there's an electro-magnetic relief valve, which we'll talk a great deal about during the discussion, an isolation valve on the pressurizer side of that power-operated relief valve. There are also two code safety valves located in the top of the pressurizer.

All of these valves discharge into a drain tank which condenses the steam and keeps that steam out of the reactor building.

There are a number of other features shown here. The normal line to the letdown coolers comes off the bottom of the steam generators here. High-pressure injection comes back into each of the four reactor coolant loops on the cold side, on the pump discharge side of that loop. And the makeup control valve normally supplies makeup through that same path.

There are two core flood tanks, which are pressurized with nitrogen and which tie into the reactor vessel through check valves as shown here.

(Slide.)

Looking at an elevation of the nuclear steam system, you will recognize this as quite similar to the diagrams that Carl Michaelson had all colored up for you this morning. This is the reactor vessel in the center, the reactor core in the middle of that reactor vessel, one steam generator shown here. High-temperature water comes out of the reactor, goes up through the top of the steam generator, flows down through the tubes on the inside of the steam generator, discharges through two lines coming out of the bottom of the steam generator, which feed the circulating pumps, back into the reactor vessel.

The position of the pressurizer is shown here, the surge line tieing into the hot leg, the high-temperature leg of the A loop, and the surge line feeding into the pressurizer. The pressurizer electrical heater is located at the bottom of hte pressurizer. The relief valve is located on the top of the pressurizer.

DR. CARBON: And these are to scale as far as elevation?

MR. MAC MILLAN: Yes, these show the relative elevation of the components.

Let's look, then, at the secondary system.

(Slide.)

This secondary system is schematic, and I say a simplified schematic of the Three Mile Island 2 system. The steam generators you see on the right-hand side of the chart, each, of course, tied in with the reactor coolant system. Steam comes out of the steam generators, flows over to the turbine in normal service, and the turbine into the condenser. Suction is taken on the condenser by the condensate pumps. The condensate polishing equipment, located upstream of those pumps, feeds the condensate booster pumps through a series of heaters to the feedwater pumps, through high-pressure heaters and back into the steam generators, through the main feedwater nozzles of the steam generator.

For emergency service, there is a series of feedwater pumps, two half-size electric motor pumps and one whole-sized steam-driven pump. These pumps can either take suction from the main feedwater header here, you see, or from the condensate storage tanks.

I would hasten to say, these check valves are shown diagrammatically as installed backwards. They allow free suction from the suction of the feed pumps, from these feed pumps through the control valves which modulate the feedwater flow from the auxiliary pumps through block valves --these are the block valves that were closed in the early phases of the incident -- and then into the steam generators at the auxiliary header, which is located at or near the top of the secondary side of those steam generators, as you saw this morning in Carl Michaelson's diagram.

I didn't mention that when the turbine is out of service there is a turbine bypass valve which allows steam to be taken directly from the main steam lines through bypass control valves and dumping into the condenser, and in fact, that's the mode in which the A generator is presently operating at Three Mile Island 2.

As designed, this arrangement will satisfactorily accommodate a loss of feedwater transient. This is confirmed by our safety analyses and experiences with a number of loss of feedwater transients which have occurred at this plant and other B&W-operated units.

With that background, then, let me turn to a summary of the actions that we've taken in support of the incident at Three Mile Island 2.

Early in the morning of March 28th, B&W management in Lynchburg was notified of the incident. Immediately thereafter, we convened a meeting of experts to identify specific information and manpower needs for providing support to the licensee.

As a result of that meeting, five people were dispatched to the site, and by early afternoon a communications center was established in Lynchburg, which was staffed by our senior management and technical people.

By the second day, Thursday, we had established on organization to provide round-the-clock support within that organization. Specific responsibility was assigned for evaluating data obtained from the site and developing a postulated sequence of events for conducting simulations of the events on the B&W control room simulator and for developing and recommending contingency procedures for performing comparisons of the physical plant data, for conducting specific analyses, as requested by the licensee or the NRC, and for reviewing reports of other loss of feedwater transients.

As the course of the incident progressed and the need for support increased, we dispatched additional people and equipment to the site. I personally went to the site to head the B&W on-site team. At the peak of the B&W effort on the incident, we deployed 47 people to the site and 218 people in Lynchburg were assigned to the communications center and related support activities.

Out of this initial effort grew an organizational framework which gave us the capability to shift our emphasis to efforts to assure continued safe operation of the other B&W operating reactors.

(Slide.)

Let me turn now to a discussion of the significant factors in the incident. For the purpose of today's discussion, we accept the sequence and the list of six significant factors identified by the NRC in its I.E. Bulletin 79.05A. Thus I will not retreat ground already covered, but instead, will summarize our views on the significance of those factors and their sequence.

First, after the loss of feedwater transient was underway, the absence of auxiliary feedwater to provide secondary side cooling for a period of in excess of eight minutes resulted in delay of residual heat removal and temperature increase in the reactor coolant system. The presence of auxiliary feedwater, as designed, would have stabilized reactor coolant temperature earlier in the transient and eliminated a complicating distraction to the operator.

Second, as a result of the system pressure increase, the pilot-operated pressurizer relief valve opened as designed, but did not reseat properly, thus allowing reactor coolant system pressure to continue decreasing. In our view, the significance of this factor is not only the failure of the valve to reseat, but more importantly, the time which elapsed between the failure to reseat and the recognition that this had occurred.

Third, the high-pressure injection system, which had been automatically actuated, as designed, on low reactor coolant system pressure, was prematurely terminated, even though there were indications of an opening in the reactor coolant system pressure boundary, such as increasing quench tank pressure and decreasing reactor coolant system pressure.

Fourth, the containment did not isolate at the time the emergency core cooling system was actuated. This is in accordance with the licensed design. This led, through a series of circumstances, to radioactive water in the reactor building sump, and the lack of containment isolation allowed this fluid to be pumped to the auxiliary building, from which subsequent radiation releases occurred.

DR. CARBON: Question. Could I go back to Item 3.

MR. MAC MILLAN: Yes, sir.

DR. CARBON: I've asked several times in the last two weeks whether there is or is not an indicator in the control room that the PORV is open or closed. Is there or is there not?

MR. MAC MILLAN: Let me answer that very specifically: There are indicators in the control room which indicate whether or not the solenoid on that power-operated relief valve has been energized or de-energized. And in the event that it is energized, it indicates the valve is open; and when it's de-energized, you would assume the valve was closed.

However, that does not measure the position of the seat on the pressure-operated relief valve. So the operator is not seeing an indication of whether the valve is open or shut; he is merely seeing whether the solenoid which operates the pilot on that valve has been energized or de-energized. So he could get an indication that the solenoid is de-energized, presume that the valve was closed when in fact the valve was open.

Now, there are other indications which would lead him to an indication of open valve. We talked thi. morning about thermocoupling the tailpipe. That's in the line that comes from the discharge of the power-operated relief valve to the quench tank. That tells him whether he's got hot fluid in that tailpipe.

I think you raised a question this morning about the response. It was a very fast-responding thermocouple.

DR. CARBON: How about in a small leak, if the valve closed 95 percent or something and you still had steam going out. Would the thermocouple show it?

MR. MAC MILLAN: The thermocouple has a couple of purposes. One is to show that the valve is open, if you go and look at the thermocouple. A second one is also to tell whether the valve is simmering, and when it simmers you get a higher temperature on that thermocouple than you do in the other, the tailpipe of the other valves. But it's not at the temperature of the steam in the pressurizer.

If the valve is wide open, then the temperature you see in that thermocouple is essentially the pressurizer steam temperature.

Now, in addition to that, there are indicators on the quench tank for both pressure and level. These are audible and visible light alarms in the control room. So there is that backup indication as well that the valves may be open.

DR. PLESSET: Has consideration been given in the design of that pressurizer valve to its withstanding exit flow, particularly if it's not of high quality? Do we know that it would still close if the solenoid were de-energized?

MR. MAC MILLAN: The valve is designed primarily for steam service. We've had evidence that it will operate with a mixture of steam and vapor.

DR. PLESSET: But have they analyzed it to see what kind of loads that low-quality flow might give which would act so as to make it less likely that the valve would close?

MR. MAC MILLAN: I can't answer that question. I don't know. But we'll get you an answer for that.

DR. PLESSET: Thank you.

MR. MAC MILLAN: Yes?

DR. SHEWMON: Is there anything in the record -- I don't know whether this is from you or the staff -- as to whether or not the operator had in the operating room an indication that the solenoid had been de-energized?

MR. MAC MILLAN: No, I just don't know. I don't know what the operator had available to him at the time of the incident, and I couldn't confirm that.

DR. SHEWMON: Thank you.

MR. MAC MILLAN: Fifth, high-pressure injection was evidently manually operated, based on high pressurizer level indication.

We have conducted reviews of data from Three Mile Island and performed analyses that lead us to conclude that the indicated pressurizer level was not significantly in error. Plus or minus one foot, we believe that the pressurizer was essentially full during a long period of this transient. But a portion of the reactor coolant system was void. Consequently, termination of high-pressure injection flow should not have been based on the single parameter of pressurizer level.

Sixth, all four reactor coolant pumps were secured. Although securing one coolant pump in each loop in response to indications of low coolant flow may be advisable, securing all pumps under the circumstances then present caused an uncovering of the core.

e-1

PROF. KERR: Excuse me. Under the fifth item, I presume "operating" refers to, at least initially, the pumps being turned off?

MR. MAC MILLAN: Yes. Let me understand, Bill, what your point is there.

PROF. KERR: You say high-pressure injection was manually operated?

MR. MAC MILLAN: Was manually initially turned on.

PROF. KERR: Thank you.

MR. MAC MILLAN: The high-pressure injection pumps went on at 1600 pounds, as designed, and the evidence was that they were secured, one or more were secured shortly thereafter.

DR. CARBON: One more question on that thermocouple. Does it read out on some instrument?

MR. MAC MILLAN: I know it reads out on the computer. I don't know whether it reads out on an instrument. But we'll find that out.

Would you make a note of that?

DR. CARBON: And if it's in the computer, an associated quer ion would be: Does the operator routinely see it or does he . ve to look for it?

. R. MAC MILLAN: He would have to call for that information from the computer.

MR. CASE: John, do you know if HPI was turned on and if so, when, again?

MR. MAC MILLAN: Ed, I ought to say right here that one of the missing pieces of evidence in this incident is a time-phased understanding of what actions were taken in the control room, including the timing of securing HPI and re-initiating HPI and whether or not it was being throttled, and if so, to what extent.

I think the comment was made here earlier that we ought to try to go through and try to reconstruct an analysis of the events as they actually took place at Three Mile Island 2 in order to understand the transient better. I would say one of the important missing pieces of information in conducting that analysis is the amount of high-pressure injection or makeup flow that was being pumped into the reactor coolant system as a function of time. That's a very vital piece of information in order to make that analysis.

I'd like now to turn to actions implemented for our operating reactors. Our analysis of the foregoing factors has led us to conclude that the B&W systems can be operated safely for a spectrum of equipment failures, including those experienced at Three Mile Island 2.

However, the severity of the Three Mile Island 2 incident warrants timely actions to encourage proper operator performance in these events. Our recommended actions can and should be implemented in chronological stems to ensure and enhance continued safe operation. Thus, my discussion consists of addressing: A, the actions already taken; B, the near-term actions to be taken; and, C, longer-term actions appropriate to meet the above objectives.

Before proceeding to a discussion of the specific actions, I would like to establish a context for those discussions with our initial view of the lessons learned from the incident.

(Slide.)

Our analysis of the six factors identified by the NRC has yielded a set of three basic principles which we believe warrant emphasis in considering any future actions.

First, renewed emphasis must be placed in the near term on administrative controls to assure that plant systems important to safety are available. In the longer term, consideration should be given to whether plant systems to augment those administrative controls should be developed and implemented.

Second, renewed emphasis must be placed on maintaining the individual operator's focus upon the fundamental physical processes which assure core cooling and on determining that our systems complement or increase the likelihood of maintaining that focus in any event in the near term. This means placing emphasis in operator training programs and instructions on the fact that the most stable and forgiving condition in a pressurized water reactor is one in which the reactor coolant is subcooled and core cooling is maintained.

As a corollary, a saturated loop must signal in the mind of the operator: One, extreme caution before securing any means of maintaining primary system inventory; two, a warning that a system opening exists; and three, a prohibition against any action which might diminish core cooling.

Third, any actions or modifications implemented must be considered in the broader context of total plant safety. Hasty and ill-conceived actions which might be partially responsive to the TMI-2 events could, in certain cases, produce adverse impacts in other safety systems which were not involved at TMI-2.

Now, with that introduction, I will proceed to discuss the actions already taken and those anticipated for the near and longer term. Let's look at those that we've already taken.

B&W contacted representatives of its other operating plants by telephone between March 29th, the day after the incident was initiated, and March 31st, to provide them with the information regarding TMI-2 and to recommend that they have station personnel check the configuration of their auxiliary feedwater systems and make such inspections and tests as necessary to confirm that the systems would initiate flow of auxiliary feedwater upon actuation.

By April 1st, Sunday, B&W had further data regarding TMI-2 which we believed would be helpful to other B&W operating plants in understanding the causes and the course of events of that incident. I personally contacted each of the utilities, the management of each of the utilities, and invited them to send representatives to a meeting in Lynchburg scheduled for Tuesday, April 3rd.

Soon thereafter, I guess almost concurrently, NRC issued its Bulletin 79-05. The meeting was held in Lynchburg on April 3rd and 4th, with each of the utilities having representatives present.

At that meeting, B&W presented the data we had on the incident and discussed with the representatives similarities and differences in their equipment and procedures from those of TMI-2.

I might say that much of the information that Carl Michaelson presented to you this morning on the curves and graphs formed the basis for that presentation to those utilities.

Additional information was provided and specific questions by customer representatives were answered. Bulletin 79-05 was discussed and B&W provided assistance in responding to Bulletin 79-05, both during this meeting and subsequent thereto.

The first B&W advisory was forwarded by telecopy to these utilities on April 2nd. It recommended as a precautionary step that the operators perform a thorough review of the auxiliary feedwater system, associated support and control systems, and normal maintenance and emergency procedures to identify potential problems that might lead to failure of the auxiliary feedwater system when it is required. It also recommended that the design of the auxiliary feedwater system and the operating, maintenance and emergency procedures associated with this system be reviewed with all operators, maintenance and supervisory personnel, with special emphasis on the importance to plant safety.

The second advisory was forwarded by telecopy to operating plant customers on April 4th, 1979. It recommended that if the high-pressure injection system has been actuated because of a low pressure condition, it should remain in operation until specific plant conditions exist. The conditions stated are that the operation of the high-pressure injection continue for at least 20 minutes and as long thereafter as necessary to obtain temperatures in the loop which are at least 50 degrees Fahrenheit below saturation temperature, or that operation of the high-pressure injection continue until both low-pressure injection pumps are flowing at a rate of at least 1,000 gallons per minute each in a stable condition, and have been so flowing for at least 20 minutes.

The advisory also called for continued operation of at least one reactor coolant pump per loop if the high-pressure injection system has been actuated and the reactor coolant pumps are in operation at the time of the actuation.

On April 6th, another meeting between B&W and the owners was held specifically to discuss information available and B&W recommendations regarding the responses the utilities were preparing to I.E. Bulletin 79-05 and -05A. We provided further assistance in regard to Item 1, involving understanding of the sequence of events, and Item 3, involving operating procedures for coping with transients with a potential for introducing voids in the reactor coolant system.

We understand that the actions implemented and the audits conducted in response to NRC Bulletin 79-05 and -05A have been positive. This, coupled with the NRC staff's review of utility responses to these bulletins and its ongoing review of the incident, provide high confidence that the significant factors in the TMI-2 incident have been properly addressed. Thus, we believe that the actions taken to date by B&W, the utilities and the NRC provide adequate assurance of continued safe operation, while considering additional near and longer-term actions.

Let's now look at those actions which we categorize as near-term. Although we believe that the steps taken by the utilities, the NRC and B&W assure safe operation of the nuclear units, we recognize that additional measures must be taken so that operators are better able to manage transients.

I would like to summarize the actions B&W currently has underway or will be commencing soon to further enhance the safety of B&W units.

First, B&W is preparing a supplementary advisory requesting that all operating and supervisory personnel review the indications of an opening in the reactor coolant system boundary resulting from an open relief valve. The supplementary instructions will be issued this week to all our customers with operating reactors.

Second, during the April 6th meeting with representatives of our other B&W operating plants, B&W suggested a special training program for operators, to be conducted on our simulator, so that they would be more familiar with the TMI-2 sequence of events. On Monday, April 9th, B&W began conducting training for operating and management personnel on the events involved in the TMI-2 incident.

(Slide.)

The training consists of the following: A discussion of the TMI-2 transient from the information available to B&W.

Secondly, a demonstration of the incident on the B&W simulator. We have modified our simulator so that we can fully simulate the events that took place, including our best knowledge of what actions were taken by the operators during the course of this event.

MR. MICHAELSON: Would you clarify whether that simulation is the long-term or the first, say, 20 minutes?

MR. MAC MILLAN: It's long-term.

PROF. KERR: Excuse me. I did not hear Mr. Michaelson's question and I would like to.

MR. MICHAELSON: The question was simply a clarification as to how far out in time the simulation went.

MR. MAC MILLAN: The simulation deals primarily with the early events in the incident. I think there was a question earlier -- perhaps Dr. Okrent asked the question -- about just how well we could simulate the various features of the reactor system and the reactor core. We believe we have a valid simulation of all of these features involved in the thermal hydraulics of the reactor system and the reactor core up to the point where there might be the introduction of non-condensible gases or some type of major cladding interaction. But the basic thermal and hydraulic characteristics of the system and the core, we believe we have.

A training session on the simulator, having students recover the plant from a depressurization event which involves the formation of steam voids in the reactor coolant system outside the pressurizer. This is characteristic as to what was shown at Three Mile Island. It could also simulate other events which could get the nuclear system into a similar kind of steam void condition in the reactor coolant system.

Six operators are included in each training session. The training session lasts one day. At the present time, 33 operators have been through the course, and 99 more have definite schedules established, including operators from all the operating B&W plants.

We believe this course will significantly contribute to the ability of operators to respond properly to transients in general and the loss of feedwater transient in particular. We also believe it will serve to emphasize the procedures to be followed in identifying a small reactor coolant system leak and particularly an open pressurizer relief valve.

The third near-term action item: Based on information currently available to B&W, the equipment in both the primary and secondary plant, with the exception of the pilot-operated pressurizer relief valve, performed as designed. However, considering the unanticipated events at TMI-2, design improvements should be considered in order to assist plant operators in controlling nuclear power plants during transients. Some potential design improvements are currently being studied.

DR. CARBON: Question.

DR. PLESSET: Mr. MacMillan, could you send to us some description of this simulator program and how the training is carried out?

MR. MAC MILLAN: Yes, sir.

DR. PLESSET: That would be much appreciated, I think.

MR. MAC MILLAN: I would even offer, if you would like, for some of your Committee members to come to Lynchburg and try it yourself. I'll leave that as an open invitation.

DR. CARBON: What level of operators have you been having? Senior operators? Supervisors?

MR. MAC MILLAN: Yes, all of the above.

MR. MATHIS: One other question: How does the simulator present the formation of voids so the operator can recognize it?

MR. MAC MILLAN: He has to determine that from the in-plant instrumentation that's installed and displayed on the control panel. He has system pressure, he has pressurizer level, he has the hot and cold-leg temperatures, all of these on one segment of the control panel right adjacent to one another. By looking at the pressure and the temperature, he can determine whether he is in a subcooled or saturated condition. And in the event he is showing saturated conditions and he has to assume that there are voids in the system at some place, that should trigger him to be concerned about whether or not he's getting a valid pressurizer level indication.

Yes?

DR. SHEWMON: How does he know whether or not he's saturated?

MR. MAC MILLAN: That's a good question, and the only way that he knows right now is to either look at a chart that has been drawn for him -- some utilities have put the pressure versus temperature on their computer, so he can call that up and look and see what it is. Other utilities put a little chart, just pasting it right on the control panel.

It would not be difficult to make that kind of a display available to the operator right adjacent to the gauges he has.

DR. SHEWMON: Before the Three Mile Island incident, did your computer have the ability to simulate the significant part of the primary system going into a steam system, and thus what would happen by way of pressure pulses when he starts trying to refuel that again?

MR. MAC MILLAN: We had built into the simulator fault conditions, including the loss of off-site power and obviously the loss of feedwater flow. And we had built into the simulator various breaks in the reactor coolant system, which would be equivalent to having a valve left open. And then he had to respond to those in his training.

Now, I guess I would have to say -- I would have to qualify that at this point by saying, I'm not sure that we had the simulation perfected to the point of getting into a position where he had substantial voiding in the system and then trying to work his way out of it.

DR. SHEWMON: Do you now?

MR. MAC MILLAN: That's what we are trying to do in the course of this training program.

DR. LAWROSKI: Has there been any feedback yet on the 33?

MR. MAC MILLAN: Dr. Lawroski, I have not been in Lynchburg very much lately and I don't have any feedback. I don't know whether any of the others have it or not. We -an get some feedback for you, if you'd like.

Again, turning to the item of design or equipment improvement, in the near-term we expect to recommend design improvements which do not affect other plant systems or require extensive analysis to improve operator performance during transients similar to TMI-2. In this category are such things as more positive indication of pilot-operated relief valve position, an interlock that would isolate certain containment penetrations, including the containment sump, upon emergency core cooling system actuation, and instrumentation which will indicate to the operator whether the reactor coolant is approaching the saturated condition without his having to consult steam tables or curves. And this gets to the point, the question you raised just a minute ago.

We anticipate that recommendations of this type will be made within about six weeks. Implementation would be possible during almost any outage.

We are also reviewing the implication of these design improvements for other B&W 145, 177 and 205 fuel assembly plants now being designed and constructed.

e-2

MR. MICHAELSON: I notice the absence now of level indication in the reactor vessel as a parameter of possible interest.

MR. MAC MILLAN: I'm getting there.

MR. MICHAELSON: Okay.

DR. LAWROSKI: You're in a big hurry, Carl.

MR. MAC MILLAN: The fourth item of near-term action. I have appointed a special task force to advise me within three months concerning other implications for plant design as a result of the TMI-2 incident.

The charter of this task force is shown on the next overhead.

(Slide.)

I have hasked them to review the technical aspects of the occurrence, to developed recommendations on equipment improvements, operator interface or intelligence made available to the operator, recovery requirements, and what would we do to make the recovery and support a recovery -- more effective -- and what incident support modifications we might be looking at in the event that a similar occurrence might transpire in the future; then, finally, assess the impact of the occurrence and potential resulting changes in the regulations -- on our divicion, technical activities.

This task force is comprised of a diverse group of technical personnel, both within our nuclear power division and from other divisions of the company, including our research and development division.

Let me turn now to what we classify as longer-term actions. Beyond the immediate- and near-term actions, the longer-term actions will be undertaken. The ACRS has recommended a major reanalysis effort on transients and pressurized water reactors that involve initially, or at some time during their course, a small break in the primary system, and expressed its belief that the TMI-2 incident has -- and these analyses will demonstrate that additional information regarding the status of the system will be needed in order for the plant operator to follow the course of an accident and thus be able to respond in an appropriate manner.

Although we agree that the TMI-2 incident has shown a need to consider on both a near-term and long-term basis the feasibility and the desirability of potential design modifications to improve the information available to operators, we do no believe that major reanalysis is necessary for these near- and longer-term design decisions.

At this juncture we intend to undertake of those anticipated transients which result in the opening up of the pilot-operated relief valve to confirm that an open-up, pilot-operated relief valve, in conjunction with this antiicipated transients is covered by, or enveloped by existing, small break analysis.

It these reviews -- our own and the NRC's Staff's ongoing reviews of the TMI-2 incident -- and our planned efforts to assess proposed near- and longer-term modifications should indicated a need for additional analyses, obviously, we will promptly undertake to perform that.

With respect to further criteria for design modifications, beyond that being immediately addressed, we will be examining such other criteria, but with the caveat that each must be carefully evaluated with respect to any impact on other design requirements within this area.

We will consider the merits of reactor vessel fluid level indication instrumentation and reactor trip on loss of feedwater flow.

More extensive consideration will be given to containment isolation upon actuation of the emergency core cooling system to review particularly which systems should be isolated and which should be maintained as necessary to enhance plant safety.

An additional direction for consideration of furhter criteria involves recovery from and mitigation of the transients. Obviously, prevention is now, as before, the foremost goal of design, but consideration will be given to such items as isolated and shielded long-term decay cooling, reactor vessel venting, more formalized structure, and procedures for communication between the site and outside support, and the handling of hydrogen generation.

In conclusion, it is B&W's view that the B&W-designed plants can be safely operated. The severity of the TMI-2 incident warrants reemphasis of, first, near-term upgrading of administrative controls, and longer-term consideration of system modifications to provide additional assurance that the safety systems will be available on demand.

Secondly, near-term operator training and instructions and longer-term consideration of system modifications to provide additional assurance that the operator will recognize the importance of maintaining sub-cooled, loop conditions and core-cooling capability for a broad spectrum of transient conditions.

In response to the TMI-2 incident, B&W has, first, expended major priority efforts to support and assist the licensee in brining TMI-2 to a long-term, shutdown condition.

Secondly, taken immediate action to review the incident with operators of other B&W plants, issue instructions and advisories to these operators, and to provide support and assistance to the operators of B&W plants, all with a view to assuring that incidents similar to TMI-2 will not recur.

Third, undertake efforts to continue its review of the incident and revise and update instructions and advisories as necessary, and to implement an operator-training program, with specific reference to the TMI-2 incident.

Fourth, B&W implemented efforts to evaluate potential near term design modifications which do not otherwise impact other elements of plant safety, with a view toward providing further assurance against recurrence of incidents similar to TMI-2.

Fifth, we've developed plans for consideration of longer term improvements in the capability of B&W plants, to prevent, mitigate and recover from incidents similar to TMI-2. While the TMI-2 incident was serious, we believe there are constructive lessons to be learned and that timely, responsive actions have been taken to assure the safe operation of B&W reactors.

We believe that the additional actions which I have outlined today will further enhance that safe operation.

In closing, let me emphasize that we will remain open to any suggestions that the Committee might have at this time and as the results of our near and long term actions become available. In the meantime we will endeavor to keep the committee and the NRC advised at each significant juncture in our efforts.

That concludes my prepared statement. I'd be glad to answer any questions that you might have.

DR. CARBON: Dr. Catton, in most of your presentation it wasn't obvious to me that you're doing any human engineering with respect to your control room. Too much information can be pmac 2

as bad as too little. Have you looked into how best to display the information so that the operator of the reactor can respond properly?

MR. MAC MILLAN: In the comments that I made relative to the issue of modifications that might encourage the operator to take the correct actions I was really driving at exactly that point. How can you display information to the operator so that he can quickly assess what the situation is and take the appropriate action. I would call that human engineering, the operator-machine interface. I believe that's an area where we can do substantial work to enhance, encourage him to make the right kind of decisions.

What has to be recognized is a very hectic environment in the event of one of these major transients.

DR. CARBON: Dave?

DR. OKRENT: I have several questions. Could you tell me why the core thermocouples are connected to the computer in such a way that, when you go above a relatively low temperature, you get a question mark, instead of continuing to read the actual temperature?

MR. MAC MILLAN: I think I can answer that. The core thermocouples are put in the computer and are used primarily for getting some confirmation of core power distribution during normal operation, to assist in the fuel management and to confirm the in core detector indications relative to power distribution.

They are put into the computer so that, I believe, they peg it somewhere around 800 degrees, which, of course, in the normal operation of the unit is a substantial margin above the temperatures we'd expect to read on those thermocouples. The thermocouples were not installed in the plant originally as a means of following significance transients of this sort.

DR. OKRENT: Yes. But is there anything that prevented these thermocouples from reading to a higher range?

MR. MAC MILLAN: Strictly a case of the limitations that were put on the computer in its interface with the thermocouples. In fact, during the sequence of the transients some of those thermocouple readings were checked that were indicating that they were being pegged at 800, were checked in fact to find what higher temperatures were indicated.

DR. OKRENT: Again, if I understand correctly, it didn't even say high. It said question mark.

MR. MAC MILLAN: That's correct. When it gets up in that range, it just prints out a question mark.

DR. OKRENT: Yes. Now, it seems awkward, to say the least, that in the two events that have led to significant damage to the core in a power reactor, namely Three Mile Island -2, and many years ago Fermi-1, there was thermocouple information available. The thermocouples were installed, and in this case in fact the information as to temperatures was unavailable to the operator.

In the other case it was not in a place where he would see it, and it wasn't built into any alarm system, and it seems to me at least that for the future I might have heard an interest expressed in getting this additional piece of information built into the system in a way where it could be useful for safety purposes. Well --

MR. MAC MILLAN: I respect your comment.

DR. OKRENT: I'll leave that for the moment.

Could you tell me something else?

PROFESSOR KERR: Mr. Okrent, I want to hear your comments, if you could use your mike.

DR. OKRENT: I'm wearing it, but it may be set down low. If I understand what I've been reading and have read about the behavior of the control system that relates core power and feed water flow and demand and so forth, and I'm quickly going to get over my head, since my area of knowledge is not reactor control. I'm trying to understand how B&W decides what constitutes an acceptable control system from the point of view of how many times it challenges the operator or the safety system to do something to get the reactor shut down safely.

Is the question clear?

MR. MAC MILLAN: I'm not sure I understand what you're driving at.

c 5

DR. OKRENT: Well, let me put it this way. If you had a control system that every day required a reactor protection system to work to keep the reactor safe, I think you would feel that you were challenging it too frequently. Or if every day the control system required the operator to do something not routine in order to either get the reactor shut down safely or to restore it to some acceptable steady state condition, I think we would both agree that this was too frequent.

Now, as I look at the number of events that have transpired in the last few years, there have been several situations where the operator was pressed one way or another to restore the reactor, where in some cases the control system received faulty information because of some malfunction, a short circuit or whatever, or the operator got misinformation or both.

And I'm trying to understand whether this in any way relates to the particular mode of control used, whether it, in your opinion, a reasonable number of challenges, a reasonable number of anomalous situations, whether all reactors should be expected to have this kind of behavior or just how do you evaluate the safety implications of the control system employed on the B&W reactor.

MR. MAC MILLAN: If I understand what you're saying, do we have a criterion that says, if your control system has a mac 6

fault more than three times a month, that's unacceptable, the answer to that question, we don't have such a criterion. Our integrated control system reliability is an area where we're working to improve its reliability. I'm sure you'll understand that that was not a factor in the sequence of events which we are discussing today relative to Three Mile Island-2.

DR. OKRENT: I understand it very well; however, in looking through the history, I can see other transients that might have transpired into a complex or more complex event than they were, situations where, at least for a period of time, full information concerning the status of the reactor was not available to the operator, and situations where the operator needed to do things far from what he ordinarily does to return it to a state of normalcy.

And again I'm trying to understand whether in some way the control system has been or should be reviewed as a contributor to, let's say, the initiation of possible accidents. I guess that's a way of putting it.

MR. MAC MILLAN: Let me answer that, if I could, with a couple of comments. First of all, let me say that we are not satisfied with the reliability of the integrated control system and are working to improve that reliability.

Secondly, the safety of the equipment, the safety of the operation is not controlled by the ICS. It's controlled by the reactor protector system and the engineering safeguards features actuation system. I agree with your concern that we do not want to have an integrated control system that is challenging your operator on a daily basis to see if he's on his toes, to handle abnormal events.

And the thrust of our reliability program would be to reduce the number of those instances.

DR. OKRENT: Let me ask a related question. There is some history of what you might call feedwater transients, one way or another, that transpired prior to Three Mile Island. None of them, to my knowledge, was associated with, for example, isolation of the auxiliary feedwater system or other things here, but there sometimes might have been other things associated with them.

Do you review the frequency of such events and judge whether there is some pattern that needs consideration, or is that outside the scope of the B&W area of responsibility? Is it the architect engineers who are supposed to worry about this or just what? Where does this fall?

MR. MAC MILLAN: Let me address the issue of loss of feedwater experience. We've had a number of those transients on the B&W systems. I don't know the exact number, but it's in the range of 60 instances of loss of feedwater.

I guess I ought to set the record straight. In direct answer to your question, the design of the feedwater system primarily is not a B&W responsibility; however, we do c 8

place certain requirements in terms of the quantities of feedwater, the temperature of the feedwater, the quality of the feedwater, which must be satisfied in order to assure the appropriate operation of the B&W equipment.

Most of the loss of feedwater transients that have occurred have been initiated through factors which are involved in the design of the feedwater system. Some designs are much more susceptible to loss of feedwater than other designs, and it's closely related to the number of safety features and interlocks and protection devices that are built into the feedwater system.

And the features of the feedwater system that determine, seem to determine the frequency of these events, where we see an abnormal number of those events, it's been our practice to work with the utility or his architect engineer, depending upon any particular customer, to try to understand what it is that's causing these transients, and are there things that can be done to reduce their frequency?

I have to say to you in most cases the corrective measures associated with that are involved usually in changes in the feedwater system rather than changes in the equipment which B&W supplies.

end 3

CR 4051
HOFFMAN
t-4&5 mte 1

DR. OKRENT: If I can ask a few more questions. You indicated that you thought you didn't have a need for major reanalysis. I think those were your words.

By the way, I don't think they're in the ACRS letter. Maybe they shouldn't have been.

MR. MAC MILLAN: Maybe I inferred that from the third paragraph of that letter, Dave.

DR. OKRENT: But I'm a little bit curious. I have to assume you didn't analyze any transients like Three Mile Island transients before it occurred. It's an unusual sequence of events.

Had you analyzed any at B&W and documented them, at least internally, which led to overheating of the fuel?

MR. MAC MILLAN: All of the accident analyses we've done, including the spectrum of small break analyses, including loss of feedwater transients and loss of off-site power, we have documented, and in each of those instances we have demonstrated that, given the continued operation of the emergency injection system, the high-pressure injection systems, water is maintained in the core and the core condition is maintained in a safe configuration, and you do not see the kind of temperature transients that we have seen here at Three Mile island 2.

The answer to your earlier question is, we have not previously analyzed the sequence of events that transpired at

CR 4051
#4
jwb fols
mte 1

Three Mile Island 2, nor do I think we could have predicted ahead of time the sequence of operations that transpired there at the time the incident occurred.

DR. OKRENT: No. My question was: Have you analyzed any that led to overheating of the core?

MR. MAC MILLAN: On the design-basis accident, the core is overheated.

DR. OKRENT: Ah, but only in a modest way.

I mean, to something that resembles this degree of degradation-- I'm just curious -- as part of your simulation studies.

MR. MAC MILLAN: The most severe transient in terms of core temperature that we have analyzed is the design-basis accident.

DR. OKRENT: Do you think with your current simulator you could have put in these conditions as actually occurred, and let's assume we'll be able to find out with sufficient detail, into your simulator and predicted formation of hydrogen gas bubbles and where it would be?

I'm just trying to understand the power of your current methods.

MR. MAC MILLAN: Our present simulator -- nor do any of our analytical methods in our computer account for the formation of noncompressible gas or hydrogen, or try to say where that would be in the system.

DR. OKRENT: Do you think you could have described the matter, including the formation of voids in some detail that's boiling in the core and so forth with your current simulator?

MR. MAC MILLAN: Yes, sir.

DR. OKRENT: Now as you know, there are some questions about whether for very small breaks there is the possibility, if you don't have the primary system pumps, that there may be a mismatch of heat input from a shutdown core and heat output from the small break, and so forth.

Have you done calculations covering the full spectrum of that specific accident at various break locations throughout the primary system in the pressurizer, in the pipe, the cold leg, hot leg, and so forth?

MR. MAC MILLAN: We have looked at and have documented an evaluation of a series of break sizes down to and including a .05 square foot break, and we have looked at that sized break at various locations around the reactor coolant system in order to determine which may be the most severe condition that we have to be prepared to address.

And in each of those cases, as I indicated earlier, we have determined that we maintain water in the core and would not expect to see significant fuel cladding temperatures under those circumstances.

DR. OKRENT: I can't tell, though, whether going down to .05 is a way of answering the question I posed, because my break starts at 0 and goes up. And it may be the interesting sizes are below .05. Have you looked?

MR. MAC MILLAN: We have looked at smaller break sizes, yes, and concluded that they are not as severe as the ones around the .05 square foot size.

DR. OKRENT: So you've looked exhaustively, then, for sizes below .05. Is that what I should assume?

MR. MAC MILLAN: I'm very hesitant on that word "exhaustive."

DR. OKRENT: There should be no surprises below .05?

MR. MAC MILLAN: We don't believe there are, from the work that we have done.

DR. OKRENT: Just one other question.

There are other kinds of instrumentation that one might think of that could have been useful here, had we had it. Some of it would fall within the scope of the NSSS supplier, I would think, or at least some of it might fall in the area that the balance-of-plant man would supply.

I wonder if you have developed any opinions about whether and what other kinds should receive serious consideration?

MR. MAC MILLAN: I think I ought to answer that this way: We're in the early phases of analyzing this event.

As I indicated in my testimony, the primary thrust of our efforts has been directed toward the support of the activities of Three Mile Island 2, and any of those immediate actions which we deem to be appropriate in terms of supporting the continuing operation of our other nuclear plants.

Obviously a lot of people are doing a lot of thinking about what other sources of information might we have? What kinds of design modifications might we make based on the lessons to be learned at Three Mile?

I believe that's something we need to do in a very orderly and a very, I'd say, cautious way, as we look at the events therein, as we try to get more information about what took place in that incident.

I do not have at this point any suggestions or recommendations about other kinds of instrumentation that we ought to have as a consequence of a detailed analysis of TMI 2. I think that will come in due course.

I'd be interested in suggestions, if you have some ideas.

DR. CARBON: Dr. Kerr?

PROF. KERR: John, I think earlier you indicated a rather extensive look at systems, not an exhaustive reanalysis, and I am sure you're concentrating on this kind of transient, as I think one has to.

All of us, I think, are conscious of this as an example of the fact that we may have overlooked some other things, as well.

Is there any systematic way -- do you have any plans to try to look perhaps a bit further than this kind of transient for -- I don't know how to describe looking for things that one hasn't thought of -- but do you have any plans to do anything that would be a systematic approach to perhaps a finer sieve than we have used?

MR. MAC MILLAN: You do pose a very difficult question: How do you look for things you don't know about?

DR. PLESSET: Let me throw one your way. May I?

MR. MAC MILLAN: Yes, sir.

DR. PLESSET: I'll give you a "for instance."

Supposing you have delayed scram. Have you looked at that?

MR. MAC MILLAN: We do look at the effect of various delay times before scramming and the impact.

DR. PLESSET: I was just trying to help Bill.

PROF. KERR: As a matter of fact, on this transient, they did have delayed scram.

DR. PLESSET: I was thinking of a more significant delay than the one they had.

MR. MAC MILLAN: Our system is designed so that we do not normally -- it's not part of the safety system to scram a reactor when either the turbine trips or there's a loss of feedwater.

In this particular incident, as designed, the reactor tripped on high reactor coolant system pressure, and that took place, if my memory serves me right, somewhere around 12 seconds after the initiating incident.

The question could be asked -- and I think I mentioned in my testimony -- that one of the things we are looking at is whether or not it would be more appropriate for us to build the system in such a way that the reactor scrammed on the loss of feedwater flow.

What I said in my testimony also was: I didn't think we ought to rush in any hasty or ill-conceived solutions because we need to look at what the implication of that would be relative to all the other operating phases that the reactor may be subjected to.

I believe, Bill, the other thing I said in my testimony that gets at something of the point that you are making is that we have -- we are going to look at all of the transients that we are aware of that cause the power-operated relief valve to open. And there are a number of them. And then evaluate, if the valve sticks open in the course of that transient, what is the impact on the system? What happens in the system? What actions are automatically initiated by the safety systems? What kind of actions would be expected by the operator? And what would be the extent of the effect of those transients?

Now that's a very specific area of looking at, on a systematic basis, those things which could cause that valve to open, and what happens if it sticks open? And what happens if that open valve goes undetected by the operator in the subsequent time?

PROF. KERR: You mentioned "feedwater" earlier, and I don't want to belabor it, but it has been my impression that feedwater control systems in some cases may be somewhat primitive, especially in the way in which they react to feedwater flows at low power levels or low loads.

Is any additional analysis of the system -- I recognize that this is probably never, or at least not normally your direct responsibility, and you said that you supply specifications -- but specifications are not very useful if they can't be adhered to.

Is it your experience that specifications you provide are generally met? Or is that somebody else's responsibility?

MR. MAC MILLAN: We have the responsibility, Bill, to check the design to assure that the secondary system, the feedwater system as designed accomplishes the requirements that we have established.

But I have to say to you again, those requirements relate primarily to how much feedwater flow you're going to get at what kind of temperature and what kind of quality, and don't necessarily address how many heaters are in the train, what kind of interlocks do you put on the feed pumps so that if you lose some inlet pressures --

PROF. KERR: I'm not thinking so much of interlocks as I am whether you specify steady-state, or quasi-steady-state, which it seems to me must frequently be the case, and don't really have much of a specification on the transient operating performance.

That doesn't seem reasonable to me. But from looking at the experience with these systems, one could almost get the impression that not much attention is given to the transient performance, especially at low loads, because that's where the difficulty seems to occur.

MR. MAC MILLAN: We do have some limits that we put on the system relative to how rapidly it can change temperature, because that has some impact on the temperatures, the transients in the steam generator itself.

We also have requirements on -- in which we would accept a change in steam flow as a function of time, and that affects the rate of feeding of the feedwater. So there are some transient requirements that are required, but I sense that what you're driving at is: At low flows, you sometimes get some oscillations in the feedwater flow.

PROF. KERR: I can remember an instance in which we were looking at water hammer, in contrast to this particular transient. And on this plant, it seems to me, it was discovered that at low flows the design of the valve was such that one, in effect, got a very high gain in the loop gain of the control system, and it simply was unstable, apparently.

Those things don't show up in a quasi-steady state analysis, but they're very important to the transient performance of the system.

MR. MAC MILLAN: I guess my response would be that where we see a high incidence of loss of feedwater, and this was the case on Oconee 1, we sat down with the designers and said, "Now what can we do to decrease the frequency of these incidents? What were the causes? How can we eliminate those causes and have a more assured continuity of feedwater flow?"

Again, that's not our design responsibility, but we feel, when we see that kind of repetitive performance, we need to get together with the designer and try to work our way through it.

PROF. KERR: On another subject, both the NRC and you have urged operators to look at their administrative procedures for making certain that either of the safety systems are available when needed, yet unquestionably there must have been other objections to review this same sort of thing, and we found the situation in which the auxiliary feedwater was available.

One could try to move in a direction o_ additional interlocks on the operator startup unless these were available, but then one would have to have interlocks on the interlocks, I suppose.

Do you plan to give any thought to whether one can obtain appropriate operation if these auxiliary feedwater systems are manual? Maybe we're going in the wrong direction.

I'm not asking you to design the system today. I would urge that at least that possibility not be neglected.

MR. MAC MILLAN: That's an interesting thought. I'll have to say that's one we hadn't thought of. Clearly we'd thought of other ways to make sure those shut-off valves are opened at the time that they need to be open, but going into manual --

PROF. KERR: It may be irrelevant or impossible, but at least if somebody had to do something and had time to do it -- well, it strikes me as an alternate approach which it seems to me ought to at least be looked at before it's completely discarded.

MR. MAC MILLAN: We'll make a note of that.

PROF. KERR: I have no more questions.

DR. CARBON: Paul?

DR. SHEWMON: Yes, a couple of comments.

Do you have any idea of why the primary feedwater failed in this case? There was some talk about demineralizers, or something else coming out of the rumor mill. I'm not sure.

MR. MAC MILLAN: I heard the same rumors you did. I don't really know what happened as the initiating event in the loss of feedwater.

DR. SHEWMON: Okay.

In the handout that Tedesco had this morning, he had a list of six feedwater transients. The PORV was activated in five of them. It stuck open in three of those five.

MR. MAC MILLAN: Yes, sir.

DR. SHEWMON: That's not a batting record that anybody outside of the Major Leagues would be very pleased with. And I wonder if you could say -- I assume, since that's on the top of the pressurizer, that it's something you people specify, if you don't build it.

Could you tell me something about how these are tested, and whether we can see any improvements down the road? It's nice to tell the operator, to train him to tell him that it always sticks open, but that doesn't quite seem like the way to whip it.

MR. MAC MILLAN: Let me respond to several of -- where I think your question is at.

I think the implication was that three out of five we had the valves stick. That isn't really the right statistic. We've had somewhere -- and I don't have an exact number, but it's in the range of 150 events in the history of the B&W units which have caused the power-operated relief valve to open. Out of that 150, in 3 instances the valve has stuck open, for one reason or another. That is not far from the kind of statistics that have been generated in the evaluation of reactor safety, about a .02 probability. It seems to be right on target.

Now there was some question this morning about whether all of these valves were the same valves, or whether they were different suppliers.

The valve at Oconee and the valve at Three Mile Island 2 are Dresser valves and are essentially equivalent, identical valves. The valve at Davis-Besse is a Crosby valve of a different design.

These valves are used extensively not only in the nuclear business, but in the fossil steam business, for pressure relief, pressure control.

end #4

The testing of these valves involves a hydro test. The normal manufacturing involves a hydro test. And then a subsequent cycling test of the valve, where the valve is relieved, the pressure comes down. It's allowed to sit for five minutes, blown again.

DR. SHEWMON: What's going through the valve?

MR. MAC MILLAN: Steam.

DR. SHEWMON: At 2200 psi.

MR. MAC MILLAN: The steam at the design relief pressure, and this is cycled three times to check the relief pressure and the re?eding pressure and to assure that in a receded position that the valve -- the seal is not simmering.

DR. SHEWMON: That happens when?

MR. MAC MILLAN: At the time the valve is manufactured.

DR. SHEWMON: Did that ever happen again in the course of the semi-annual review or the decennial review? Is there any in service inspection on these?

MR. MAC MILLAN: I don't know the answer to that question. Do you know what the annual inspection requirements are?

MR. TAYLOR: Jim Taylor of B&W. After each of the two instances that Mr. MacMillan referred to in the cases where valves stuck open, in the first case it was at Oconee. That, I believe, was in 1975. An investigation was made of the causes

pmcc 2

of the problem. It was determined to be corrosion and improper clearances in the valve. These valves were reworked. Field changes were put out to all the plants that had these valves installed, and they were tested.

In the case of the Davis-Bessie transient, which was a Crosby valve of a different design, it happens to be the only B&W plant that has the Crosby valve. The rest of them are Dresser valves. It was an electrical problem quite different than the one that occurred at Oconee. And that electrical problem involved a relay having been left out of the circuit, which was not a part of the equipment that we had supplied, and that valve was corrected and tested after that also.

So in each of the cases where a difficulty with a sticking valve had occurred, an investigation of the cause was made. The valve was retested, and all the other subsequent valves were also reworked. We have recently developed a thorough periodic test procedure which has been sent out to the field on each of the plants, which involves a very extensive test, both each time the plant goes into the cold shutdown condition and during each heatup. So that the cold tests are run involving a solenoid voltage position indication.

The input of dummy signals into the valve operating circuits and a host of other tests are made during the cold condition. And then the valve is lifted during the pre-critical heatup phase. And so there has been a suggestion passed on to each of the plants to make these periodic tests, where the Dresser valves are involved.

DR. SHEWMON: And that pre-critical heatup is after you've got your system at pressure?

MR. TAYLOR: Yes, Dr. Shewmon, it is. That's when you can blow steam through the valve into the quench tank, and they will not only check the operation of the valve at that time but also check the response of the thermocouple on the pipe and the pressure in the surge tank. Those are just very recent test procedures.

DR. SHEWMON: And these are things the operators would do as part of their startup. They would know what that downtail,or whatever your word is, for the indicating thermocouple looks like when the steam is going through.

MR. TAYLOR: Yes, sir.

DR. CARBON: Harold?

MR. ETHERINGTON: Mr. MacMillan, you recommend on a contingent basis using the high pressure injection to continue for at least 20 minutes. In this particular incident at Three Mile Island they would probably have gone solid in about nine to ten minutes. Would that concern you?

MR. MAC MILLAN: It would not concern me to the extent that that is the expected result of high pressure, continuing high pressure injection, and we'd expect to relieve the pressure through the open relief valve in that particular

pmcc 4

way.

MR. ETHERINGTON: Would the relief valve take the water hammer, if any?

MR. MAC MILLAN: We believe so, yes.

MR. ETHERINGTON: I have one more question. You're planning, I expect, at some time to address in detail the conditions required before going to natural circulation.

MR. MAC MILLAN: I hadn't planned to talk about that this afternoon.

MR. ETHERINGTON: I didn't mean that.

MR. MAC MILLAN: I'm sorry.

MR. ETHERINGTON: You know, I consider it a pretty important item, and you don't address it here. But it's something you have under consideration to instruct the operators of B&W plants?

MR. MAC MILLAN: Let me answer that in a couple of parts. You remind me that I wanted to respond to a comment that you made earlier this morning relative to the importance of maintaining the cold part of the steam generator, the driving force for natural circulation in the top of the steam generator.

And the question that was asked is has this been looked at without reactor coolant pumps, for example, in a loss of off site power? The answer to that is, yes, we have looked at that event in loss of off site power, and in that event the

pmcc 5

reactor coolant stopped.

The auxiliary feedwater comes on in that circumstance and is admitted at the top of the steam generator and provides cooling of the reactor coolant in the upper region of the steam generator, in order to provide a driving force to induce the natural circulation and sustain the natural circulation in the post-loss of power sequence.

Now, I believe in the discussion this morning of what was happening at the Three Mile Island-2 in the first eight minutes of the transient we saw a demonstration there of what we believe the steam generator is boiled dry, and then the auxiliary feedwater came in at the top of the steam generator and was evaporated as it ran down the tubes, and no water was accumulating in the bottom of the generator.

But we did see a very significant turn-around, you recall, in reactor coolant system temperature. As soon as that water was introduced in the auxiliary feedwater on the steam generator, that reactor coolant temperature turned around and started back down.

So we believe that, on the basis of our calculations, that in this accident condition without reactor coolant pumps we do in fact through the auxiliary nozzles in the top of the generator get the driving force for heat removal and for induced natural circulation at the proper level.

MR. ETHERINGTON: That's our closely packed tube.

67-241

Does the penetration of the spray -- how far does the spray penetrate?

MR. MAC MILLAN: There's a header on the inside of the steam generator which goes around the tube, with holes on the inside of the header which direct the water right at the tubing in the steam generator.

MR. ETHERINGTON: The bundle is more like this, isn't it?

MR. MAC MILLAN: Yes, we're getting this impact mostly in the outer few rows of tubes.

MR. ETHERINGTON: And you're relying on those as your heat sink?

MR. MAC MILLAN: Yes, sir. And I believe -- well, we saw in the results today that in fact you do get significant cooling in that condition.

MR. ETHERINGTON: But in this case,when they went to natural circulation, the spray was not effective.

MR. MAC MILLAN: In this case, by the time they decided to turn off the reactor coolant pumps, as was indicated earlier, we were in a situation where we had such a rate of temperature in the hot portions of the reactor and would not have anticipated in that condition.

MR. ETHERINGTON: Almost saturated, I think you referred to 150 pounds per square inch below, didn't you?

MR. MAC MILLAN: It was fully saturated and had been for some time. In fact, you can see on the curves where the saturation temperature and reactor outlet temperature, they're right on top of one another. I think to the second issue that you raise, maybe I misunderstood. We are in the process now of developing the information required to make a transfer at Three Mile Island to -- from forcec circulation to natural circulation.

MR. ETHERINGTON: My question really related rather to your other plants besides Three Mile Island.

DR. CARBON: Bill?

PROFESSOR KERR: I don't want to interrupt Harold.

DR. CARBON: I thought you were done.

DR. SHEWMON: Let me ask the question which may be rephrasing his. Is it part of operating procedure or training procedure for an operator to be asked to take a plant into natural circulation? Does he go through that operation?

MR. MAC MILLAN: In the event of loss of outside power that's exactly what he does.

DR. OKRENT: If I can pursue it a little further, it seems to me that where we find difficulties in operation, this represents the most serious one, but we've seen others that were, let's say, one step short of this or two steps short of this.

It's when the situation was not like the one in the FSAR. In other words, you didn't just lose off site power and

pmcc 8

then everything transpired normally. But there would be another complicating factor, whatever it was, either some instrumentation read wrong or a wrong signal point somewhere and so forth.

And what I'm still unable to tell is whether for small breaks or for loss of off site power or for a loss of feedwater or for various other transients one could identify, whether in fact there has been a hard look at what you might call degraded functional conditions and how the system then looks different. It's not clear to me that you're having trained the operator to respond to a situation involving just the loss of off site power and getting to natural circulation will prepare him for a compounded set of circumstances.

And I think in this sense I really question your confidence that you've done enough analysis. I really question that you can now train the operator for these other things if you yourself haven't studied them in some detail and thought about them under differing sets of circumstances.

I think in fact my own feeling is it's two or three weeks after the event. We can sort of sit here and say, well, he should have seen that the temperatures were all giving a question mark, and he should have seen that the pressure was dropping, and he should have seen that it was high in the hot leg and cold in the cold leg and so forth.

But I'm reluctant to say that, had I been an

pmcc 9

operator with the training that they received, I would have been able to see an event. I don't know about you.

MR. MAC MILLAN: Is that a question?

(Laughter.)

DR. OKRENT: Yes, indeed. I'm trying to see, for example, with regard to natural circulation, whether in fact we are in such good shape. You provided assurance that the operator is trained to get it into natural circulation from a loss of off site power. But I don't know whether I should feel all that assured from your having told me that this has been tested on a simulator.

MR. MAC MILLAN: Okay, Dave. Let me see if I can perhaps come at it this way. In the testimony I did indicate that there were some principles of operation that we felt were very important to reinforce with the operators, and those were that he needed to be aware of what his temperatures are doing in the reactor cooling system, what their relationship was to saturation temperatures and what his water inventory was as indicated by the pressurizer level under a circumstance where he has sub-cooled conditions in the coolant system, and then to take those actions which would drive his system in the direction of maintaining those kinds of core cooling conditions.

Now, that's a general principle of operation, and I don't know that I can tell you out of 100 different circumstances how he might get himself into an unusual or abnormal situation if he maintains his focus on those principles. It's our belief that he will be able to maintain the system in a safe condition.

DR. OKRENT: Let me put it another way. What are the circumstances in which there would be need for some unusual insight or some unusual path to get to natural circulation? In other words, which of those that are not routine, so that you can see whether there are any places where the operator, trying to do what you just said, in fact ended up down the wrong path?

MR. MAC MILLAN: I have no answer to that.

DR. OKRENT: I think if you don't try to look for those situations, you're in less than the optimum position to be confident that there are none or to give adequate instructions, and I'll leave it there.

DR. SHEWMON: You're suggesting a single failure mode for training operators?

DR. OKRENT: I'm not sure I want to put it that way.

MR. MICHAELSON: I've got a follow-up question.

DR. CARBON: You're going to have to wait a minute, Bill, I guess. Just go ahead, Carl.

MR. MICHAELSON: Perhaps what Dr. Okrent is alluding to is a very likely situation that you could get into, wherein the system experiences one of these very small breaks of sufficient size where its natural circulation is lost fairly

pmcc 11

early in the ev nt. But now you have to resort to some sort of a boiling condensing mode to remove the heat. If at that point in time the operator discovers where his break is and has the capability of isolating it, a natural thing for him to want to do, and the instruction which often exists is to close the break.

In that case one has to explain how to get back to natural circulation, since you may not be able to get into the boili:, condensing mode at that point.

MR. MAC MILLAN: Well, I don't know how to answer that. I think you would have to look at the sequence of events that would lead to that and determine that your higher pressure injection system was capable of handling that kind of a small break situation.

MR. MICHAELSON: The problem you get into is, unless you have pre-analyzed such a situation, it's very difficult for the operator to make an appropriate judgment.

MR. MAC MILLAN: In that event where you are still depending on your reactor protection system, the ECCS systems to respond, to get the high pressure injection water into the system, in that sense it's equivalent to a small break analysis that has been done.

The essential element again is one of keeping water in the core, and I think, as I said earlier, that those are the results that have come from the analyses that we've performed.

pmcc 12

DR. CARBON: You indicated earlier to Dave's question that you do tell the operator how to get into natural circulation with something like loss of off site power. Do you carry that one step farther and tell him how to do this with loss of off site power and, for example, diesels failing?

MR. MAC MILLAN: I may have put you under a misconception here. On a loss of off site power the mode of cooling is natural circulation. So the events that transpire in that case and what he is trained to do in that case, you in fact put the reactor system into a natural circulation mode.

Now, your question was do we then also look at what happens if a diesel fails?

DR. CARBON: It failed to start up.

MR. MAC MILLAN: If all the diesels don't start up? I don't believe we've looked at that.

end #5

pv

DR. CARBON: Could you tell me what kind of tests you run? Well, how often do the plants get into natural circulation? How often are they called upon?

MR. MAC MILLAN: Very seldom. I don't have any statistics on that. It's not a very frequent occasion. We did do that at Oconee, as I mentioned earlier.

DR. CARBON: But that was probably a special test, as I understood it, at Oconee and Davis-Bessie. Is that correct?

MR. MAC MILLAN: I am not sure about that. Was that special test in both those cases?

MR. ROY: Yes. For Oconee in dealing with natural circulation tests.

DR. CARBON: Are there cases where, aside from those tests, that the plants due to some shutdown condition have gone on to natural circulation?

MR. ROY: I believe there have been cases. I believe there have been cases in the loss of offsite power, something like six or eight. But I don't know the duration, you know, for which the power was lost.

DR. CARBON: I have another question or two along this line if I can get my thoughts straight here. When you run the tests, are they sort of steady-state tests, or is there any transient involved? And when you have the situation, do you try and take into account the effects that would exist as a result of being a transient somewhat different from your pv steady-state test?

MR. MAC MILLAN: The test is run as a transient because you start with the reactor coolant pump on and you turn the reactor coolant pump off, and there is a transient flow condition going from forced circulation into the natural circulation mode. And what we've done in that circumstance is to try to get a correlation or a benchmarking of our calculational method to say does our calculation method predict, in fact, the kind of transient condition that we observed in the plant. And so that test has really been a benchmark to confirm the validity of the transient analysis technique. So, it is transient; it's not just one steady state versus another. We run the actual transient from including the flow coast down to the pump and then the thermal effects which cause the natural circulation to start.

DR. CARBON: And I understood this morning that the Davis-Bessie and Oconee represented the extremes of the Davis-Bessie having the highest steam generator and the Oconee the lowest of all your plants.

MR. MAC MILLAN: There are two basic configurations: The arrangement I showed you today is what we would call the "Oconee arrangement," and is typical of all our operating plants except Davis-Bessie. Davis-Bessie has the steam generators elevated relative to the reactor vessel, and that configuration is characteristic of our later plants, including pv our standard 205 fuel assembly.

DR. CARBON: You have put some sort of flapper valves in the core barrel somewhere, have you not, to perhaps help on this? The tests that you've run on natural circulation at both Oconee and Davis-Bessie, do they have these?

MR. MAC MILLAN: We call them "vent valves," not "flapper valves." Both Oconee and Davis-Bessie have internal vent valves, and, of course, they were operational during the transient from forced circulation to natural circulation. If there is any tendency to open or to short-circuit flow, we would have seen it in those tests. As far as we can determine, they did not.

DR. CARBON: Bill.

PROF. KERR: Mr. MacMillan, I think earlier you indicated general agreement with the NRC Bulletin and instructions which were being sent to operators. But I wanted to make certain that you did not have any reservations or, if you did have reservations, what they were, concerning your interpretation of any instructions and any adverse bearing these instructions might have on safety. If you had any comments, I would like to have them.

MR. MAC MILLAN: We're in agreement with the recommendations that were made in the Bulletin relative to maintaining high-pressure injection for the 20 minutes or until the low-pressure injections are established at a thousand pv gallons per minute each and stabilized, and maintaining in the case of the high-pressure injection 20 minutes, maintaining the temperature at 50 degrees below.

PROF. KERR: I understand that these recommendations had been discussed with B&W.

MR. MAC MILLAN: They are consistent with the informatives we have sent to our customers. The NRC Bulletin and the informatives are consistent.

PROF. KERR: Thank you.

DR. CARBON: Milt.

DR. PLESSET: I think we realize that after the event and further, in view of your training program, that operators are all sophisticated relative to this kind of transient. But if we think back before the event, do you think that an operator would have to be particularly sophisticated to know what was going on during that transient? Did he have the instrumentation he needed, or would he need to have been an engineer or something?

MR. MAC MILLAN: You're asking me to speculate on something which I really would rather not speculate on.

Perhaps I can answer your question this way: I believe that this information as displayed in the reactor control room should have been adequate for him to assess the situation and appreciate that he had conditions under which he should not have turned off the high-pressure injection pumps pv and should not have turned off the reactor coolant pumps. These engineers, these operating engineers, are very sophisticated personnel, and I think that they should have had that degree of sophistication.

DR. PLESSET: Can you tell me, as a matter of curiosity, what you told the people at TMI-2 during the first few hours that you were involved?

MR. MAC MILLAN: I was in Florida at 4:00 in the morning on March 28, and by the time I got reservations to get back to Lynchburg, it was Thursday afternoon, so that I really cannot tell you from firsthand experience what instructions were given to the operating staff in that situation.

The degree of communication that we had from Lynchburg to the site was very restricted, particularly during the first two, three, or four hours of the incident. And I would have to say, even going out much further in time, that communication was a very loose connection. And when I mentioned in my testimony that one of the things I am asking this task force to look at is what recommendations should be made for closer coupling with our operating reactors in the situation, that's one of the things that I believe we need to address and see what lessons can be learned from the TMI-2 experience.

DR. PLESSET: Thank you.

DR. CARBON: I would like to ask a question that's pv similar to what Dr. Plesset was asking. When you think of the operator there and you design the instrument panel and so on for him, what kind of knowledge do you assume he has? How much physics, for example? Do you assume he's taken a high school course in physics 10 years ago or that he's given an extensive several-weeks, several-month course on some basic principles? Just what do you assume? And do you assume that the supervisors have more knowledge of physics; whether they get it formally or informally, it doesn't matter? What kind of assumptions do you make there?

MR. MAC MILLAN: Let me first say that I am not a control room designer. As Dr. Okrent said, I am quickly over my head in this arena.

But as you know, in the process of licensing senior reactor operators and reactor operators, they go through an extensive program of training which includes basic fundamentals of physics, as it's appropriate to the operation of a nuclear plant. And then, beyond that, of course, they go through very detailed training in the specific equipment that they're going to be operating, and they observe operations of other units in service and go through simulator training where they have a chance to operate the simulator which acts just like a real plant.

So, they do have some comprehension of basic physics and engineering principles as it applies to the operation of pv nuclear plants.

Now, I can't answer your question specifically, when the control room is laid out, just what degree or what level of specific training is presumed. That's not my field.

MR. ETHERINGTON: I don't want to belabor particularly this question of whether the water was at saturation at the time of the recirculating pump trip, but there might be a misunderstanding. The figure which showed coincidence of saturation temperature with actual temperature covered the first 30 minutes, and at the time of the pump trip the hot leg temperature is showing at 550 degrees.

I don't have steam tables here, of course, but I believe that that is being about 1050 psi, and the actual pressure is 1300 psi. So, there would appear to have been an overpressure. I may be wrong in my numbers, but that may be worth looking at at some later time.

MR. MAC MILLAN: Harold, the curve I had in mind was Figure 12.

MR. ETHERINGTON: Yes, that's right. That's the first 30 minutes.

MR. MAC MILLAN: Which does show that even in the first 30 minutes of the transient, while the reactor coolant pumps were operating, we had saturated temperature in the hot leg of the reactor coolant.

MR. ETHERINGTON: Even in the first 30 minutes, with

pv

no water entering the steam generator.

MR. MAC MILLAN: He had water in the steam generator after eight minutes.

MR. ETHERINGTON: Well, let's look at the Figure 8. It shows the temperature as a little under 550 degrees.

DR. PLESSET: The saturation pressure is 1047.

DR. LAWROSKI: You're wrong three degrees, Harold. You're slipping.

(Laughter.)

MR. ETHERINGTON: The pressure curve, long term --

DR. CATTON: Harold, if you'll look at Figure 19 --

MR. ETHERINGTON: That's the wrong list.

DR. CATTON: It looks like the pressure is somewhere between 1000 and 1100.

MR. ETHERINGTON: No. At the time of the trip and before the drop, it's, I guess, 1300, between 1300 and 1400. Then it drops off at the time of the pump trip.

DR. SIESS: That scale is questionable.

MR. MAC MILLAN: Figure 19 shows pressure inside of the one-hour time frame of somewhere around a little under 1100, 1050.

MR. MICHAELSON: 1080, I think, is pretty close to what it was.

MR. ETHERINGTON: I would assume that that dropoff occurred at the pump trip.

pv

MR. MICHAELSON: Mr. Etherington, I can give you the numbers, if you like. I did look them up last night.

At that point in time, when the pumps were tripped --

MR. ETHERINGTON: Here I have a different curve altogether for the same data.

MR. MICHAELSON: You should find about 1080, though, in the system pressure, which was about 554 degrees saturation. The hot leg at that time was at about 540. So, apparently, we were about 14 degrees sub-cool.

I think your observation is correct. It appeared to be sub-cooled from the time the pump was tripped.

DR. SHEWMON: In your jargon, "sub-cooled" is where you want to be. Is that right?

MR. MICHAELSON: That's the right side, at least, yes. It appeared to be about 14 degrees sub-cooled. It's hard to read these curves that precisely; but, certainly, it appears they were sub-cooled, yes. It's getting closer than you would like. In fact, you've got to keep in mind that, you know, where the thermocouple or the RTD is and things of this sort -- but it appeared to be slightly sub-cooled.

MR. ETHERINGTON: The thing that I am a little surprised at is a lack of insistence to plant operators that they maintain the pressure as high as possible at the time they go into natural circulation. This has not been, apparently -- they have not, apparently, been alerted to that. And I don't pv know whether there's any feeling that they need not be.

MR. MAC MILLAN: We obviously would rather have them at high pressure, that they get with the sub-cooled condition before they would attempt a natural-circulation condition.

MR. ETHERINGTON: But you don't think it sufficiently important to include it in your instructions to them?

MR. MAC MILLAN: Yes, we do.

MR. ETHERINGTON: This is something you plan to do, then?

MR. MAC MILLAN: Yes, sir.

MR. ETHERINGTON: Thank you.

DR. CARBON: Ivan.

MR. MAC MILLAN: That was one element of the training program that I outlined in my presentation, that they would be looking at getting it from a voided condition to a recovered condition.

DR. CATTON: I have a question that has to do with the layout. I noticed your pressurizer is tied in with the hot leg through the loop. Is that on all of the plants? And is there some design reason for doing that?

MR. MAC MILLAN: The answer to the question is: It's that way on all the B&W plants.

DR. CATTON: Yes.

MR. MAC MILLAN: The principal reason for it being that way is to provide flexibility in the running of the pipe.

pv

I don't know of any other real fundamental reason for it being that way.

DR. CATTON: Thank you.

DR. CARBON: Dave.

DR. OKRENT: Why don't you get Carl.

MR. MICHAELSON: I have a question, and then I would like to solicit a comment on natural circulation.

In the case of Davis-Bessie is the auxiliary feedwater fit from the top of the steam generator, or does it flood from the bottom? And if it floods from the bottom, then what would you have to say concerning natural-circulation problems?

MR. MAC MILLAN: The question to your question is that at Davis-Bessie the auxiliary feedwater header does not go in at the top of the generator as it does in the Oconee configuration; it goes in closer to the bottom of the steam generator.

The reason we felt we could do that at Davis-Bessie was because of the relative elevation of the steam generators with respect to the core, and with the steam generators well above the core, bringing the auxiliary feedwater in at the bottom of the steam generator provides enough thermal head to get natural circulation.

The reason the auxiliary nozzles are at the top of the Oconee steam generator configuration is: in order to get pv cold auxiliary feedwater in those generators at an elevation well above the core, in order, again, to have natural circulation.

DR. CARBON: Dave.

MR. ROY: Excuse me. Even though that's a raised loop, the natural-circulation situation is even better because the aux feedwater is in at the top, Davis-Bessie being the once-through steam generator, rather than the IEO with the compromiser.

MR. MAC MILLAN: I am sorry? You're saying Davis-Bessie has it at the top?

MR. ROY: It does have the auxiliary feedwater flow at the top. It was also one of the plants tested under natural circulation; with a very good natural circulation flow, by the way.

MR. MAC MILLAN: Our standard plant has the feedwater at the bottom.

MR. ROY: Yes. For the raised-Loop plants with the 205 fuel assembly model, the aux feedwater is at the lower.

MR. MAC MILLAN: I am glad you corrected me on that.

MR. MICHAELSON: Does that mean, then, that there is a spray tower at the top of the steam generator? Is that right?

MR. ROY: Yes.

DR. CARBON: Dave.

pv

PROF. KERR: Excuse me. Then that really seems to mean that there has not been an experimental test of standard plant kind of configuration for natural circulation. You mentioned Davis-Bessie.

MR. ROY: No test yet. The first will be the Bellefonte unit.

PROF. KERR: Okay.

DR. OKRENT: Earlier in the discussion you indicated that you could provide or perhaps had already provided documentation of the simulator programs. Is it "could" or "have"?

MR. MAC MILLAN: We could. We have not.

DR. OKRENT: Is this in detail so that it describes fully all the equations and so forth?

MR. MAC MILLAN: We could make it that way. We wouldn't normally.

DR. OKRENT: And is this a proprietary program?

end#6

MR. MAC MILLAN: I doubt it.

MR. MAC MILLAN: Is it proprietary?

MR. ROY: I would say yes.

DR. OKRENT: Does proprietary mean that the NRC doesn't have access to it?

MR. ROY: No.

DR. OKRENT: Could they put it on their computers if it were proprietary?

MR. MAC MILLAN: I'd have to guess that the answer to that is yes, they have that authority.

DR. OKRENT: All right. Also, you indicated that you thought that you had done a sufficient amount of small break analysis, including breaks below the point of five square foot. Do documents exist that I should have seen on this?

MR. MAC MILLAN: I doubt it. The only information we've presented in our licensing dockets has been down at the .05.

DR. OKRENT: But since you've done these, this is something that you presumably have then in internal reports and could provide?

MR. MAC MILLAN: We could.

MR. ROY: We have done the .04 square foot case, and we have done the 0073 square foot case, which corresponds to the stuck open pilot-operated relief valve, and extensive qualitative review of the expected response to small breaks at various other locations. And that material can certainly be made available.

DR. OKRENT: Well, I gather from Mr. MacMillan's answer that, by either qualitative or quantitative analyses, you have assured yourselves that there were no untoward situations in any break sizes. So I think I for one would like to see such documentation in the near future, to see what does transpire and be satisfied in that regard.

A different question. I've heard it suggested that level instrumentation in the hot leg might be practical and might be a way of getting information on the level in the vessel, albeit not directly. Have you looked at that specific alternative as a possible way of providing further information for a B&W plant? Is it practical? Is it impractical? Can it be done only on plants to be built? Or what can you say about it, if anything?

MR. MAC MILLAN: That suggestion has been made. We have not looked at it in any detail. I can't tell you whether it's practical or not practical, or whether it can be incorporated or not. I would put that, Dave, in the same category as looking at the reactor vessel level measurement alternatives.

DR. CARBON: Chet?

DR. SIESS: Would it be possible to explain to me in a relatively short time the principle on which the pressurizer level instrumentation works?

MR. MAC MILLAN: I can give you a very simple description, and if that isn't good enough I'll have to call on somebody else.

DR. SIESS: Simple will be short.

MR. MAC MILLAN: Basically, we're reading the pressure difference between the steam space and the water space in the pressurizer and taking that delta P as an indication of the hydrostatic head. The reference, the line comes outside and it gets cooled just by heat loss, so that in the event you get a rapid depressurization in the reference leg or the instrumentation leg, it will not flash and lose that.

Very simply, that's what we're doing.

MR. MICHAELSON: To follow up that comment -- and this is just a question maybe you need to look at to put to bed -- and that is, depending on exactly how that instrument line is routed, it appears that for certain types of breaks in certain locations, it would be possible to heat the reference leg by the fluid emitting from the break.

I was wondering, do you know if anybody has checked the instrument panel which is near the relief tank to see if this instrument by chance is routed near there or located on it?

MR. MAC MILLAN: I can't answer that. Does anybody know?

DR. PLESSET: I think that Dr. Hanauer has a viewgraph that maybe he could show to us. Would that be worthwhile, if it's all right, Mr. Chairman?

DR. LAWROSKI: It's worth a thousand words.

DR. HANAUER: Mr. Chairman, I'm Steve Hanauer of Regulatory staff. The subject of the level instrumentation seems to be of great importance, and so, anticipating these questions, I have a couple of pictorial representations.

(Slide.)

This shows the general principle. One puts a differential pressure instrument with two legs, the one in the steam space, the one in the water space. One measures, therefore, the mass per unit area of the liquid, with the mass of the steam being negligible.

Clearly, the situation in these pipes is crucial. The most obvious thing that could go wrong is that this pipe could fill up with water exactly this high and the differential pressure transmitter would read zero. In point of fact, it doesn't look like that; that only shows the principle.

(Slide.)

In point of fact, it looks like this. This was obtained from some Burns & Rowe drawings at some considerable effort.

(Laughter.)

DR. HANAUER: You can't believe how much effort.

(Laughter.)

DR. HANAUER: All of this is inside containment. The containment wall, not shown, is here, and some feet inside the wall is the cylindrical, approximately, shield wall. And the actual differential pressure transducer is located in this annulus, so that the instrument man who goes in and makes adjustments and callibrations is shielded from the primary system.

The pressurizer sits maybe 40 feet off the floor, and the taps are approximately 33 feet apart. And instead of the transmitter being located as shown in the schematic diagram, it is in fact 50 or 60 feet away, and the routing is approximately correct and approximately to scale.

The question then is: What's in these pipes? The answer is: These pipes are full of water. This lower one is full of water, because when the transmitter is installed there's a collection of valves, drains and the like, not shown, which you manipulate in order to get it full of water, and then there's no further difficulty.

This line is also full of water and has to be filled at the time the transmitter is installed, or monkeyed with, after which condensation will keep it full, because this line is cooler than the pressurizer. This is shown in still more detail in this viewgraph --

(Slide.)

-- which is a view of just the pressurizer. The pressurizer itself is this cylindrical object with hemispherical ends. The pink stuff is the thermal insulation around the cylinder, about which we obtained much more information than anybody here wants.

(Laughter.)

DR. HANAUER: The yellow thing is the lower pipe, the blue thing is the upper pipe, both drawn to scale. The important question is whether it's inside or outside of the insulation. It's outside.

We've done some conduction-convection heat transfer calculations, and in fact, within a few inches of the blue pipes runs at the containment temperature of about 100 degrees, rather than the pressurizer temperature of 650 degrees.

DR. SHEWMON: To help me understand that scale drawing you've alleged to have up there, the red insulation is 6 inches thick and the space between the blue pipe and the outside of the insulation is one inch?

DR. HANAUER: So it says.

DR. SHEWMON: Thank you.

MR. MICHAELSON: Steve, did you check to see where t e panel is relative to where the dump tank, the reactor coolant drain tank, is?

DR. HANAUER: No, sir, I didn't. It could be ascertained, but I didn't do it. It is in this annulus outside and you would have to tell me where the dump tank is. It's known. I just don't have it at my fingertips.

MR. MICHAELSON: Do you know the panel number?

DR. HANAUER: Not standing here. We wrote a report on it, which will tell you more than you could possibly want to know.

MR. MICHAELSON: Okay.

MR. TAYLOR: Dr. Michaelson, I believe it is true, however, that the dump tanks, if it were near one of the transmitters, would only be near one of them, because of the physical separation requirements. And there are three separate transmitters, which, when they were all working, were reading identically.

DR. CARBON: Steve, some flashing is said to have taken place in the pressurizer line. How much did, or what do you theorize because of the 100 degrees?

DR. HANAUER: We've done some calculations on that, and the temperature there is just the point I was making. Initially, the fluid inside, water and steam, is at 650 degrees at 2155 pounds per square inch. There's a temperature gradient in the liquid in the first few inches of this line, this horizontal piece. And as far as we can tell it is horizontal. This horizontal piece will presumably be empty. There will be a stagnant column of liquid, approximately full, from condensation. And there will be a temperature gradient in these first few inches of line.

We made a calculation and only for the first small number of inches will the fluid be subject to flashing, even during the initial pressure dip down to about 13 pounds per square inch, since the total span is 33 feet. We conclude that less than a foot will flash.

We also did calculations on the dissolved gas content and on the potential for sucking fluid out of here by virtue of the velocity past the end of the pipe. Neither one seems to have the potential for significant level instrument errors.

DR. SIESS: Steve, mention was made of three transmitters. Does that mean there are three reference legs?

DR. HANAUER: There are three reference legs, three measuring legs and three transmitters, done at different azimuthal positions in the annulus.

DR. CARBON: Are there other questions of Mr. MacMillan?

(No response.)

DR. CARBON: Mr. MacMillan, could you provide me some documentation on the natural circulation tests that you have run and on the associated documentation where you extrapolate or whatever from the actual test to other conditions, as well as information on the cases where B&W plants have relied upon natural circulation, where they have gotten into natural circulation?

MR. MAC MILLAN: Yes, sir.

DR. CARBON: Are there other questions?

(No response.)

mte 8a

DR. CARBON: If there are no further, let's take a break.

(Brief recess.)

DR. CARBON: Dave?

DR. OKRENT: Mr. Chairman, out of listening to the discussions this afternoon and trying to remember what I had read that the staff had recommended to various PWR operators, it wasn't clear to me whether the staff had dealt with whether operators had sufficient guidance with regard to when and how they would go into the natural recirculation mode, should this be required because of some future transient. And I wonder if the staff could help me in that regard?

DR. MATTSON: Well, the loss of power transient is a transient that's required in the course of licensing review to be analyzed and accepted for licensing purposes. And loss of power requires the plant to go into natural circulation from full power.

I'm not sure what your question is. To the degree we've looked at that, or to the degree we're going to look at it in the future? Which is the thrust, Dr. Okrent?

DR. OKRENT: Well, I suspect I probably could have said one month ago, a situation where a relief valve was stuck open in the primary system is a situation that's been analyzed and for which the operator is prepared. Yet, we had a combination of circumstances where things didn't go like the FSAR.

Now, I'm trying to understand whether the staff has looked in sufficient detail at possible instances in which one might need to go into the natural recirculation mode and looked at the kinds of things the operator might have to do and when and has decided that adequate procedures exist at all operating PWRs, and just what is the situation in that regard.

DR. MATTSON: At this point in time, we haven't looked at those transients that lead to natural circulation and compounded then with the kind of failure which occurred in the power-operated relief valve at Three Mile Island 2, to answer that question for all PWRs. Clearly, that's a question that has to be addressed in the generic program that was described this morning.

DR. OKRENT: You know, I've never been able to tell when something that's generic is going to be resolved. We've only very recently been talking about a 10-year-old generic problem.

DR. MATTSON: I would recall for you what Tedesco said this morning: that the report on his generic activities, saying what's been done and what needs to be done, is due to be published the end of the month. And I say with some certainty that resolution of that question in the near term is a very important thing to accomplish. I can't tell you that it will be answered tomorrow.

DR. OKRENT: If I can put words into your mouth, are mte 10

you telling me that the question of what constitutes adequate interim guidance for operators with regard to natural recirculation load of cooling will be handled as part of the Tedesco study to be published by the end of April?

DR. MATTSON: It'll either be in there or a reason given as to why it's not necessary in the short term, or a date set in the near term for accomplishing that, with a basis as to why it's safe to do that in the meantime. I can't prejudge the outcome of that. All I can tell you is that the question will be very seriously and forthrightly addressed over the next two weeks as part of the charge.

DR. OKRENT: Harold, did you have anything?

MR. ETHERINGTON: No, I don't think I have any questions. I would have thought that whether or not the problems possibly are real or not, we could make some requirements in a safe direction. That is, we could insist that there be higher pressure prior to the time of going into natural circulation. We could specify some limits on the temperature. These would be in the safe direction and would seem to impose no problem.

e-7

DR. MATTSON: Dr. Okrent, Mr. Etherington, I would agree with that.

The question that's in my mind is the one that's come up a couple of times today, that you have to set those conservative limits with some caution to make sure that you don't exacerbate another safety concern. And to the extent we can derive such limitations or such guidance within the next several weeks, I'm sure we will.

And if it's found to be necessary to set them, and it's impossible to set them, then you'd have a reopened question of continuing plant operation.

So it's in that sense that if it's necessary and they can't be developed in that short time, then you have to reopen that question.

The indications are so far that that won't be the case, but as I said at the start this morning, there is no question that there are questions that remain unanswered. That's one of them we're working on.

MR. ETHERINGTON: The warning that the low temperature at Three Mile Island could have contributed a little to the problem, would this be in order?

DR. MATTSON: I think I understand what you're saying. As a result of reviewing the information that's come in for the moment, the things that Steve Varga was talking about off the bat this morning, and as a result of continuing to review the information that we're gathering from you here today and things that are still coming in from the plant, if such warnings can be derived -- it may very well be that they can -- then of course we'd act promptly through the bulletin process to get that information to the operating plants.

DR. OKRENT: But I didn't see anything in the responses I've read that addressed the question of natural recirculation. Did you?

DR. MATTSON: Well, that's why I said the information we're gathering here today. I think one of the things I learned this morning was the significance of the attempt to establish natural circulation some hours into the accident, and the relevance it played to being able at that late juncture to turn the accident around.

Those awarenesses are coming with each passing day, and certainly if the bulletin needs to be augmented to go to that point, and if on further scrutiny that turns out to be an important issue, then we'll deal with that issue.

I think I said this morning that our concentration up to this point in time has been to avoid -- to find ways to assure -- I'll say that again -- to find ways to assure that the initial sequence of events that eventually led to the need to establish natural circulation with this depressurized system with some loss of coolant, that you don't get to that situation.

I think what we're talking about now is that even if you did get to that situation, there may be other guidance devices that could be developed. That's certainly a good idea, and we'll be working on them.

MR. ETHERINGTON: There is a premise that is probably correct, but I don't wholly accept that the early events are the reason that we couldn't get into natural circulation.

I would like to postulate that it's just possible that we'd of had the same trouble even without the early events.

DR. MATTSON: Well, I think I might argue with you on that.

One of the early events is the failure of the auxiliary feedwater delivery valves to be open, and the subsequent boiling dry of the steam generators, and then the slow recovery level of the steam generators.

Had we tried to go to natural circulation without those events having transpired, it would be my judgment that we'd have gone to natural circulation quite normally and quite straight forwardly.

MR. ETHERINGTON: You're presuming gross damage, or serious damage to the core during those early transients.

DR. MATTSON: No, sir. I was talking in the same sense that we were talking this morning: that after the pumps were tripped at the time the plant tried to go into natural circulation and didn't make it, and subsequently the core was damaged.

MR. ETHERINGTON: So you assume there was no damage after that point, then?

DR. MATTSON: That's my understanding in reconstruction of the transient, yes, sir.

MR. ETHERINGTON: Then I would agree wholly with that. But wasn't an hour and a half enough time for it to recover?

DR. MATTSON: I'm sorry?

DR. OKRENT: Why did the steam generators not fill up, and so forth? You know, in eight minutes they were turned on.

DR. MATTSON: I would point you to a figure -- my figures are the same as yours, although I've got different numbers, and I don't know which one your number is -- but it's the figure that depicts steam generator level in A and B as a function of time after turbine trip in hours. The one that looks like this (indicating). I don't know what your number is. I got these about the same time those were sent down here.

By my reckoning, the B pump, the B loop pumps were tripped -- I shouldn't put it on the record without the numbers in front of me. The B loop pumps were tripped at 1-1/2 hours, and the A loop pumps were tripped at 1.8 hours.

If you look at this figure, you will see that the B loop pumps were tripped when the steam generator level was at about 5 percent of the operating range, and shortly after the B loop pumps were tripped the A steam generator level began to rise rather rapidly.

Yet, the aux feedwater to the A steam generator and the B steam generator had been flowing since about 8 minutes into the accident; but the level in the A and B steam generators hadn't risen out to more than an hour and a half into the accident.

MR. ETHERINGTON: Yes, but we don't know how that level was being controlled -- or at least I don't.

DR. MATTSON: And I do not, either. And when I said the appreciation was dawning on me this morning of what you were talking about: Was it an operator action that caused the level of the A steam generator to begin to increase abruptly after the B pumps were tripped? It may very well be that when the B loop pumps showed that they needed to be tripped and the operator tripped them, that he took some action to begin to fill the secondary side of the A loop.

MR. ETHERINGTON: Or, alternatively, for some reason the water might have continued to flow in, but it was all being evaporated for some reason.

DR. MATTSON: For some reason. But, if he was attempting to establish natural circulation -- which he would attempt to do after he turned pumps off, or after he turned the first set off, he would know that he was in the potential jeopardy of having to turn the second set off.

And if he was reading his A and B steam generator levels, he knew they were low and he would know from his operating procedures for loss of off-site power that he needed high center of heat, as we were discussing this morning, to establish natural circulation.

So he had begun to fill the A and B steam generators to the best of his ability at the time the pumps were tripped.

MR. ETHERINGTON: He needed the higher level of the water, but there's no evidence that he had thought of it before 1.8 hours. So why did he suddenly get smart and decide to do this?

DR. MATTSON: It may be that he didn't anticipate that he was going to lose the pumps.

MR. MAC MILLAN: Mr. Chairman, I believe the reason that the water level was increased at that point was that it's an automatic function of the integrated control system, that when you lose your active coolant pumps, the demand is to increase the water level to approximately 50 percent of the operating level.

So I believe that was an automatic function resulting from the securing of those reactor coolant pumps.

DR. MATTSON: Which would be an automatic function associated with getting optimum conditions for starting natural circulation.

MR. MAC MILLAN: Getting the level up for natural circulation.

DR. MATTSON: But, John, do you know the answer as to why the level was low up to that point?

MR. MAC MILLAN: I don't.

MR. ETHERINGTON: Roger, I don't think there's any basic disagreement between us. I think there's just a slight difference in our feeling of the urgency of getting word to the operators at least to watch this situation and give them some kind of a guidance or warning, that's all, the urgency of it.

DR. MATTSON: We'll take it in tomorrow morning first thing, sir, and we'll address that question right off.

DR. OKRENT: It seems to me there's some obscurity at least among those present here as to why the steam generator level stayed low up to that point. I'm not sure again that this has been factored into your thinking about "are there adequate instructions with regard to natural recirculation modes"?

DR. MATTSON: It may not be in the top of my mind, Dr. Okrent. We may be underestimating the work that's going on while this meeting is going on. Certainly there is a lot of it.

MR. ETHERINGTON: I know you didn't mean anything by it, but I would like to dispel one possible misunderstanding.

You mentioned that I had heard this discussed out at the site. This is true. However, I was concerned about this before going to the site, and Tom McCreless and I spent a couple of hours the night before I went out tryint to find out from the SAR actually what the levels were.

And as far as concern over natural circulation is concerned, this is an old interest of mine. It was addressed in the chapter in a book that I wrote on furnace technology in connection with natural draft, and as far as solubility of gases is concerned, this is also an old interest back in the '30s in connection with steam condensers when I was assistant engineer to the Engine Condenser Department.

The book was written in 1937, so I'm not quite a Johnny-come-lately in this thing.

(Laughter.)

DR. MATTSON: I understood that background as I was talking to you, sir.

One feature we can't lose track of, I think, in trying to understand this is that the first several hours of this transient were evidently believed by the operating staff to be a rather normal situation that they were dealing with, with an intact system.

It wasn't until 2-1/2 to 3 hours into the transient that they realized they had something different than that. And in that sense, there may not have been an urgency to raise that level.

I think those are the kinds of questions we have to answer rather quickly in reconstructing that event.

MR. ETHERINGTON: I in no way blamed the operators; I just suggest that we try to warn other operators in as timely a fashion as we can.

DR. MATTSON: Yes. The point is very well taken.

DR. CARBON: Paul?

DR. SHEWMON: To make sure I understand the situation, Harold, the things which B&W has urged, and that the staff has urged, would make this a third line of defense if the pressure had been kept up so there had not been flashing, and they had better analyzed whether or not the relief valve was open or shut, then we would of not had to get to the natural circulation.

It's just that this is an essential fallback position? Is that the interest in it?

MR. ETHERINGTON: That's the interest. I don't think the intention would be to go to natural circulation if you had full power. Just in case you didn't, then you might be forced to precipitously.

DR. OKRENT: If they cut the first line, you lose the power to your coolant pumps, possibly -- not necessarily, but pos ly.

DR. SHEWMON: Then you've still got -- you may have pressure, yes, but the question is whether you are going to have 20 percent of your system, whether you're under-saturated or over-staturated, or which way is up on the scale; whether you've got steam in part of your system may not be the situation there. It is here.

Having enough pressure is the first line.

DR. CARBON: Does that finish that topic, then?

(No response.)

DR. CARBON: Let's move on, then, to the next subject.

Roger, are you the spokesman for the staff?

DR. MATTSON: The next two subjects are:

One, the status of the plant today; and then a summary of the activities that are underway in the plant that are in motion for placing the plant in the long-term cooling mode.

Vic Benaroya, Branch Chief of the Auxiliary Systems Branch, is going to give us a summary of plant status, some numbers and things like that, to bring you up to date. That shouldn't take more than about 15 minutes or so.

Then Carl Berlinger will talk about the ongoing work.

MR. BENARIOYA: My name is Victor Benaroya. I am Chief of the Auxiliary Systems Branch.

First let me give you a brief overview of the NRC organization at the site. There are about 100 NRC personnel at the TMI site, most of them from I&E.

There is the NRC Command Center under Harold Denton.

There is the I&E operation at the TMI site.

There are two main groups of I&E personnel. There is the plant operational surveillance and the radiological and environmental surveillance, which covers both health physics and environmental surveys.

The environmental surveys group has a helicopter at their disposal, and a mobile lab.

NRR has several groups at the site. In the turbine deck area, there is a group that reviews and approves all new plant procedures, including emergency procedures.

The procedures are also reviewed and approved from the ALARA point of view. There is a technical review team to review and approve plant modifications.

One group is overseeing waste management activities. All emergency technical specification changes are being reviewed and approved at the site.

Then Bennie Ross coordinates the industry group activities with NRC. However, most of the analysis is being in Bethesda. As of 9:00 a.m. today, the heat removal path is from the reactor to the reactor coolant pumps to a pump 2-A through steam generator A. Steam lead is through bypass around the MSIV of steam generator A to the condenser.

The condensate return to steam generator A is via the condensate pump. The pressure in the reactor is 810 psig. The inlet temperature to steam generator A is 250 degrees, and outlet is 246.

The pressurizer temperature is 534 degrees. The boric acid concentration in the primary coolant is approximately 3400 parts per million.

The five highest in-core temperatures as of 9:00 o'clock this morning are location H-5, 342 degrees -- that's the highest; H-8, 335; G-5, 312; M-9, 299; and L-6, 275 degrees.

The letdown flow is varying between approximately 10 and 24 gpm.

One HPCA pump is running in the makeup mode, and two are on standby.

The containment is at -1 pound and a temperature of 82 degrees Fahrenheit.

Three of the five pumps with a capacity of 170,000 cubic feet per minute in emergency mode are operating.

One of the two hydrogen recombiners with a flow rate of approximately 95 cubic feet per minute is in service. The other recombiner is on standby.

CR 4051
'FMAN t9
. .c 1

The latest hydrogen concentration is around 1.4 percent. There's about 17 to 18 percent of oxygen and 80 to 81 percent nitrogen. It's estimated that between 150,000 and 200,000 gallons of primary coolant, with 5,000 gallons of caustic, is in the containment.

A second primary coolant sample, unpressurized, was taken on April 11th. The sample was sent to four labs -- Savannah River, Oak Ridge, Bettis and B&W. The analysis from the different labs differed by less than a factor of two. That's pretty good.

But unfortunately, any caustic in the water might affect the iodine and cesium. As an example, the Oak Ridge analysis shows that the iodine 131 is 8.2 times 10^3 microcuries per cc; cesium, 137, 330 microcuries per cc; strontium 90, 50; barium, 140, 219.

The pH of the primary coolant is around 8, and there was no detectable uranium or plutonium. For a 15 mile radius, 2 million population, the total dose was calculated to be approximately 3000 milirem for an average dose of 1 to 2 milirems.

HEW calculated 3500 millirem, and DOE, 2000 to 2500. The calculation is based on 50 to 100 millirem per day, that higher value based on the highest release during the accident.

All three organizations, namely HEW, DOE and NRC,

pmcc 2

agree that the maximum dose to an individual is less than 100 millirem. Most of the gaseous rad waste is in the containment. The two waste gas decay tanks were vented to the containment after some plant modifications.

Today there is practically no gaseous rad waste from degassing. The pressurizer is being degassed into the containment of the reactor building, as it's called in the plant. The pressure in the makeup tank is being increased. As a consequence, there is nothing at the moment going into the waste gas decay tanks.

The main activity today is to locate the sources of iodine releases and to change the charcoal filters. There are 240 filters that need to be replaced, 160 of those in the auxiliary building and 80 in the spent fuel building. A charcoal filter bank has been installed on the exhaust of the condenser vacuum pumps to reduce the potential iodine releases from that source.

A backup charcoal filter to the auxiliary building vent is under construction. There is approximately 50,000 gallons of primary coolant in the bleed tanks and approximately 10,000 gallons in the miscellaneous waste storage tank from post-accident conditions in unit 2.

5600 gallons of post-accident primary coolant was transferred to unit 1 liquid rad waste tanks. All the primary coolant that was in the auxiliary building sumps has been

pmcc 3

transferred into tanks. A solution of ten percent caustic, tcn percent thiosulfate and 80 percent water was sprayed in the sumps, tied on the iodine.

At the beginning the generation rate of liquid rad waste was about 100 gallons per day. By cutting down pumps seal leakage liquid rad waste has been reduced to 25 gallons per hour from leakage and 35 gallons per hour from sample decontamination. I should say 100 gallons per hour, not per day. I'm sorry -- for a total of 60 gallons per hour.

Under those conditions the holdup volume that's presently available is good for 17 to 20 days. The main activity today is the installation of tanks in the spent fuel pool with a capacity of 100,000 gallons and facilities to accommodate tanks.

A multitude of schemes are being considered for modification of the chemical cleaning area to eventually process the primary coolant. That's all I have.

DR. SHEWMON: The primary coolants you're talking about is also the stuff that goes in your sumps, not necessarily inside your primary system.

MR. BENEROYA: No, there is quite a bit that was in the sumps. All has been transferred into tanks.

DR. SHEWMON: And they will try to lower the volume or condense it, or how will that be taken off site?

MR. BENEROYA: They are proposing to make modifications in the chemical cleaning area, the chemical cleaning section of the plant, where they're going to be destroyed eventually.

DR. SHEWMON: Does that end up with solid plus pure water eventually?

MR. BENEROYA: It depends on the scheme that they select. It might be clean water. It might be solidified at some point. It could be degasified at some point. This is under consideration.

DR. SHEWMON: How do they normally do it in an operating plant?

MR. BENEROYA: In many plants they use evaporators, taking the overhead, demineralized, particularly in the bottom, solidified in many areas in many cases.

DR. MATTSON: Vic, I think you're talking about the cap gun. Isn't that right?

MR. BENEROYA: The cap demineralizers. They have been demineralizing also, which is one of the ways of doing it. They have demineralized quite a bit of coolant already.

DR. MATTSON: There's a portable cap gun that was in unit 1 that's been running now for, I guess it must be close to two weeks. There is a larger scale, permanent processing facility being built in the auxiliary building of unit 2, I believe, for processing these wastes.

MR. BENEROYA: In the chemical cleaning section,

pmcc 5

chemical cleaning building.

DR. SHEWMON: With this demineralizer you then take normally with the demineralizer on the primary circuit, at least you backflush. You're doing with this one what you normally, obviously don't - you then take demineralizing material out.

DR. MATTSON: Some of the tanks have low level waste in them from normal operation. Process that and dispose of it in the normal manner. Then you capacity for higher level waste in those same tanks. The processing of the higher level waste, I think, as Vic said, there's a variety of schemes being discussed, and that kind of activity will be underway soon.

DR. SIESS: What's the status of the instrumentation that you need to monitor the present mode of cooling?

MR. BENEROYA: The pressurizer has one good level indicator and one so-so. Also they tried to install a gauge as a backup, and that line was being tested, and it didn't come out very well.

DR. SIESS: What other instrumentation do you need?

DR. MATTSON: Thermocouples and thermocouple readings in the hot leg are things that are especially important as you go forward into natural circulation. Those are thought to be good for the indefinite future because the transmitters' instruments are hardened in the sense of radiation. They've been performing well. There's no reason to expect those to be lost.

DR. SIESS: That'll take you into transition to natural circulation, and after you get in natural circulation, is there any particular instrumentation that you need that you have any concern about?

DR. MATTSON: Yes. There's another instrument on the primary system I should mention, which is primary system pressure. A system is being designed-- I think Carl's going to talk about it briefly -- for positive pressure control over the long term as a backup to that instrumentation.

DR. SIESS: Do you know where the instruments in site containment are located with respect to water level in unit 1, I guess it is?

DR. MATTSON: As Victor said, there's some uncertainty as to where the water level is because of the uncertainty as to exactly how much water was delivered from the primary system to the containment floor and exactly how much was pumped over into the aux building early in the transient.

But the best estimate says that the water level is in the vicinity of the transmitters that have been failing. Now, those transmitters are also non-safety grade transmitters in the sense that they're used for normal operation, not for safety systems, and they would be predicted to have radiation sensitivity at the stage of the accident, in fact, some time ago. That's why backup level instrumentation was one of the high priorities early on, in the event that level transmitters were lost. The water level is probably over those transmitter locations today.

DR. SIESS: The instrument Steve mentioned are separated. Is there any separation vertically?

DR. MATTSON: No, maybe a couple inches, but nothing significant. They're in instrument racks in the bottom of the containment.

DR. SIESS: You mentioned that those instruments were not safety grade. The reactor coolant pumps aren't safety grade, are they?

DR. MATTSON: In the run modes the reactor coolant pumps are fine. In the start mode there's a sensitivity of one element in the starting circuit when we tripped the pump and had to start a second one, and it started without difficulty. And there's reasonable expectation that, if you had to start another one, it would start.

DR. SIESS: But they're not safety grade. This is gratuitous.

DR. MATTSON: They're safety grade to a certain extent because of their location relative to the primary coolant system during normal operation. So that they're hardened more perhaps than some of these transmitters that are located way outside the outside containment wall outside the shield.

pmcc 8

DR. SIESS: The loop system, the electrical systems, are they expected to survive an accident?

DR. MATTSON: The design basis accident doesn't establish the requirements because they're not used for it, but they have some margin because of the location.

DR. LAWROSKI: What kind of decontamination factors are you getting on your charcoal filter for iodine removal?

MR. BENEROYA: I don't know. Roger, do you know?

DR. MATTSON: It's not high. Calculations of how much iodine should be in there say that there should be plenty of charcoal left, but there was a moisture problem because of all the water that was in the building, and so for some reason the CFs are not very high. That's why they went back to a backup charcoal system on top of the auxiliary building.

It's been a little slow changing out the filters, and we're disappointed that it's taken so long, although we're convinced they're doing everything they can to get them changed. It's probably going to turn out that the backup system is going to available at about the same time as the changed one. So we'll have a double filter system. But it's taken a few days longer than we had hoped to get it.

DR. LAWROSKI: The ones from the WPPPS site were delivered last -- a week ago?

DR. MATTSON: There were 26,000 pound filter banks transferred by C5A from the state of Washington. They're still

pmcc 9

being installed on the roof of the building.

DR. CARBON: Other questions of Mr. Beneroya.

(No response.)

DR. CARBON: Thank you very much.

DR. LAWROSKI: Could I ask one more question? What else is in the primary sites of boric acid at this time? What else is in the water, the primary coolant, besides water? What is the boric acid concentration?

MR. BENEROYA: 3400 parts per million.

DR. LAWROSKI: Is it boric acid?

MR. BENEROYA: Boric acid.

DR. LAWROSKI: I didn't know how serious it --

MR. BENEROYA: It is still boric acid. Okay.

MR. BERLINGER: Gentlemen, I'll be discussing the proposed TMI-2 long term cooling plant.The licensee and B&W have proposed to use natural circulation for long term core cooling for decay heat removal. The proposed plan is known as the base case summary plan and is shown in my first slide. It should be noted that the base case plan involves several preliminary plant maneuvers and plant modifications.

(Slide.)

The procedure will start at point A, and initially the system will be degassed by lowering the system pressure to point A prime; the degassing procedure from A to A prime is a maneuver which is needed to remove noncondensables from the primary coolant and also to eliminate any gas bubbles that may be trapped in the control rod mechanisms in the upper part of vessel.

This operation from A to A prime has been completed. A prime pressure was ultimately reached at around 300 psi, so it's lower than is shown on this chart. The plant was then brought back up to point A and from point A to point B is a procedure where the reactor coolant system temperature will be reduced to approximately 230 degrees. I say approximately. At the present time this procedure is ongoing, and the mode of operation is to run the A steam generator in a steaming mode, in which the steam through the main steam line bypasses the turbine.

You do have one reactor coolant pump running. You are using for pressure and level control normal pressurizer operating mode, and this procedure going from A to B has reached approximately 250 degrees as far as that cool-down is concerned, and at this point I'm not certain how much further towards the 230 degree mark they'll be able to achieve, but this mode is continuing.

DR. MATTSON: It's my understanding that the 250 seems to be the natural limitation on this mode of operation. They estimate that they can get to 230. It looks like it's going to bottom out at around 250.

MR. BERLINGER: Thank you, Roger. In going from

pmcc 11

point B to C the plan is to fill the B once through steam generator water solvent. This will be done on a closed cooling secondary system. Also steam generator A will be isolated, and by operating on only the B steam generator, plan to reduce the reactor coolant system temperature to approximately 100 degrees.

The reduction from 250 to approximately 100 degrees is made possible by going to the water solid mode of operation on the secondary side. During this mode of operation the A steam generator, which will be isolated, will have a modification, a major modification made to the A steam generator, such that a closed cooling loop type of system will be made available for the A steam generator.

In addition this mode of operation is preferable because it enables modifications to be made to the A steam generator and the B steam generator allows the water solid operating point to be reached;rather than from a steaming mode, it will be more or less from an isolated mode and eliminates the potential problem of water hammer.

Now, by the time we get to mode point C there will have been modifications to both the B steam generator secondary side, the A steam generator secondary side and, as I'll point out later, there will be some other plant modifications which will be complete.

At point C this will be the initiating point for going

pmcc 12

into the natural circulation mode. The react coolant system will be approximately 100 degrees. It will be using normal reactor coolant system pressure control. A and B steam generators will be operating in a water solid mode on the secondary side.

The flow on the secondary side from feed pumps will be in the three to 5,000 gallons per minute range, at somewhere in the vicinity of slightly below 100 degrees fahrenheit. In initiating natural circulation mode of operation the reactor coolant pumps will be tripped. Once natural circulation has been established, the reactor coolant system will be brought water solid by turning off the heaters in the pressurizer and allowing the system to be brought solid using makeup;while operating in a water solid mode, the primary system will use a new pressure and volume control system which is being planned for installation, and the system pressure will be progressively reduced in steps, slowly maintaining a stable, subcooled margin and operating in the core region.

end #9

pv In addition, I should point out that the modifications that I have mentioned in general are short-term modifications. For long-term mode, there is an additional, more reliable modification which is planned which will permit the secondary side steam generators to be operated at a pressure in excess of the primary system pressure. This will act to reduce any primary to secondary leakage. This high-pressure system will be transferred into operation when it is available. And it also is a closed cooling loop system, and it will operate at approximately 750 psi and provide flow of approximately 5000 gpm.

As I have mentioned, in preparation of going into this preferred mode of operation -- "preferred" being defined by the base case operating plant -- the licensee is performing several plant modifications. And I will describe these at this point:

These modifications involve the short-term A steam generator modification and the short-term B steam generator modification, the long-term A and B steam generator modifications and modifications to the decay heat removal system, pressure control system. And at the present time there is an evaluation in process or in progress in which they will be evaluating the potential elimination of the short-term B steam generator modification -- and I will explain that shortly.

pv

It should be noted that these modifications are in various stages of design and fabrication and installation, and that the ultimate configuration that will exist at the plant when natural-circulation mode is initiated will be dependent on availability and on schedules.

The licensee has been advised by B&W that these modifications should be completed prior to plant transition to natural circulation. But, if necessary, in the event that they have to go to natural circulation before they are planning on going to natural circulation, the available systems have been ready, and they are capable of sustaining natural-circulation operation.

MR. MICHAELSON: Question: Maybe I missed it, but would you explain again in the short term how you are keeping the overpressure on the primary side?

MR. BERLINGER: In the short term?

MR. MICHAELSON: Presently, for instance, how are you keeping the overpressure?

MR. BERLINGER: The primary side is maintaining a bubble in the pressurizer.

MR. MICHAELSON: Okay. Now, as you go on to the natural circulation, how do you intend to maintain the overpressure?

MR. BERLINGER: When you go -- before you go into natural circulation -- no, after you go into natural pv circulation, you will remove the bubble from the pressurizer and run the primary system water-solid.

MR. MICHAELSON: The question is, then: How are you keeping an overpressure on the system? Are you going to put a small pump in? Are you using the main charging pumps?

MR. BERLINGER: Okay. This is the new pressure and volume control system, which is in design at the present time. I don't know exactly what stage of construction they're in.

DR. MATTSON: I don't believe they're in construction. I believe they're in procurement. And the central part of the design was complete several days ago. But it's a makeup pump with surge tanks on the outlet with the nitrogen overpressure to maintain pressure control.

MR. BERLINGER: Right. And the surge tank is really a series of surge tanks, the last one of which has the nitrogen bubble on it, nitrogen overpressure.

MR. MICHAELSON: Is the system redundant?

DR. MATTSON: I don't remember the answer to that question, Carl, but it's a good question.

MR. BERLINGER: The system has two positive displacement pumps. In that respect, it's redundant. As far as the other flow paths are concerned, it does hook into the normal makeup system. I will take that back. It does hook into the normal makeup system, but through the pressurizer spray. I don't know if it's redundant; I really don't know.

pv

DR. CATTON: As I understand it, there are going to be two loops on the system, as well; isn't there? And if there are, as I understand it, either one of the loops can have the low flow.

DR. MATTSON: Let's stick with the pressure control just for a minute.

Now, the pressure control system is redundant in the active sense; that is, there are two pumps available to do it, and they've been originally designed to work in tandem. The isolation valves would open and all that good stuff. The passive portion of the system, and the degree to which it's redundant, is, I think, what Carl had aimed at. And I don't remember the drawings. To the extent I could say to you, Carl, it was a good question.

MR. BERLINGER: We'll check it through.

DR. MATTSON: I think the other point here was that the two solid secondary systems are redundant, one to the other; and that's true.

(Slide.)

MR. BERLINGER: Well, let's start over here. Okay. Depicted on this slide is the short-term A steam generator modification. This modification will utilize existing condensate and feedwater systems. From the main steam line, from the steam generator, there will be a bypass system through the condensor makeup line to the condensor. The bypass line

pv

will bypass the turbine. From the hot well in the condensor, it will go through one of three condensate pumps. Now, one pump will be run, and two will be kept in standby. From there back through the — I take that back. These are the heat exchangers, I think. Let me regroup for a second.

Okay. From the condensate pump it will go through these pumps, which is a booster pump, and the main feedwater pump. The impellers on these two pumps will be locked in place and then backed up through the main feedwater line for injection via the steam generator.

MR. MICHAELSON: Question: Is the main feedwater pump going to be steamdriven, or are you just driving through it?

MR. BERLINGER: The main feedwater pump will be not in operation, it will be idle.

MR. MICHAELSON: But you will be running the booster?

MR. BERLINGER: The booster will not run, either. It's just relying on the condensate pumps.

DR. MATTSON: And they will have emergency power?

MR. BERLINGER: That's correct. In the event of loss of offsite power, the condensate pumps will have a backup diesel power system, which is, I think, a 2-1/2 megawatt diesel, which will provide power in the event of loss of offsite power.

On the service water system, which is used to cool

pv

the condensor, we're going to be using the normal cooling system. But in the event of loss of offsite power, there will be available from a river water source, again, diesel power, an additional source, to take over in the event of loss of offsite power.

MR. MICHAELSON: On that slide, is the new line you show up at the top of the condensor going to the spray towers on the condensor? I assume this condensor probably has a spray tower at the top.

MR. BERLINGER: I really don't know the answer to that question.

DR. MATTSON: I should, because I heard it discussed the other night.

The point of the question is relative to the location. The point of delivery is, one, to bypass the turbine, and, two, to put it at the point where you know that the condensor can stand the added load of the solid secondary sytem. That's been looked at, and that's the reason.

But where it goes, I just can't remember at the moment exactly which location it goes to. I heard that discussed the other night.

MR. MICHAELSON: So how much elevation water do you have in the condensor?

DR. MATTSON: If I could answer that question, I could answer your first one.

But it was chosen on the basis of the elevation being an elevation, and they were certain that would not cause any damage to the tubes in the condensor.

MR. MICHAELSON: Okay.

DR. MATTSON: And there was some discussion of that because one entry point was evidently at a place where they thought there might be potential for that. Another entry point was at a place where there wasn't potential for that. I don't know which two they were talking about, but they chose the lower one.

MR. BERLINGER: Any other questions up to this point?

(No response.)

(Slide.)

MR. BERLINGER: This slide depicts the short-term B steam generator modification. Up to this point there is a suspicion that the B steam generator may be leaking; and, therefore, the licensee and B&W have proposed to use a closed-cycle cooling system to contain any contaminants that might have leaked into or would continue to leak into the secondary system.

This modification will utilize existing closed cooling system heat exchangers and pumps. These are cross-connected from the main steam line upstream of the turbine into the feedwater line, downstream up the feedwater pump.

pv

In the event of loss of offsite power, diesel power, again, is available through the closed cooling pumps. And this will be as a backup in case there is a loss of offsite power. The water in this system will be demineralized water. and a new mixed-bed demineralizer will be installed.

MR. MICHAELSON: Where are the pumps and heat exchangers located?

DR. MATTSON: The basement of the turbine building.

MR. BERLINGER: That is right.

MR. MICHAELSON: Is that right?

MR. BERLINGER: Yes.

DR. MATTSON: This might be a good slide, rather than going to the next one, to talk about the point that's in controversy at the moment, not in the sense of antagonistic. but in the sense of planning.

The closed cooling heat exchangers are 150 degree Fahrenheit design. The manufacturer stated that they're good to 200 without leaking, but they're nonwelded tubes.

MR. BERLINGER: Pressed fitting in the tube sheet, yes.

DR. MATTSON: So, we initially had a concern that that wasn't a high-quality system in the sense of secondary to tertiary leakage, if you will. About the same time we raised that concern several days ago, they found some heat exchangers and some pumps at the WPPPS site, same place they got the pv filters, which are good enough for the lnog-term modification which he's about to describe.

So, the question is now whether you can actually achieve the long-term modification of the secondary side steam generator B at the same time you could have achieved the short-term modification and at the same time get a better heat exchanger and better pumps. They're good for 750 pounds. The next one is much better.

MR. BERLINGER: Let me point out, Roger, that one of the reasons they're able to get this equipment more readily available, as opposed to the short-term modification, is that this system could be skid-mounted, and it is very much similar to the skid-mounted system that's being developed for the decay heat removal system.

DR. MATTSON: That's another alternative also. The point being that the critical path in the construction of this modification is the welding of piping, not the placement and the installation of the heat exchanger at the pump. So it's quite likely they'll make a decision to do the long term and do it in the same time frame that they were originally going to do the short term. That isn't on the critical path yet, as we say. It could take a little time. I would expect it in the next day or so.

But the piping layout, the piping procurement, the piping installation is proceeding on the assumption if you put

pv

it in the same place it requires the same piping. The pump and the heat exchanger have actually been procured and were supposed to arrive at the site Wednesday.

MR. MICHAELSON: Would you care to comment a little bit now on what would happen if you, for instance, had a tube rupture in the steam generator in this situation?

DR. MATTSON: That's why it's attractive to go to the high pressure, because then the leakage would be inward instead of outward; and the design that they're proposing is an alternate to the short term. It's a preferable design, there's no question about it.

MR. MICHAELSON: But apparently, you can't go to high pressure with these heat exchangers and pumps.

DR. MATTSON: These particular heat exchangers, no. With the long-term modifications to both A and B, you can go to high pressure, and that was expected to take on the order of four to five days until this novel concept dawned on people about Friday of last week.

MR. MICHAELSON: This is a short-term question.

DR. MATTSON: Well, A steam generator is a pretty good steam generator, the way it looks. B may not be as bad as we originally thought. It was in operation for three months. And A looks like it's holding up pretty good at this point. There's no sign that there's increasing leakage there.

I think it's more of a plant contamination problem pv than an offsite-dose problem. If you make calculations, what if you start to get leakage and what if you went to the B steam generator in its current status for steaming, the signs are pretty positive. It looks like, as far as onsite is concerned, that it's not a problem. It would be a problem onsite in the sense of contamination at some low level, certainly, of the turbine building and the condensor. It could, you know, just exacerbate the eventual cleanup problem. We're trying hard to avoid that.

(Slide.)

MR. BERLINGER: I would like to point out that, as noted on a previous slide and on this one, provision is being made to hook up the long-term cooling system, which will be a high-pressure system. And that system will look something like this.

(Slide.)

Again, you come into the system as shown on the previous slide. You go through two new heat exchangers, which are welded heat exchangers; they're high pressure. There will be parallel trains. They will be cross-connected, as noted here. The encircled items would not be required if only one steam generator is required for cooldown.

DR. MATTSON That was the point we were just talking about a minute ago. I think we're about to come together on a conclusion that the two steam generators, solid, are redundant

pv

of one another; hence there is no need to make the secondary cooling system here redundant. So, the box would be removed in the sense that it's not needed for long-term cooling, and in the sense that it cuts down the construction process to get this whole thing finished by quite a lot.

MR. ETHERINGTON: Would it be connected alternatively to both steam generators?

MR. BERLINGER: Yes. This system would be hooked up to both A and B steam generator.

DR. MATTSON: One such system for each of A and B.

What I was talking about a few minutes ago is that that one such system for B is in the air on its way to the site now. It will probably be installed first on B, rather than short term, if the schedules and the constructors and the people who have to worry about getting construction people in there and what have you can agree that the two, in fact, can be delivered on the same time frame. There is a need to get on with the secondary cooling system, and time is of the essence.

end#10

MR. BERLINGER: Okay. As I mentioned earlier, the decay heat removal system is also going through modification. This is being done in two stages, with a third stage to follow. The first two stages are ongoing simultaneously. They consist of taking a look at the decay heat removal system that exists in the plant, running preoperational tests, and if any leakage is determined to exist, to seal the heat as best as can be done. And if that means welding flanges together, that's the way it'll be done.

In addition, pump vibration monitoring instrumentation is going to be installed. And at the present time, there is an evaluation ongoing of both the valve and pump seals to determine their radiation resistance.

There is also a new decay heat removal system which is being designed and installed. This system will tie into the DHR drop line and the two cold-leg injection lines. It will use skid-mounted pumps and coolers, which will be mounted outside the auxiliary building at ground level.

The secondary side of the new decay heat removal system will be a closed cooling system. The new heat exchangers and pumps will be connected to new decay heat service water cooler systems, which are in turn connected through to the tertiary ultimate heat sink, which would be river water, which is river water cooling heat exchangers.

In addition, there is what I call a long-term decay heat removal modification, which is really part of the cleanup system which is being developed at site, and this is going to be mounted somewhat underground alongside the auxiliary building foundation. As I mentioned, it's primarily for decontamination purposes later on.

DR. CARBON: Let me interrupt just a moment and remind the staff and guests that if you have cars parked in this building, they have to be removed from the garage by 7:00 p.m. or I think you don't get them back until tomorrow. Is that correct?

(Laughter.)

DR. CARBON: If you do have them in this building, get them out by 7:00 o'clock. Go ahead.

MR. BERLINGER: That's assuming the meeting ends before tomorrow morning.

DR. CARBON: Which it may or may not.

MR. BERLINGER: I'm finisned with this portion of my presentation.

MR. MICHAELSON: I thought that was the case.

In considering the present DHR system, that type of pump that is normally used in this system uses centrifugal separators for seal-water cooling, very often, at least. In this particular plant, are they using the so-called cyclone separators for seal-water cooling off the discharge pumps?

Let me just say, you may not know. The only point here: that those,cyclone separators have throat diameters of about an eighth of an inch and they're very easily clogged with particles circulating in the system, and you want to be real careful, because if you use the cyclone separator the seals go very fast.

DR. MATTSON: Carl, are you referring to the Westinghouse?

MR. MICHAELSON: I'm referring to the present DHR system already installed in the plant, which I understand they may consider using.

DR. MATTSON: Westinghouse is putting in an identical system which uses skid equipment.

MR. MICHAELSON: I might add that the Westinghouse system is also using centrifugal separators.

DR. MATTSON: They're not Westinghouse pumps; they're B&W pumps. Let me turn to the B&W people.

Jim, do you know the specifics of the design?

MR. TAYLOR: They have centrifugal separators.

MR. MICHAELSON: Yes, but you've got to be careful. You can't put it in that little bypass circuit for the seal coolant, because you'll clog up the filters in a hurry, unless you put a very large one somehow in such a very small circuit. It's a very small bypass flow, about a gallon a minute, more or less, and it clogs very easily because of the very small throat in the centrifugal separator.

DR. MATTSON: I understand your point, Carl. The preferred mode of operation doesn't involve this decay heat removal system. This is sort of a tertiary backup, if you will. Several steam generators, plus the ability to inject high-pressure coolant. In the preferred mode of operation of this system, you'd be drawing from the hot leg of the reactor, and chances are pretty good, I think, that you wouldn't be drawing crud at that location, especially since, from the samples that have been taken, you don't find crud. So the chances are pretty good that, operating with the decay heat removal system, drawing from the hot leg where it normally operates, the system would work.

I think it might be more of a concern if you were drawing from the sump.

MR. MICHAELSON: Generally, I think that the systems draw off the bottom of the hot leg. I don't know in this particular case. If it does, you've already got a beautiful crud trap that might be full of crud before you ever get started.

So just a precaution. If you're going to go that way, keep it in mind.

DR. MATTSON: It's been in mind for a couple of weeks.

MR. BERLINGER: At this point, I'd like to give you an idea of the ongoing staff review of the proposed natural circulation mode of operation. We are reviewing presently information which has been provided by B&W. We have been in contact more or less constantly with the licensee. We have people at the national labs who are performing calculations for us, as well as consultants.

The situation, as you are well aware, is a rapidly developing and changing situation from the standpoint of which configuration we're going to end up in when we do go to natural circulation. The NRC has identified issues in the proposed plans and these will be required to be resolved before we go into natural circulation.

DR. OKRENT: Unless you lose your pumps.

MR. BERLINGER: That is correct.

DR. MATTSON: The issues have to do with some nuance and a difference between emergency procedures going into natural circulation and let's call them more conservative procedures for going in intentionally, and things have to do with what are the proper indicators that natural circulation has been achieved and you stay with natural circulation, as opposed to trying to return to the present mode.

MR. BERLINGER: At the present time, we are preparing a report. The report will include these general topics: The description of the core will be characterized; an evaluation of core flow resistance on the basis of both in-house and out-of-house calculations; an evaluation of natural circulation with one or two steam generators in operation, with either of them both solid or both steaming. Core coolability will be discussed in the natural circulation mode. Effects of bubbles on core cooling and natural circulation operation; review of base case summary plans, as I have described here. This is being reviewed in great detail, not only in Bethesda, but also at the site.

In addition, it will be an evaluation of alternatives and contingency plans. As an example of alternatives, looking at the use of the A generator steaming with the B isolated; the B solid, A isolated; A and B both steaming; and other combinations similar to that.

We're also looking at contingency plans from the point of view of what-if's, that type of question: What if we lost the pressurizer level or we lost off-site power, or we lost natural circulation cooling once it had been established? We're looking at fall-back positions as to whether or not the licensee or B&W has considered all alternatives, and we are trying to understand how they've made their recommendations and make sure they've considered what we feel is an all-inclusive potential problem.

We also will address in the safety evaluation the acceptance criteria for establishing natural circulation, the control of primary system pressure and level, and water chemistry, the potential for boron dilution and recriticality, and radiological consequences such as leakage, off-gas and others of that nature.

Any questions?

DR. CARBON: Dave?

DR. OKRENT: How many curies are in the containment atmosphere now, approximately?

MR. BERLINGER: If anyone here ha that number, it would be Mr. Beneroya. The number of curies in the containment?

DR. OKRENT: About.

DR. MATTSON: A lot.

(Laughter.)

DR. MATTSON: We'll get the answer, Dr. Okrent. I'm sorry.

DR. OKRENT: A lot is sufficient.

Now, you've been thinking about different ways of keeping the core cool over the long term, which you properly should. And obviously you're very interested in keeping this radioactivity in this containment. And, if I understand correctly, you're maintaining the negative pressure valve and so forth.

Have you developed anomalous possible situations that might require you to change what you're currently doing with regard to the containment? Have you tried to anticipate what events, if any, would lead you to some changed mode of doing what you're currently doing with the containment and so forth and so on?

DR. MATTSON: Carl, I think I'd like to answer the question.

MR. BERLINGER: I defer.

DR. MATTSON: The question of whether steps ought to be taken to alter the configuration of the containment is one that's been in the back of people's minds since early after the initial accident. It's our judgment at this time -- and we've looked at some ways of doing that, primarily at Sandia Laboratories -- it's our judgment that we have time available today, given indicators that we could watch for or are watching for, that if the multiple ways now available to cool this core for long-term should somehow become unavailable, we still have time to consider such modifications. And it's our judgment that, although the probability of a core melt in this plant which has seen this accident is higher than in a new plant, a healthy plant that hasn't seen this accident, the consequences of such a core melt, given the amount of decay that has occurred in the core, are limited. They cannot be as extreme as they could be for core melts in a different plant starting from some other initiating event.

Furthermore, it's our judgment that the core melt process itself would take on the order of days, and that the potential for hurting the containment would be something that would take several days. So, given the amount of time that we're convinced we have available, using the backup cooling systems to natural circulation -- first of all, we're convinced natural circulation is going to work. We're convinced we've got margin. But in the event we didn't, there are backups to that. There's high-pressure injection, borated water, storage tanks. There's low-pressure injection from the same point. There's high-pressure recirculation, piggybacking off the decay heat removal system. There's low-pressure recirculation from the decay heat removal system.

There will be available, within a very few more days, three trains of decay heat removal systems. You only need one at a time.

So that, in the very unlikely event that there would appear negative indicators, at this point in time we believe there is still time to take steps, if warranted, to modify the containment.

DR. OKRENT: Actually, you're answering a different question. But nevertheless, I think your answer is reassuring with regard to the question you answered, that you think you have time in that regard.

But I was wondering in regard to the activity that's already there, you've tried to think through whether there are any situations that could change what is now a very favorable situation where you have inflow, if I understand correctly, and negative pressure, just to assure yourself that some modified situation couldn't arise out of whatever it is, I don't know, an electrical short or the combination of electrical short with something else, or whatever. So that you have given it the same kind of thorough thinking that I'm hearing is being given to different modes of removing decay heat.

MR. BERLINGER: I think it was mentioned earlier this afternoon at the site, we do have a team of NRR NRC people who are removing emergency procedures and contingency plans. These are being very thoroughly developed to handle potential failures that might occur at the facility which would degrade the present operating mode.

Included in these are alternatives to getting the plant to a safe shutdown condition, cold shutdown.

DR. MATTSON: Carl, I think maybe if I missed the question, you just missed the question, too. The question is, what if you lose the containment penetration seal or something like that.

Two things I know have gone on. If you've got suggestions, maybe there are more that could go on. But two that I know of is that the question of the potential for shorts in electrical penetrations, leading then to a failure of the electrical penetration, hence a breaching of containment -- that's been examined, was examined days ago. And with the equipment that's operating and with the qualifications and penetrations that are there, it doesn't look like a problem.

There was also a question over a week ago as to the status of the containment isolation signals: Were bypasses placed on any of those containment isolation signals? Were any of the valves that didn't need to be armed in fact armed, so that they could be opened inadvertently? A very thorough review was conducted of all containment penetrations, one here in Bethesda, one at the site, one by the licensee at the site, and an independent one by the NRC at the site. And I believe the industry advisory group even got a set of drawings and went through that themselves. It was a couple days of hurried activity on that some time ago.

That also was verified as being in an okay condition, a credit to the operator. They had already considered it taken care of.

A third thing that has gone on in this general area is that the licensee has been urging the installation of a method of measuring the water level in the sump, for several reasons. One, to get a better fix on the location of that water level relative to the instruments, the idea being that if it's very close, it might be possible to drain off a small amount of it and store it in tankage that's now being installed, tankage that's still available, and remove that source of instrumentation failure, if it is one.

Another thought being to get these high-level liquid wastes inside of containment under control soon, and an idea of what precisely the level is is a first step to doing that.

There are some difficulties with proceeding with those things. One difficulty is that to take such a measurement, you have to open a valve inside containment. If you open a valve, then you have to answer the question, are you sure you can close it. That's being very carefully reviewed, with some backup provisions for backflush and that kind of thing.

Other than those three, I don't believe that -- nothing, to my knowledge, more has gone on for the event in which you lose the containment, which has performed magnificently in this event, other than the isolation difficulty early in the event.

e-11

CR 4051
HOFFMAN 12
mu 1

We know that the leakage from containment -- none can be found. There was some worry earlier but it turned out to be water that spilled over from the Aux Building, upper Aux Building. The galleries are dry and there's no source of leakage that I know of.

DR. LAWROSKI: A. e you going to be obliged to remove the filters, the charcoal filters?

DR. MATTSON: Everybody's gotten a little out of his league today at one time or another. I'm afraid that's a question I can't answer, Steve. That's not my field. I don't know if we've got people here who can.

DR. LAWROSKI: Have you thought about removing cryogenically the charcoal for the noble gases?

DR. MATTSON: It's a good question. I can't answer it. It's something that ought to be factored in. I do know that at additional management structure for waste management, as we move now from the more urgent times to looking forward to the long-term cleanup of TMI-2 a new management structure was supposed to have been in place there today with just that kind of focus. So perhaps those kinds of ideas are best handled there. I'll see that yours is factored in.

MR. ETHERINGTON: Roger, how soon will it be before you can stop cooling altogether and just let it sit?

DR. MATTSON: Thre are varying estimates. Certainly, such a time does occur and 60 to 100 days, depending on who you talk to and his state of optimism. Stop cooling in the sense that it's just a swimming pool.

MR. ETHERINGTON: Just letting it go through the insulation in the building.

DR. MATTSON: That time is shorter if you conceive of flooding the containment which is also a backup in some of these far out scenarios -- flooding at least to a certain level.

MR. ETHERINGTON: Can it stand the pressure?

DR. MATTSON: That's being looked at by people who are proponents of that particular scenario for the long term, if you got into difficulty.

DR. CARBON: Are there other questions?

(No response.)

DR. CARBON: We thank you.

(Brief recess.)

(Executive Session.)

DR. CARBON: Let's continue in Executive Session at this time.

Open executive session.

I think perhaps the best thing we can do at the moment is to try and lay some plans for the remainder of our meeting. And the logical, I guess, obvious question that comes up is, Do we want to prepare a letter at this meeting, and if so, what general topics do we want to put in it. We, of course, did write a letter I guess about a week ago -- 10 days ago --and we will meeting again three weeks from now. I'd like to get expressions of opinion from you as to whether we should prepare a letter tomorrow morning specifically.

DR. PLESSET: We are having a subcommittee meeting next week, is that correct?

DR. CARBON: Yes. The current plans that have been laid out with respect to continued activities in this general vien are, of course, our meeting today and tomorrow. Then we have a subcommittee set up which will meet a week from today and a week from tomorrow -- a two day meeting. Depending on whether we get airline reservations, maybe no one will be there

I'll go back and say that we're trying to set up a meeting here in Washington a week from today and a week from tomorrow with the subcommittee of Mssrs. Okrent, Plesset, Siess, Mark, Michaelson, and myself. Mr. Michaelson is a consultant and the intention is that this will be a discussion session. We do not plan any presentations by any group, but rather a discussion of the implication of what's been going on -- the intermediate and longer term kinds of things. That's in answer to Dr. Plesset's question.

Part of the purpose of that meeting a week from today will be to lay out longer term plans to serve as sort of a screening steering committee, make plans to bring to the full committee for activities continuing on down the road.

MR. FRALEY: You mentioned that is going to be here in Washington. We announced it originally in Los Angelos but we're trying to change it to Washington

DR. CARBON: At the moment, I think no one has --

DR. SIESS: If you can get to Denver, you can get to Los Angelos.

DR. OKRENT: I have no trouble getting to Los Angelos.

(Laughter.)

DR. PLESSET: If nobody else is going to say a word, I would say that at the moment I think the letter that we already sent to the commissioners seems better and better, at least to me, as time goes on. I don't know whether we should really try to write another letter at this time or wait until after the next subcommitte meeting, to see what the full committee would like to do on the basis of that.

However, I would defer to more knowledgable people; that was my view. I like that letter now very much -- better and better.

(Laughter.)

DR. CARBON: Dave?

DR. OKRENT: I'm not sure whether I know how to answer your question without having some discussion about things like the following: Are there specific measures related to the B&W plants that the commissioners would like to have comments on? If we can decide that there are none of these that would need to -- one possible inclusion if we would decide that there are some

-- might lead the other way, as an example.

DR. SIESS: Can you remind me what the staff was supposed to have a position on, by midnight tomorrow night?

Darrel Eisenhut was going to have something done by midnight tomorrow night.

MR. FRALEY: I thought he said the rest of the answers went in by midnight tomorrow. Wasn't that it, to the remaining questions that I&E posed?

DR. MATTSON: Yes. And then I think they said that the review would be complete by Friday.

DR. CARBON: I think in answer to Chet's question, a week ago Darrel had indicated that the responses to 0509A were due in last Thursday or thereabouts. And by tomorrow night, midnight of the 17th, you pretty much have your position on things that you're recommending in response to the words that came in.

DR. MATTSON: So Mr. Vargo's presentation this morning represents somewhat of a slip from what Mr. Eisenhut estimated. I would hope the summary you heard this morning would suffice for the general nature of what we're receiving so that we can keep pushing to get the thing done by Friday, or sooner if that's possible.

DR. SIESS: Well, the point is that one thing this committee does is to give the commission advise relating to positions the staff has taken. We also give them advise where the staff has not yet taken positions. But it appears that the staff will have no formal or new position regarding other B&W plants or other PWRs, other than what has been put out in the I&E Bulletins so far.

But we have seen I&E Bulletins related to other PWRs since last week. And the staff has no formal position yet on the procedures for going to natural circulation other than the earlier things we've heard. It's still under review.

DR. MATTSON: Which natural circulation -- the one at Three Mile?

DR. SIESS: At Three Mile. I think the two immediate questions are operation of other plants, and what's being done at Three Mile. We've heard all you know about that and what you plan to do?

DR. MATTSON: Right.

DR. SIESS: And you're still reviewing and approving?

DR. MATTSON: Yes, sir.

DR. CARBON: Dave?

DR. OKRENT: One of the items in IE Bulletin 79-05A related to the review of any transients similar to the Davis-Besse event. Any others which contain similar elements -- I guess that's what's called Item 2.

I must confess I had thought that sometime during today either from the staff or from B&W, we might have had some detailed discussion as to what the input of these events was, and so forth. Not that the time wasn't spent very interestingly but somehow we didn't get to that area. It's, I guess, not inconceivable to me that we might still hear from one or both of those groups before tomorrow noon, in this area, that might or might not provide a basis for some committee thinking. So there's, at least to me, an example of one of the things that we didn't do, and there might be others of this sort that at least we might reflect on.

DR. SIESS: Could we ask the staff to what extent they reviewed the utilities' submittals on that item?

DR. MATTSON: I think Mr. Vargo summarized that this morning, saying that he didn't think that the staff was going to find in the 05A responses, any startling type transients that they weren't already aware of and in the process of evaluating under the program that Mr. Tedesco is responsible for. I thought he indicated this morning that he is not at a point yet where he can draw conclusions from looking at those transients.

Clearly he would be at a point by the end of the month to report. It might be, that meeting with him again tomorrow might be counterproductive to generating that information. It might also be a few days down the road. It wouldn't be counterproductive in the sense that after he's had a chance to look at it a little more and his people have, it would be a good opportunity to have an exchange with this committee or some subcommittee and let him say what he's learning and what his thoughts are, so that you can have input to that process before it's finished.

05A

I'm certainly not reluctant to do that. I think if we bring him down here again tomorrow morning, he's not going to be in a position to say anything much different than he said this morning on the same subject.

DR. PLESSET: We didn't have a meeting scheduled with the commissioners tomorrcw?

DR. CARBON: Yes, we do -- unless it's impossible for us to get together at the agreed upon time. But yes, we have a meeting scheduled.

DR. SHEWMON: What time is it scheduled for?

DR. CARBON: The end of the afternoon. We had had it scheduled for 2:30 to 3:30. They wanted to postpone it until 3:30 to 4:30, and that won't work for us. Currently, we're trying to see if it can be 3 to 4.

DR. OKRENT: Well, if I can pursue it a little bit, Dr. Mattson, there was this memorandum dated February 28th from Mosley to Thompson, concerning notification of licensing boards which referred to an event where pressurizing levels went off scale and thus and so, forty comments by J.S. Creswell and Streeter. I don't think we've ever had the opportunity of getting comments from the staff about this and whether it bares the general question of behavior of these reactors in transients.

DR. MATTSON: That's what I'm saying. That's what Tedesco is doing, and that's what his report is going to be. To the extent,he could summarize it today and answer your questions, he did. The particular memo you referred to had several features in it.

One had to do with the level indicator, which is something that Steve Hanauer addressed this afternoon. I think we do know much more about that subject today than we did at the time of the Board notification. There are other elements in that memorandum dealing with the transient behavior for the B&W reactor, which are being studied in a way that Tedesco described this morning.

I guess I don't understand your point.

DR. OKRENT: I guess -- I had assumed that there had been staff review of this transient, and actually the previous one.

DR. MATTSON: Staff review of the Davis-Besse transient? Yes there was, and I believe a report to the committee.

DR. OKRENT: That may be, but in fact I can't recall.

DR. SIESS: We were concerned about how hot it got in the pressurizer.

DR. MATTSON: That was a year ago or more. It sticks in my mind as about that time frame.

DR. OKRENT: While I was away -- I'm probably asking about something that everyone else is familiar with.

DR. MATTSON: Is what you're looking for is a review of the Davis-Besse transient, as to what happened, and what was looked at, and why it was safe to go on after that transient?

That was done.

A review of the Davis-Besse transient, in light of the Three Mile Island event isn't complete. That's what Tedesco is doing now in the course of looking at all those other transients, in light of the Three Mile Island event. That isn't done yet.

DR. OKRENT: Okay.

DR. MATTSON: If it's the former, we can certainly get you a copy of it. And the latter, what I said earlier applies.

DR. CARBON: Does that finish your comment, Dave?

DR. OKRENT: For the moment.

MR. CASE: I think it's fair to say you know everything we know, and that you know everything we're doing. Unless we work some more, we can't tell you.

MR. ETHERINGTON: Could I ask, is the pressurizer spray designed to take care of the rate of rise that we infer from the measurements taken up at the pressurizer level?

DR. MATTSON: Let's see, is the pressurizer spray --

MR. ETHERINGTON: As the level rises, there's adiabatic compression of the steam and the steam will go on to superheat, except the spray is supposed to cool it. Is the spray able to take care of that rate?

DR. MATTSON: I don't know the answer to that question, but that would be sort of a normal thing for the spray capability.

MR. ETHERINGTON: Was the rate of rise observed greater than the design rate?

DR. MATTSON: I don't know, Mr. Etherington.

MR. MAC MILLAN: What was the accident that was involved here, Harold?

MR. ETHERINGTON: That will cause an increase in the steam temperature.

MR. MAC MILLAN: Right.

MR. ETHERINGTON: Does the pressurizer spray take care of the rate that you observed, the rate and the magnitude.

MR. MAC MILLAN: In the early phases of the transient, there's a rapid rise in pressure.

MR. ETHERINGTON: Rapid and big-wise.

MR. MAC MILLAN: It's not competent to handle that. That's why the electromagnetic relief valve was opened. Even with the electromagnetic relief valve open, the pressure continued to rise until the reactor scrammed -- the reactor shut down. That turned the pressure off and brought it back down. The spray is not capable of handling that rapid an increase in pressure.

MR. ETHERINGTON: But the electromagnetic valve is capable of limiting the temperature rise. Obviously,it is.

MR. MAC MILLAN: In this transient, the relief valve opened. But with the reactor still running, it could not turn around the pressure,and the pressure did not turn around until after the reactor scrammed. Then in a combination of a scramming reactor and with an electromagnetic valve open, it turned the pressure around, and the code safety valves did not relieve this.

MR. ETHERINGTON: Thank you.

end 12

67-332

DR. MATTSON: Now that I understand the question, I agree with the answer.

DR. CARBON: Roger, were there a couple of cases prior to the accident that we're discussing where they had a pressurizer level,indications that it went off the scale?

DR. MATTSON: Well, the question of a pressurizer-level indication has been something of recent concern within the staff and the nature of the concern was the kind of thing that Steve Hanauer was explaining with his three slides up there earlier this afternoon. To some extent I think that concern has been resolved by some pretty intensive looking post-Three Mile Island. Whether it's really resolved -- I guess I haven't been tapped in that closely to that element over the last couple of weeks.

The question is raised in the board notification, the question that was raised by the internal memorandum in the reactor systems branch,to the extent are those fully resolved? The work that Hanauer has done, it's not completed at this point.

MR. FRALEY: Roger, I understood there were two incidents where the pressurizer level, you know, went to zero during transience when relief valves opened and perhaps failed to close. I'm not too sure on that latter. And there was some concern that the bubble from the pressurizer got out into the primary cooling system, but calculations indicate that it did not.

I understand that this happened twice at Three Mile

Island. I think it was Unit 2, but it might have been Unit 1. Do you have any information on that?

DR. MATTSON: You're over my head again. Unfortunately, a lot of my people have gone.

MR. FRALEY: I was told it happened at Three Mile Island, also.

DR. MATTSON: You're talking about something I haven't heard mentioned.

DR. PLESSET: What difference does it make? Unless it's non-condensible you wouldn't care if it got out into the primary.

MR. FRALEY: Most of the hydrogen that's in the primary coolant system is up in the steam space of the pressurizer.

DR. PLESSET: Now you're talking about the accident.

MR. FRALEY: I'm talking about other accidents where the pressurizer level was lost and there was concern, you know, that the bubble from the pressurizer got out into the system. Part of that is steam but part of it is hydrogen.

DR. PLESSET: Should they have significant hydrogen in the steam generator bubble?

MR. FRALEY: I believe they had quite a bit. I'm not sure how much.

DR. PLESSET: Do you know about that -- a gas like hydrogen in the steam generator?

MR. MAC MILLAN: I'm sorry, I didn't hear the question.

DR. PLESSET: It's been suggested that there's hydrogen in the bubble in the steam pressurizer in normal operation, let's say, which would be a noncondensible gas. Is that the case?

MR. MAC MILLAN: There is some hydrogen in the pressurizer. We maintain a hydrogen overpressure in the makeup tank in order to maintain an excess of hydrogen in the reactor coolant system. And to the extent that spray water containing disolved hydrogen goes into the pressurizer, it will relieve the hydrogen in the pressurizer and preferentially seep the gaseous base. So there is some hydrogen in the pressurizer bubble.

DR. PLESSET: If the pressure is high enough, it might redisolve.

MR. FRALEY: So that's the equilibrium condition.

DR. PLESSET: Okay.

MR. TAYLOR: The sampling of the steam space in that pressurizer usually produces a partial pressure or concentration in the 15 to 40 cc per liter range which is just about the same concentration that you have in the makeup storage tank where the partial pressure is about -- the gas pressure is about 40 psi.

DR. MATTSON: Given all that, which is what I understand to be the facts, I still don't quite understand, Ray, your point.

MR. FRALEY: Well, we heard that these two incidents had occurred, and I was wondering if there was anyone on the staff who knew about them and could describe them to us. It might help in conection with these other concerns about other types of transients.

DR. MATTSON: Well, I certainly asked to the limit I that I understand what two things you heard about. But maybe we ought to talk on the telephone and you give me some more specific information and we'll get the answer to you. I can't place what you're talking about.

DR. SIESS: I can give you specific information on one. It's on LER, Three Mile Island.

DR. SHEWMAN: It was in my handout today.

There is no number on it. This is a special report transmitted with a letter July 24, 1978.

MR. MATHIS: 7821-3L

DR. MATTSON: If it's an LER, of course it's in Tedesco's scope and he would try to explore it.

MR. FRALEY: I though maybe the project people had evaluated it earlier.

DR. MATTSON: The LER may very well have been evaluated but I didn't do it. It's over my head.

DR. SIESS: Would 7832 be an LER number?

DR. MATTSON: Was the -- the first time you gave me 7821.

DR. SIESS: One incident was on March 29, 1978. Another was on April 23, 1978.

DR. MATTSON: This is EMI 1.

DR. SIESS: EMI 2.

DR. CARBON: Dave, I guess that finished your question to Roger somewhere back there, is that correct?

I guess we're still at the point of trying to make some decision. I guess the only firm -- well, two -- comments so far: One, perhaps there's nothing to write on, and Dave's other point that perhaps we ought to discuss some of the things related to the B&W plants.

Harold, do you have comments?

MR. ETHERINGTON: No. I don't feel impelled to write a letter so soon after the other one. I believe the staff has said they will give some consideration to a warning to operators to watch out for this conversion from enforced circulation to natural circulation. And if I understand that correctly, I don't think it's necessary to write a letter on that point. And that's the only one I feel a little uneasy about.

DR. CARBON: Steve?

DR. LAWROSKI: It seems to me that's a very reasonable position unless something develops between now and tomorrow when we will have discussed this further. We still have another executive session tomorrow.

DR. CARBON: All morning.

MR. ETHERINGTON: Things are moving rather quickly now and there will be new slants coming out, I think. I think it hasn't quite crystallized to the point where we want to be too specific about additional concerns.

DR. CARBON: Comments?

MR. MATHIS: No.

DR. OKRENT: I think we heard from B&W this afternoon, I guess, that in general they had no problems with what was said about -- by the staff. In the bulletins, I'm not sure we had the benefit of detailed discussion by B&W of the various points in the Bulliten 79-05A. I don't know whether they think they could discuss this during this meeting, but if they had some information or opinions and so forth that they thought were relevant, it could be useful. And I think there might be time.

DR. CARBON: I think we have plenty of time in the morning if we want to ask for more information.

Let me ask, Did you hear Dr. Okrent's comment here, and could you respond to it, John?

MR. MAC MILLAN: I apologize. I was reading LER -- whatever -- and I didn't hear his question.

DR. OKRENT: I was saying that there might be various specific comments that you could make, you in the general sense -- the people from B&W, concerning the several points raised in Bulliten 79-05A. I mean, I assume that you're active in working with the various utilities in responding to 79-05A, and that you have thoughts on what are the factors that relate to the various items. And if so, that could be interesting for us to hear.

MR. MAC MILLAN: I thought that was the thrust of a portion of my testimony this afternoon, that in fact addressed each of the six items which were identified in any I&E Bulletin and indicated how we assessed the relative importance of those factors.

DR. OKRENT: Well, I agree that you discussed at least portions of the Bulletin this afternoon. I guess it wasn't clear to me that there weren't more things you could say about measures in here. Maybe I'm wrong.

MR. MAC MILLAN: I guess I'd have to know what questions you might have and then would have to respond to those.

MR. CASE: I think as a general matter, it seems fair to me, correct me if I'm wrong, that you're agreeing with what's in the Bulletin.

MR. MAC MILLAN: I think I said in my statement that in essential agreement with the findings of the NRC in them -- bulletins that have been issued, 05 and 05A. In fact the advisory, I think I said this, the advisory is that we send to the utilities,were in congruence with the I&E Bulletin 79-05A relative to the importance of maintaining the pressure in a sub-cool condition and keeping the HPI pumps on for a period of time on the order of 20 minutes.

DR. SIESS: Suppose that some other responses from the applicants suggested that keeping the pumps on arbitrarily for 20 minutes might not be desirable and that they had another option?

MR. MAC MILLAN: I have not read all of the responses, but I believe that one of them did raise that concern.

DR. SIESS: I think it was Duke.

DR. MATTSON: That is one of the points that is being iterated in the process of reviewing the responses. It's clear that that is an important safety question to ask. But I think it's also clear, as I understand, what Vargo said this morning and what I heard him say last night, that that problem is in hand and will be dealt with in the NRC response, the licensee's response to the Bulletin.

MR. CASE: I haven't heard any comments from any sources that that is detrimental to safety. The question was raised about damage to the plant and the water level of the containment -- that kind of concern. But as a matter of fact, we discussed the same thing with the other PWR vendors and they all agreed in essentially the same language and the same length of time as not being detrimental to safety and appropriate for this interim period.

DR. SIESS: That's not what I read here. It says: Depending upon the nature of the low pressure transients, appropriate action may be required for the operation of the higher pressure injection-system and/or the reactor coolant pumps, in order to prevent an unsafe reactor-coolant-system condition.

DR. MATTSON: Well, that was the initial response to the Bulletin, as I said.

DR. SIESS: I was speaking to Ed. You agree with me, Ed disagrees.

MR. CASE: I'm not up on that comment.

DR. MATTSON; I don't think I'm disagreeing with Ed. What Ed said is right. There was a point of understanding to work out with that particular licensee as to the intent of the procedures in the Bulletin. And having communicated that intent, my understanding is that the difference between the licensee and the staff is gone, and that that will be documented in the course of the staff's response to the licensee's response.

DR. SIESS: I'll wait.

DR. CARBON: Gentlemen, I wonder if we're at the point of saying let's stop for the evening and think about it overnight and perhaps discuss in the morning Dave's point about specific matters related to B&W plants. And certainly, if we end up having a meeting with the commissioners tomorrow afternoon, we'll want to go over our beliefs and stands with considerable care to reach a commission position. So I guess where we write the letter --

DR. LAWROSKI: I thought you said commission.

DR. CARBON: I meant committee. So maybe it's not too crucial at the moment whether we aim toward a letter or simply discussion. If that seems reasonable to you, we'll adjourn for the evening and take up at 8:30 again tomorrow morning.

end 13

(Whereupon, at 7:45 p.m. the hearing was recessed to be resumed at 8:30 a.m., Tuesday, April 17, 1979.)

67-341

A STATUS REPORT

TO THE

ACRS

GENERIC REVIEW OF

FEEDWATER TRANSIENTS IN B&W REACTORS

67-342

APRIL 16, 1979

GENERIC REVIEW GROUP

PURPOSE

TO PERFORM A GENERIC ASSESSMENT OF FEEDWATER TRANSIENTS IN B&W PLANTS IN LIGHT OF TMI-2 EVENT TO 1) ESTABLISH BASIS FOR CONTINUED SAFE OPERATION OF THESE PLANTS IN THE SHORT TERM AND 2) DETERMINE REVIEW AREAS FOR LONG TERM REASSESSMENT OF B&W PLANT DESIGNS TO MEET NRC REGULATIONS

B&W PLANTS (9)

INCLUDED IN GENERAL REVIEW *

- THREE MILE ISLAND UNITS 1 & 2 (PA)
- CRYSTAL RIVER 3 (FL)
- RANCHO SECO 1 (CA)
- OCONEE UNITS 1, 2 & 3 (SC)
- ARKANSAS ONE UNIT 1 (AK)
- DAVIS-BESSE UNIT 1 (OH)

* GENERIC REVIEW WILL ALSO INCLUDE PRELIMINARY CONSIDERATION OF OTHER VENDOR PWR PLANTS

F.W. TRANSIENTS IN B&W PLANTS

(PRECURSOR TO TMI 2 TYPE EVENT)

DATE	PLANT	PORV ACTUATED	PORV STUCK-OPEN	HPI INJECTION
6/13/75	OCONEE-3*	✓	✓	✓
6/12/76	OCONEE-2	✓		
9/24/77	DAVIS-BESSE-1*	✓	✓	✓
3/20/78	RANCHO SECO			✓
12/4/78	OCONEE-1	✓		✓
3/28/79	TMI-2	✓	✓	✓

*INDICATES TWO EVENTS SIMILAR TO TMI-2

679-346

GENERIC REVIEW AREAS (B&W)

(1)		(2)		(3)		(4)		(5)		(6)
F. W. TRANSIENT TMI-2	→	(PLANT DESIGN)		(WRONG OPERATING PROCEDURES FOR SITUATION)		(EQUIPMENT MALFUNCTION)	.	(OPERATOR FAILURE)	=	(STP)
		Pressurizer Level OTS/G & FW Control System Loop Configuration		HPCIS & RCP		PORV		AFW		

- PLANT DESIGN FEATURES (2)
- OPERATIONAL ASPECTS (3) (4) (5)
- LICENSING BASIS (1)
- I&E BULLETINS (6)

PLANT DESIGN FEATURES

- PRESSURIZER - LEVEL
  - POWER OPERATED RELIEF VALVE
- PRIMARY COOLANT SYSTEM CONFIGURATION
- ONCE-THROUGH STEAM GENERATOR (OSTG)
- FEEDWATER SYSTEM
- CONTROL AND SAFETY SYSTEMS

LICENSING BASIS

- TRANSIENT ANALYSIS METHODS
  - VENDORS
  - STAFF
- GDC - SRP
- TECHNICAL SPECIFICATIONS
- OPERATING PROCEDURES
- OPERATOR TRAINING

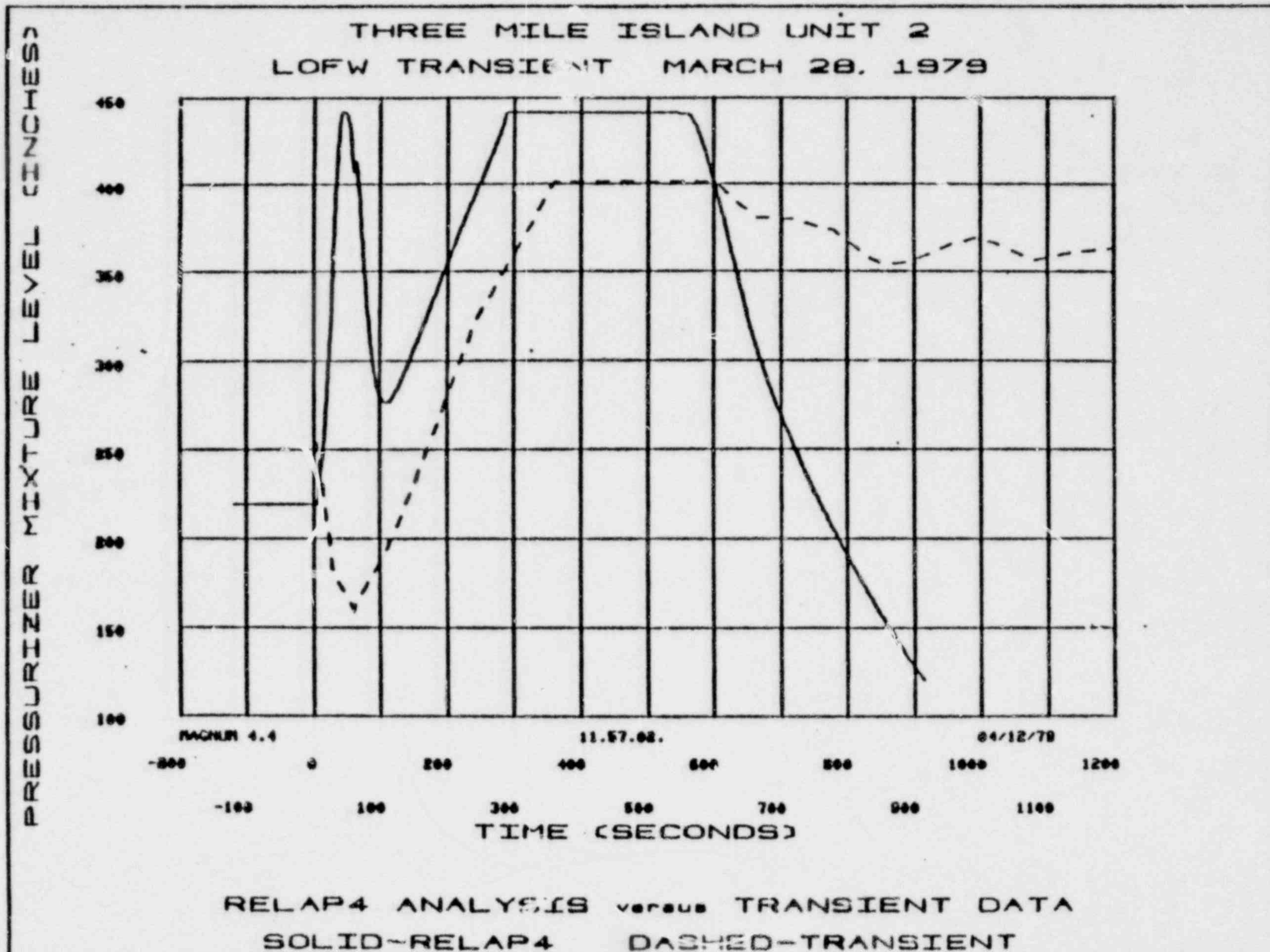
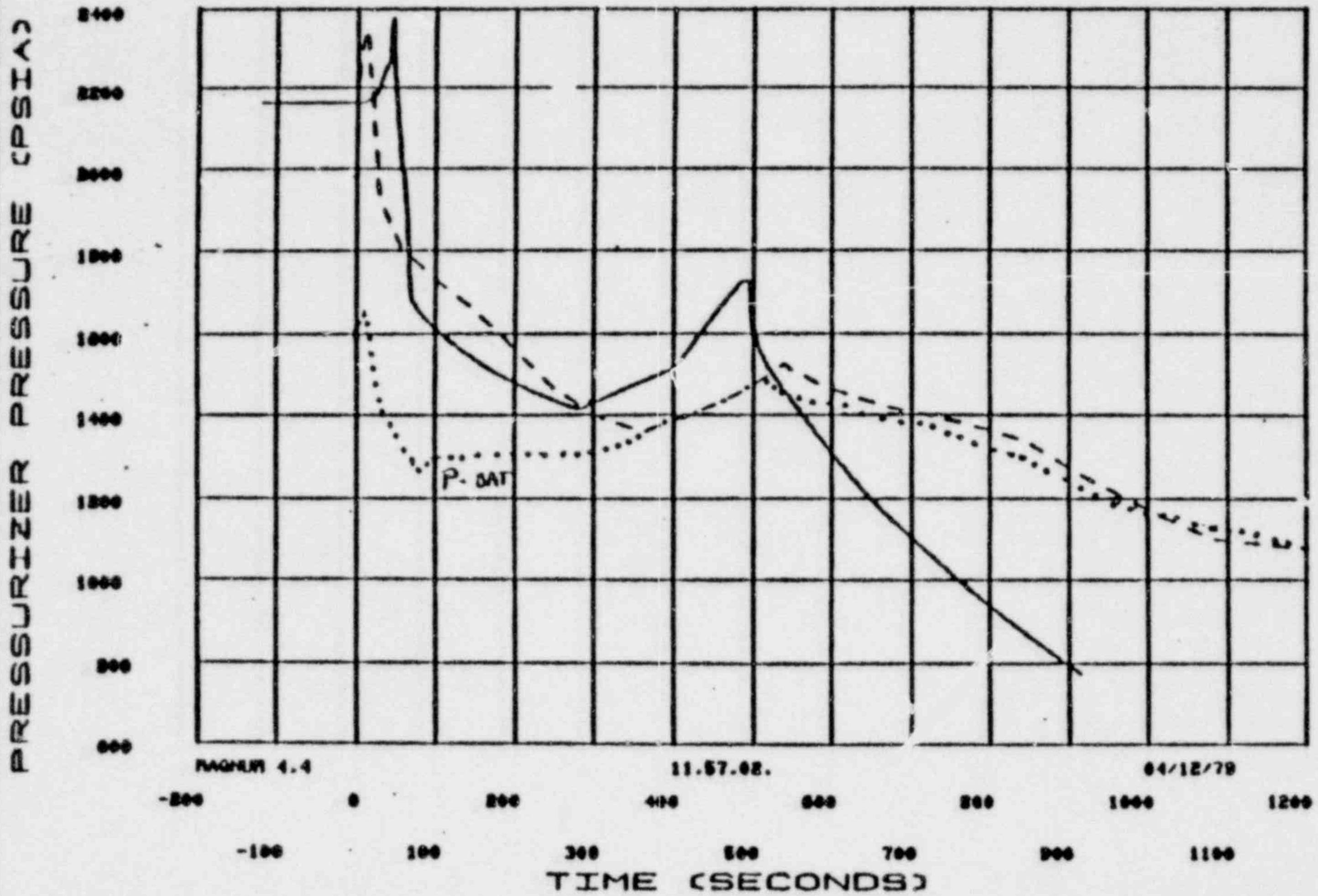


FIGURE 2

67-349

THREE MILE ISLAND UNIT 2

LOFW TRANSIENT MARCH 28, 1979



RELAP4 ANALYSIS versus TRANSIENT DATA

SOLID-RELAP4 DASHED-TRANSIENT

FIGURE 3

67-350

K•E 10 X 10 TO ½ INCH 7 X 10 INCHES KEUFFEL & ESSER CO. MADE IN U.S.A. 46 1320

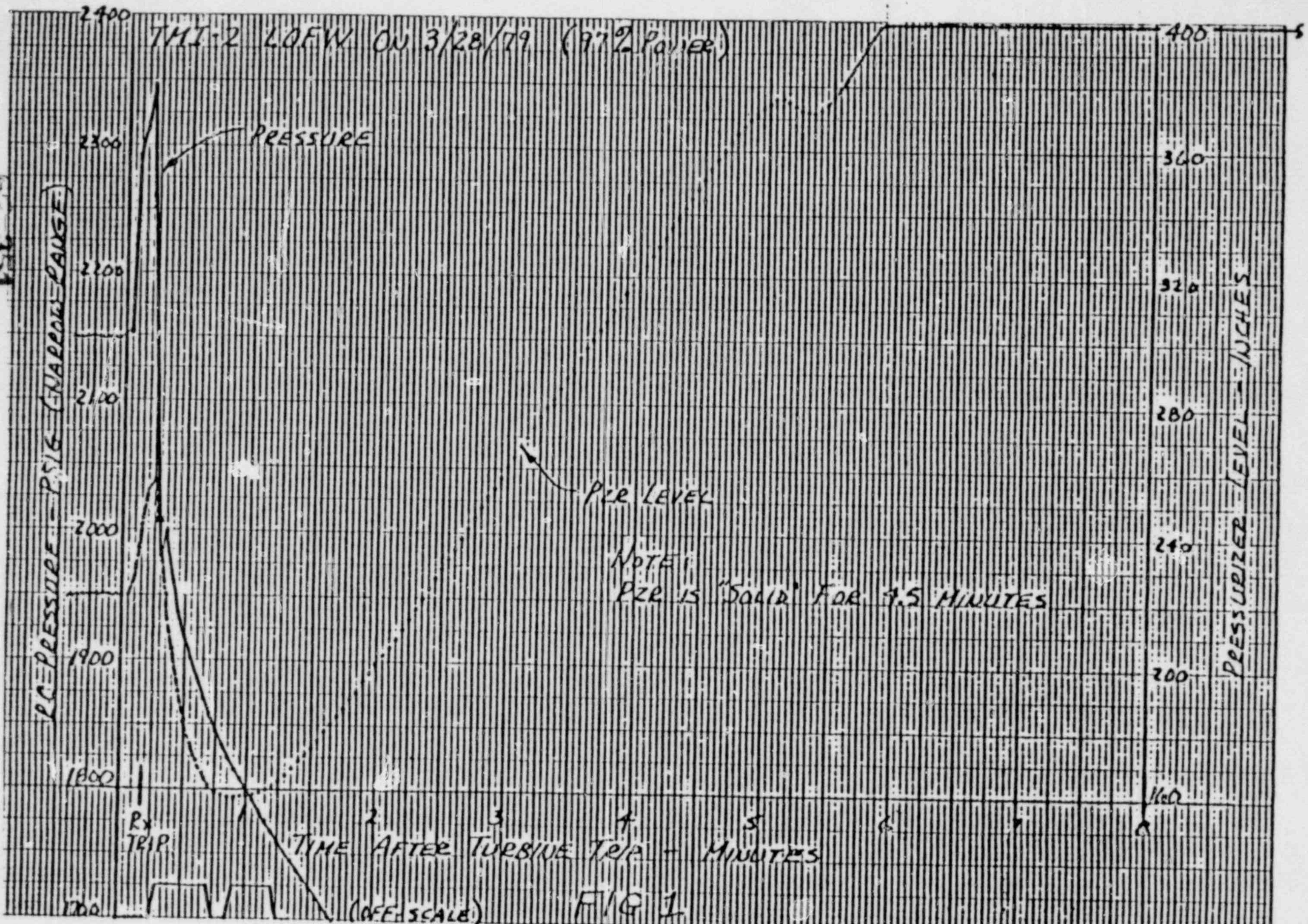


FIG 1

67 351

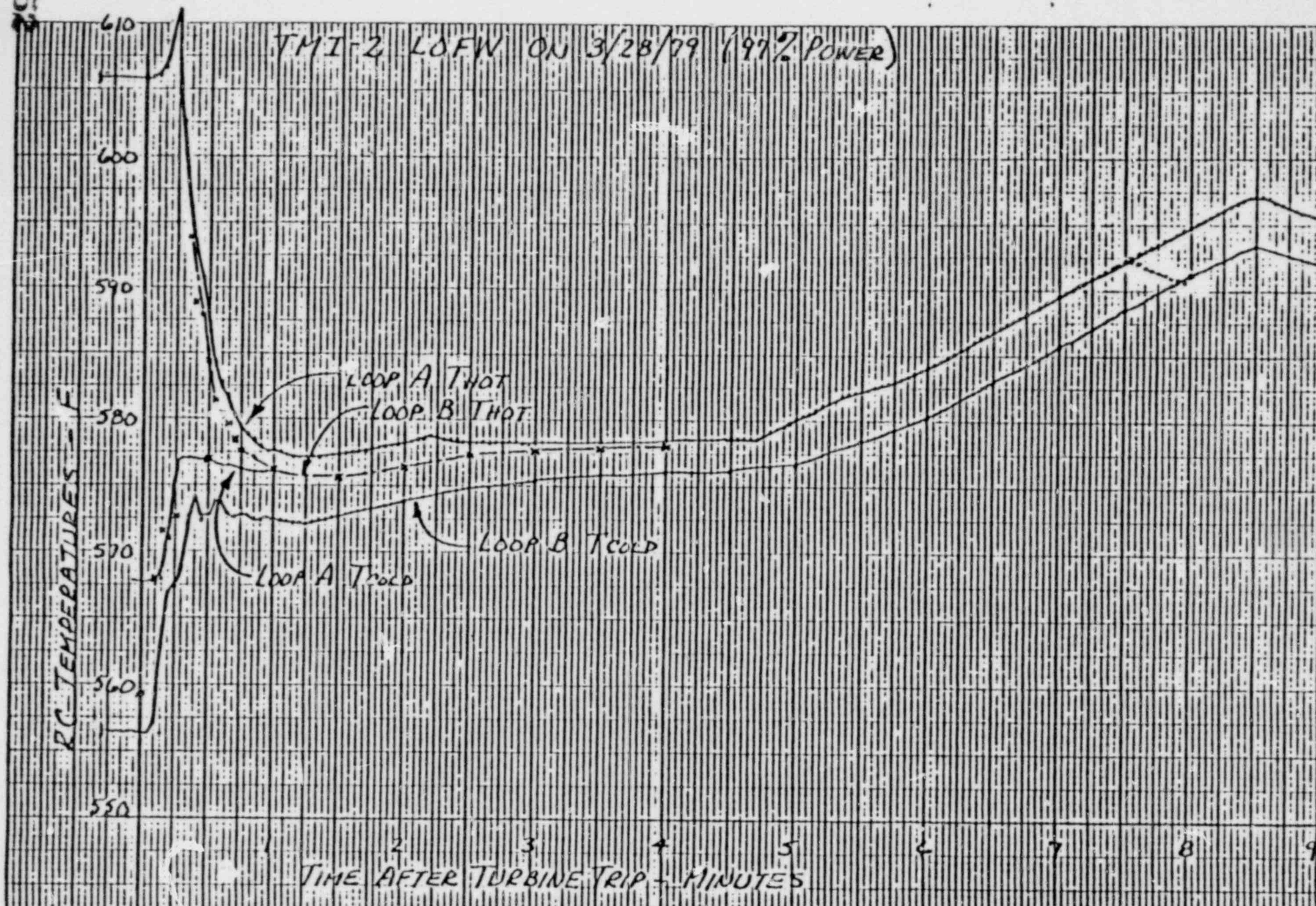
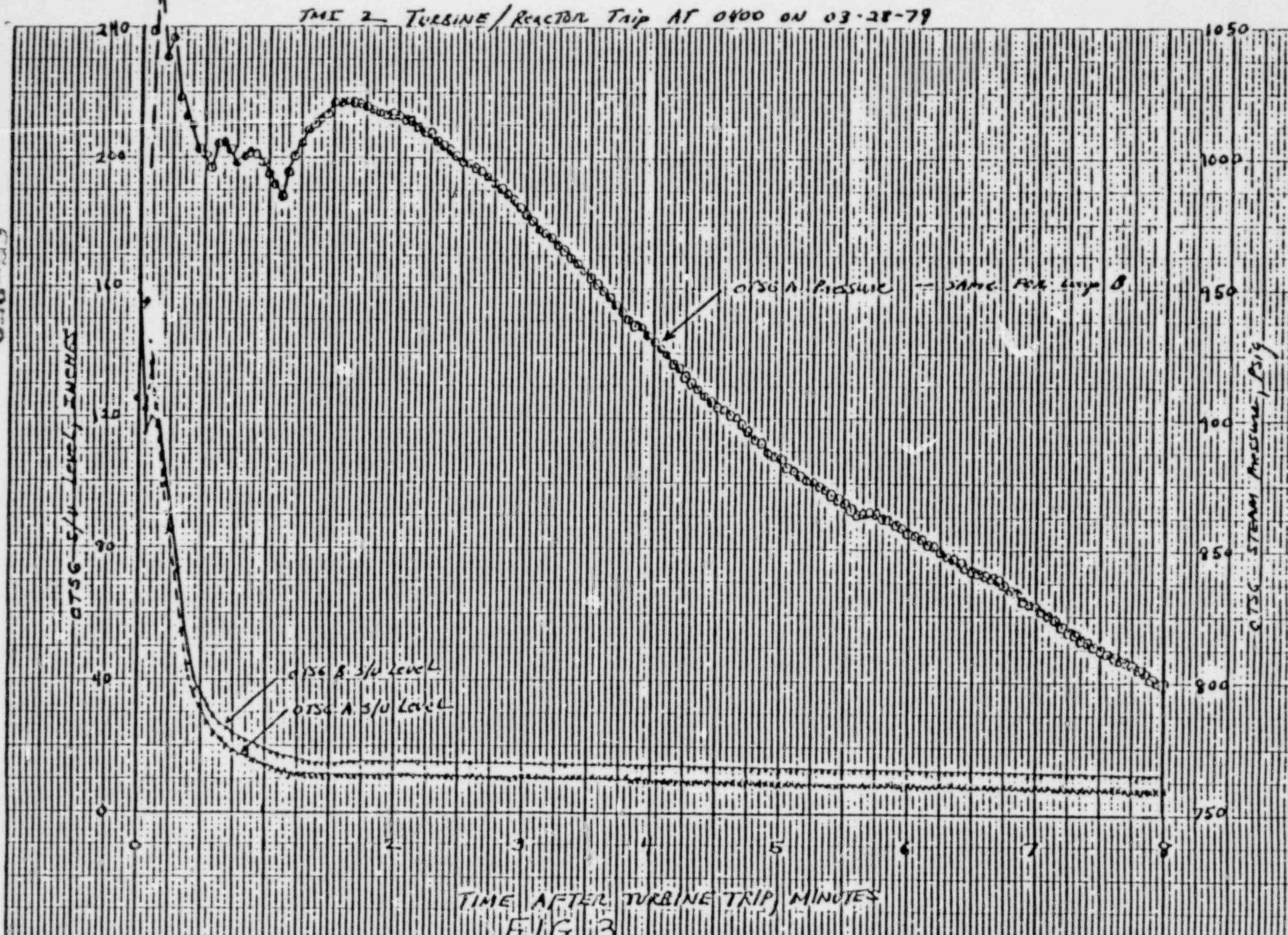

TMI-2 LOFW ON 3/28/79 (97% POWER)
610
600
590
580
570
560
550
540
RC TEMPERATURES - F
LOOP A THOT
LOOP B THOT
LOOP B TCOLD
LOOP A TCOLD
1
2
3
4
5
6
7
8
9
TIME AFTER TURBINE TRIP - MINUTES

FIG 2


TMI 2 TURBINE/REACTOR TRIP AT 0400 ON 03-28-79
240
200
160
120
80
40
0
1050
1000
950
900
850
800
750
OTSG S/U LEVEL, INCHES
OTSG STEAM PRESSURE, PSIG
OTSG A PRESSURE -- SAME FOR LOOP B
OTSG B S/U LEVEL
OTSG A S/U LEVEL
0
1
2
3
4
5
6
7
8
TIME AFTER TURBINE TRIP, MINUTES
FIG 3

67-353

K+E 10 X 10 TO ½ INCH 7 X 10 INCHES KEUFFEL & ESSER CO. 46 1320

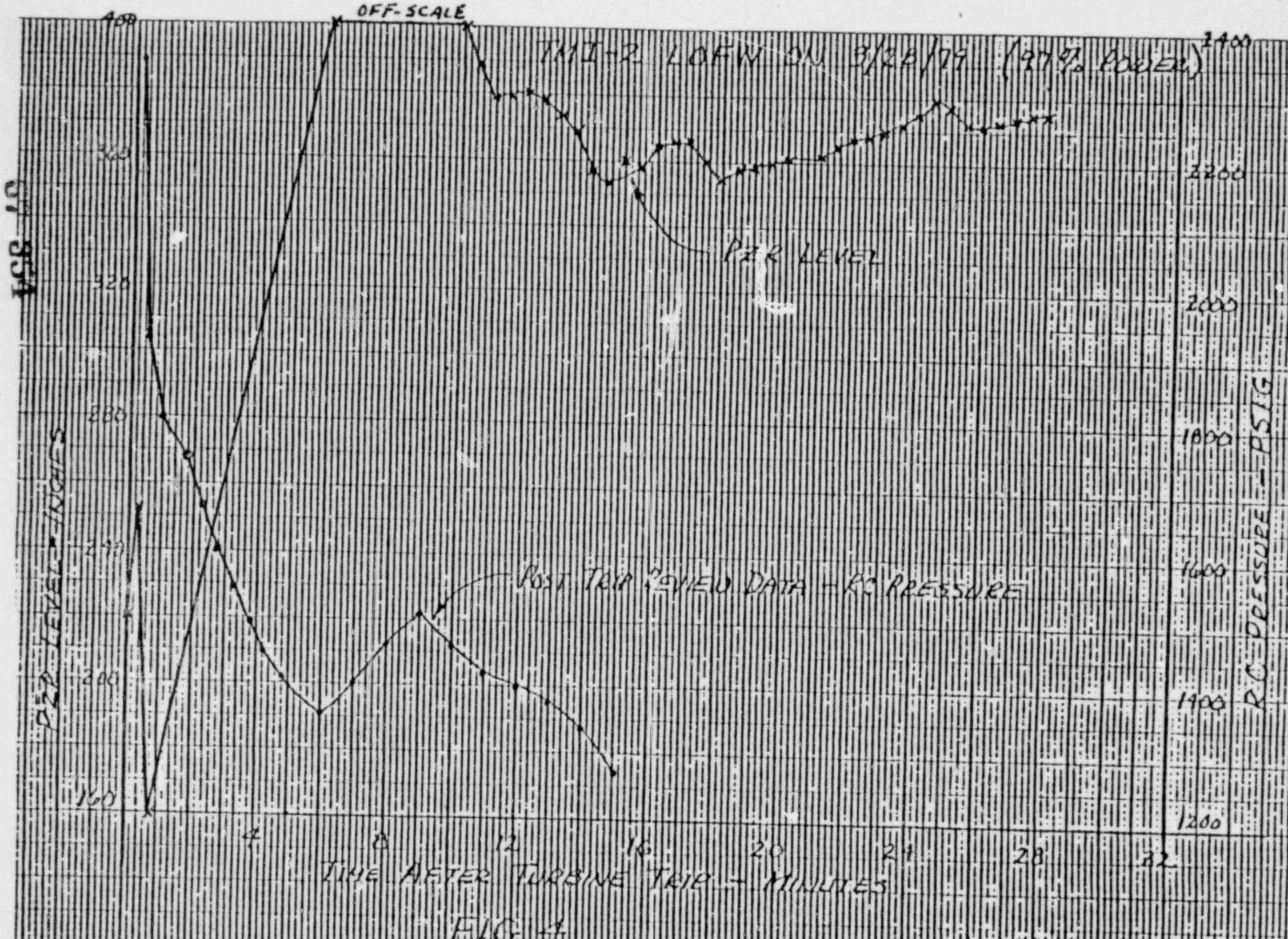


FIG 4

K·E 10 X 10 TO ½ INCH 7 X 10 INCHES KEUFFEL & ESSER CO. MADE IN U.S.A. 46 1320

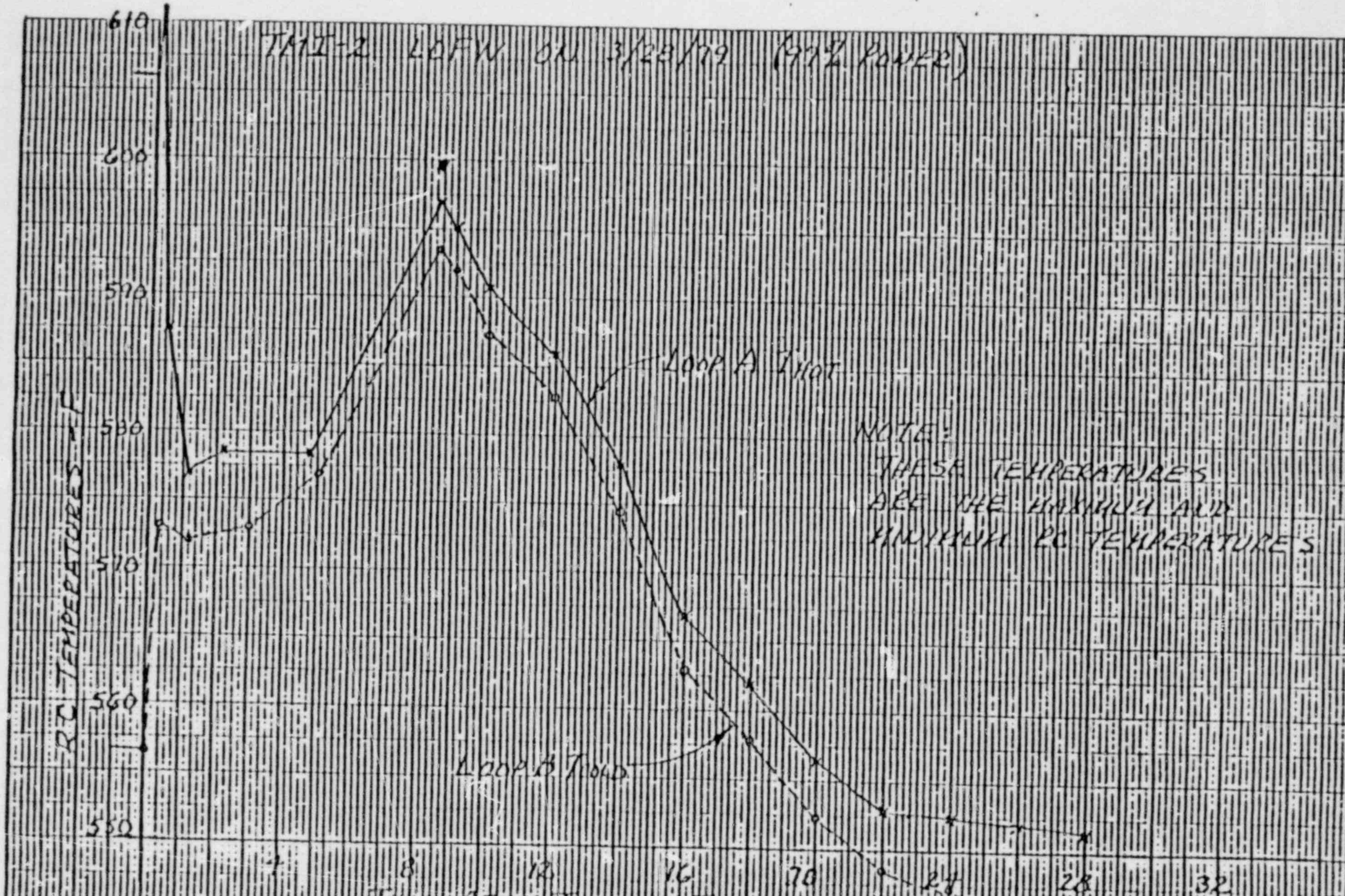
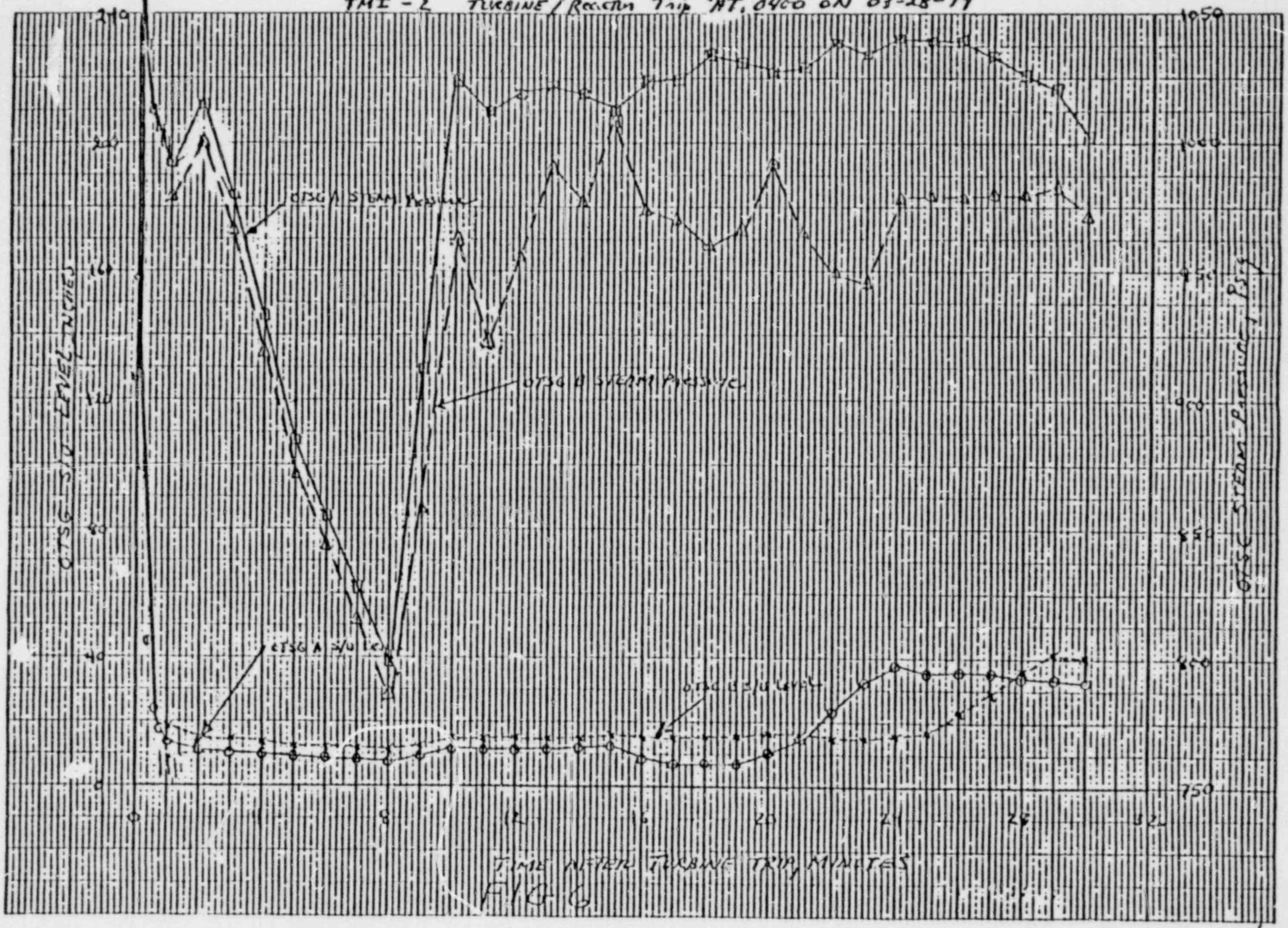


FIG 5

67-355

TMI - 2 TURBINE / Reactor Trip AT, 0400 ON 03-28-79



K+E 10 X 10 TO ½ INCH 7 X 10 INCHES KEUFFEL & ESSER CO. 46 1320

LCR TO W H SPANGLER

TMI 2 TURBINE/REACTOR TRIP AT 0400 ON 03-28-79

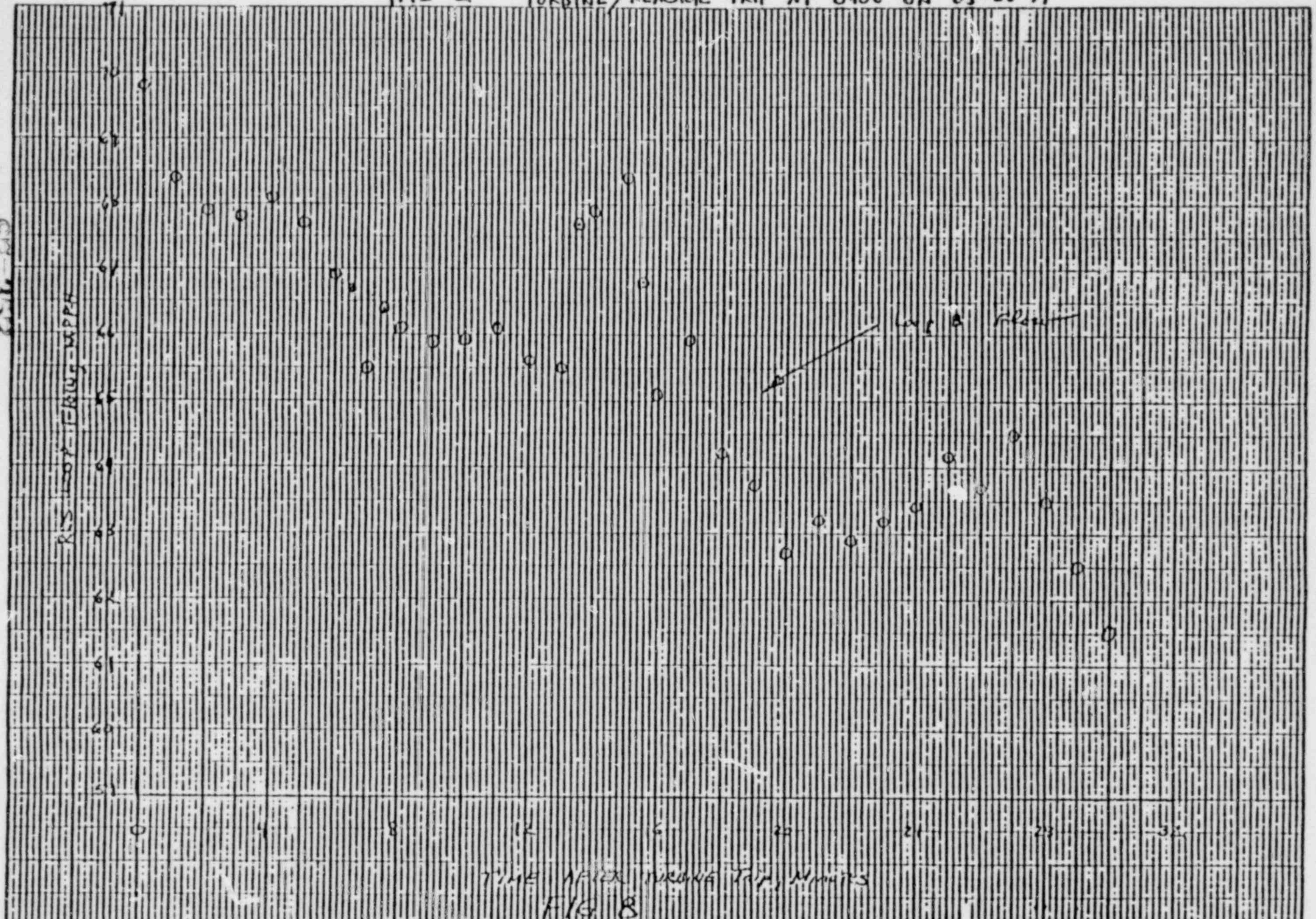


FIG 8

67-357

K·E 10 X 10 TO ½ INCH 7 X 10 INCHES KEUFFEL & ESSER CO. 46 1320

..LCR TO WH SPANGLER

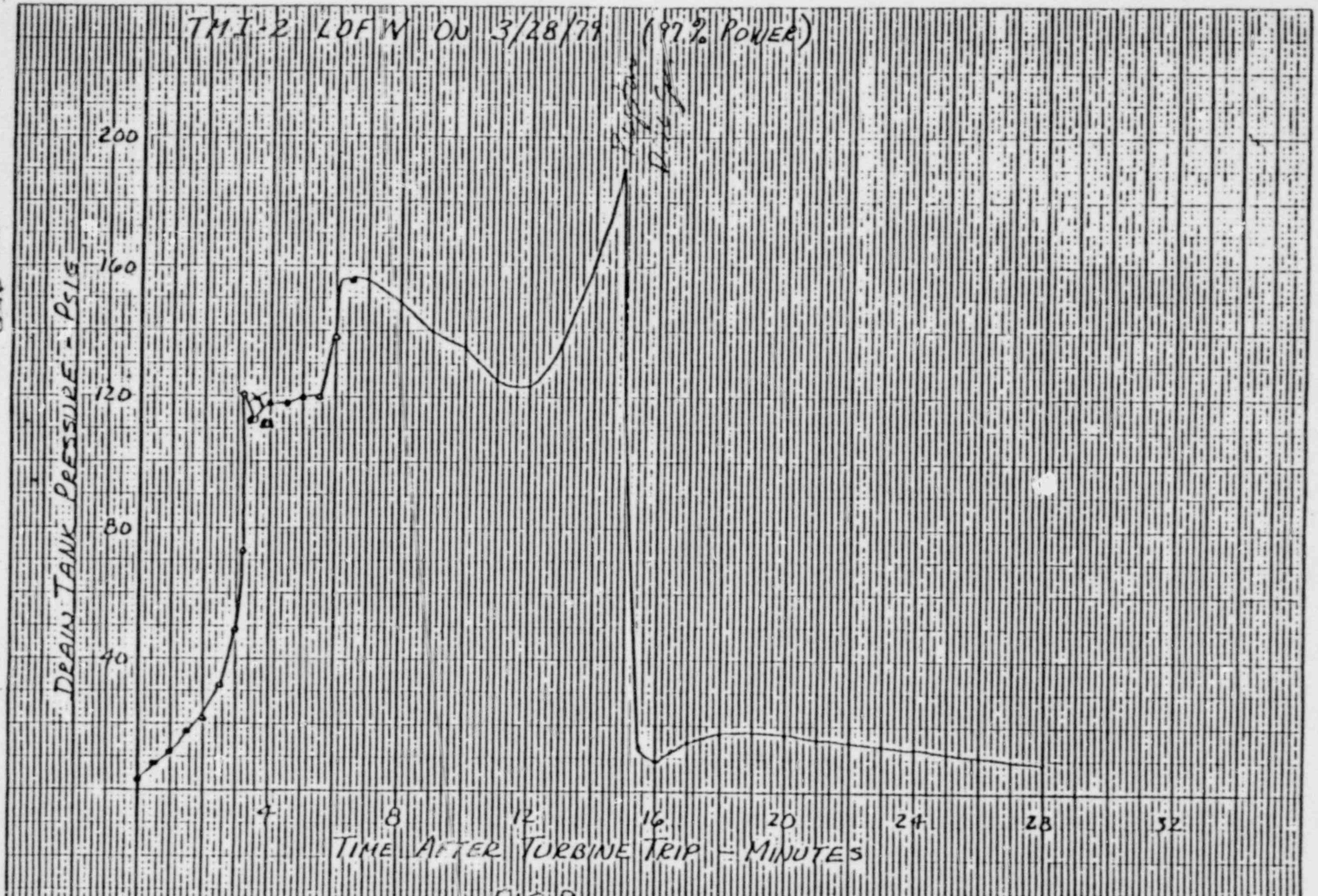


FIG 9

67-358

18

K+E 10 X 10 TO ½ INCH 7 X 10 INCHES KEUFFEL & ESSER CO. 46 1320

LCR TO WH SPANGLER

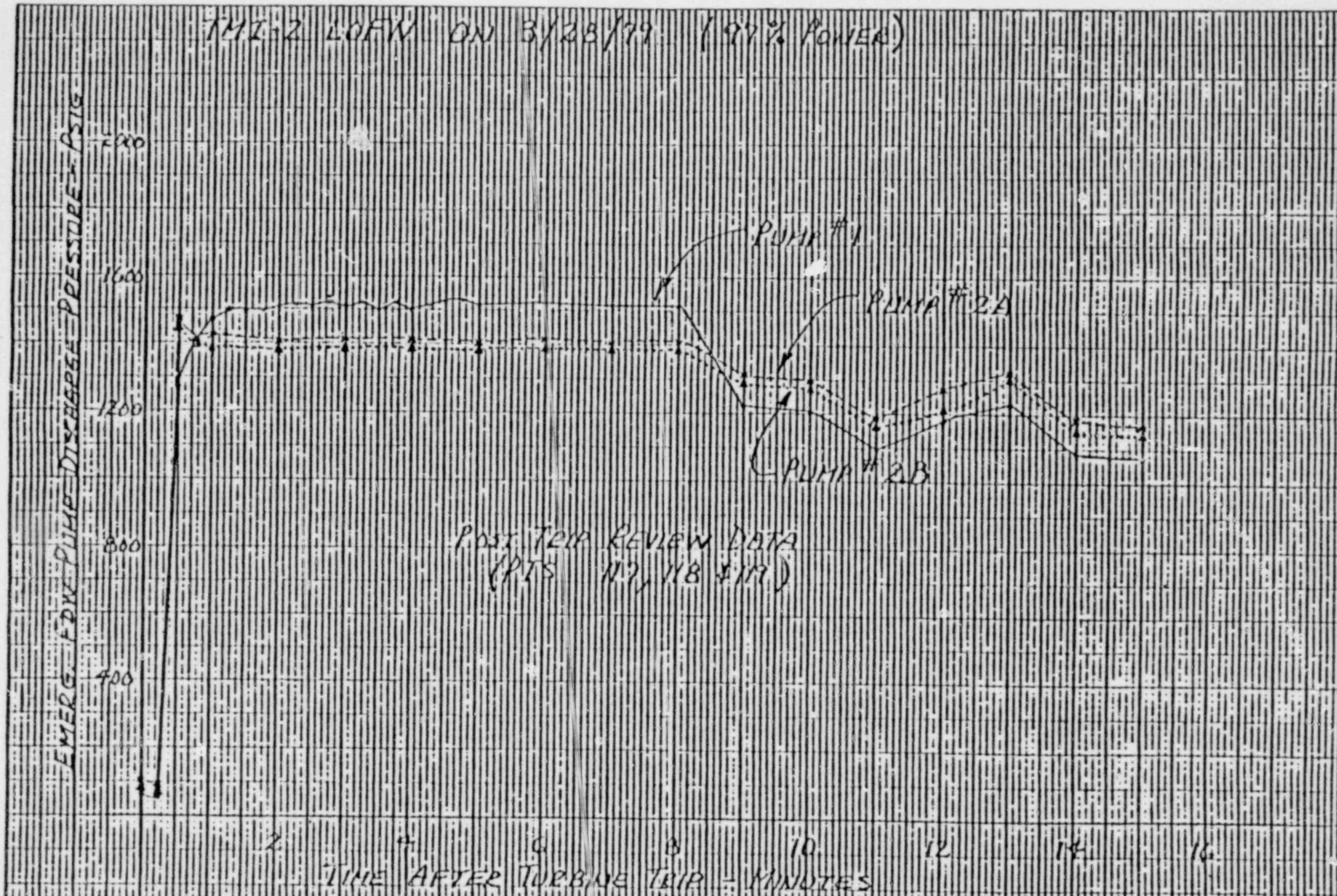


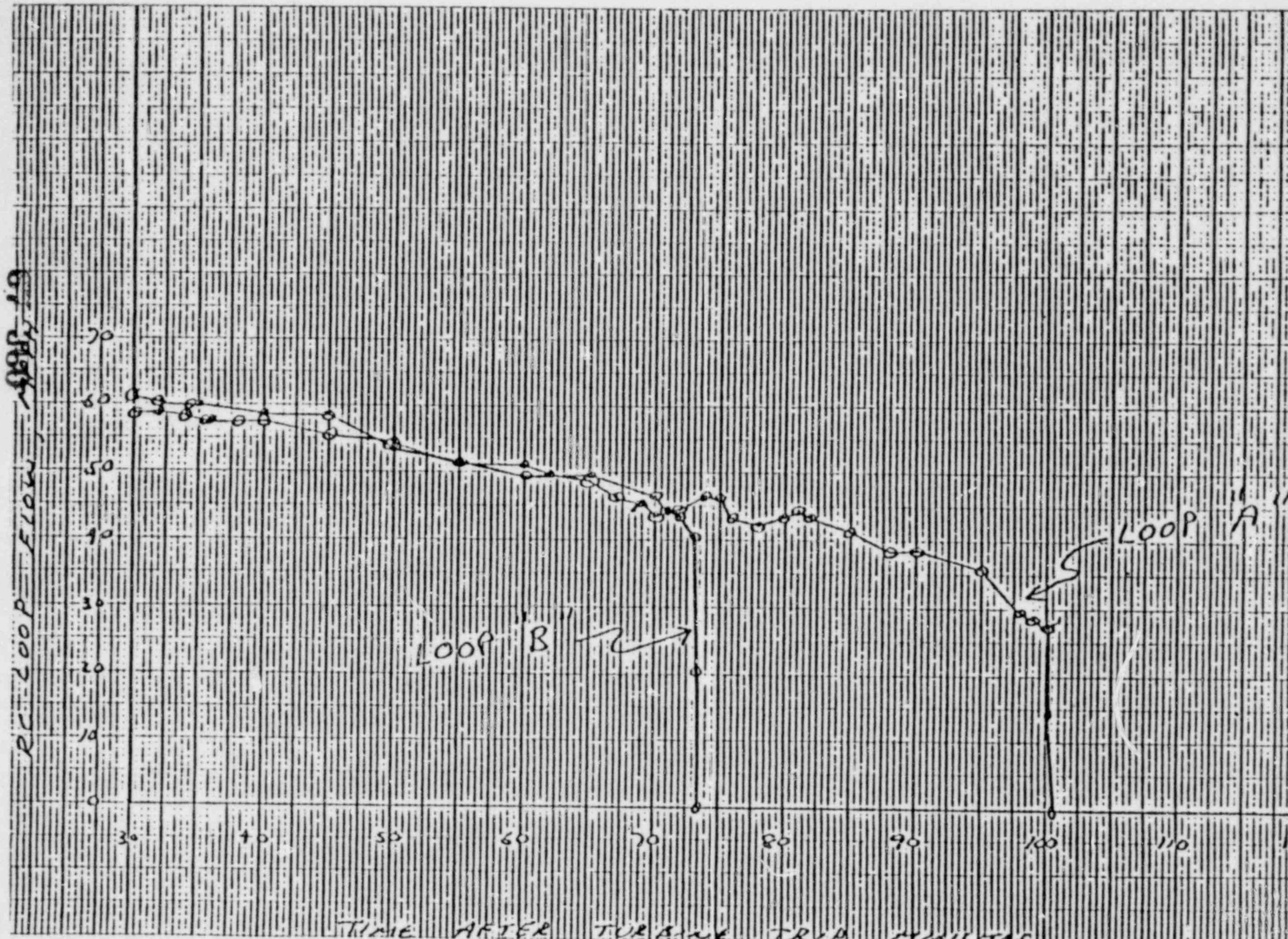
FIG 10

67-359

LCK TO W H Spangler

K+E 10 X 10 TO 1/2 INCH 7 X 10 INCHES KEUFFEL & ESSER CO. 46 1320

TMI-2 LOFW 0400 3/28/79



K·E 10 X 10 TO 1/2 INCH 7 X 10 INCHES KEUFFEL & ESSER CO. 46 1320

LCR to W. H. Spangler

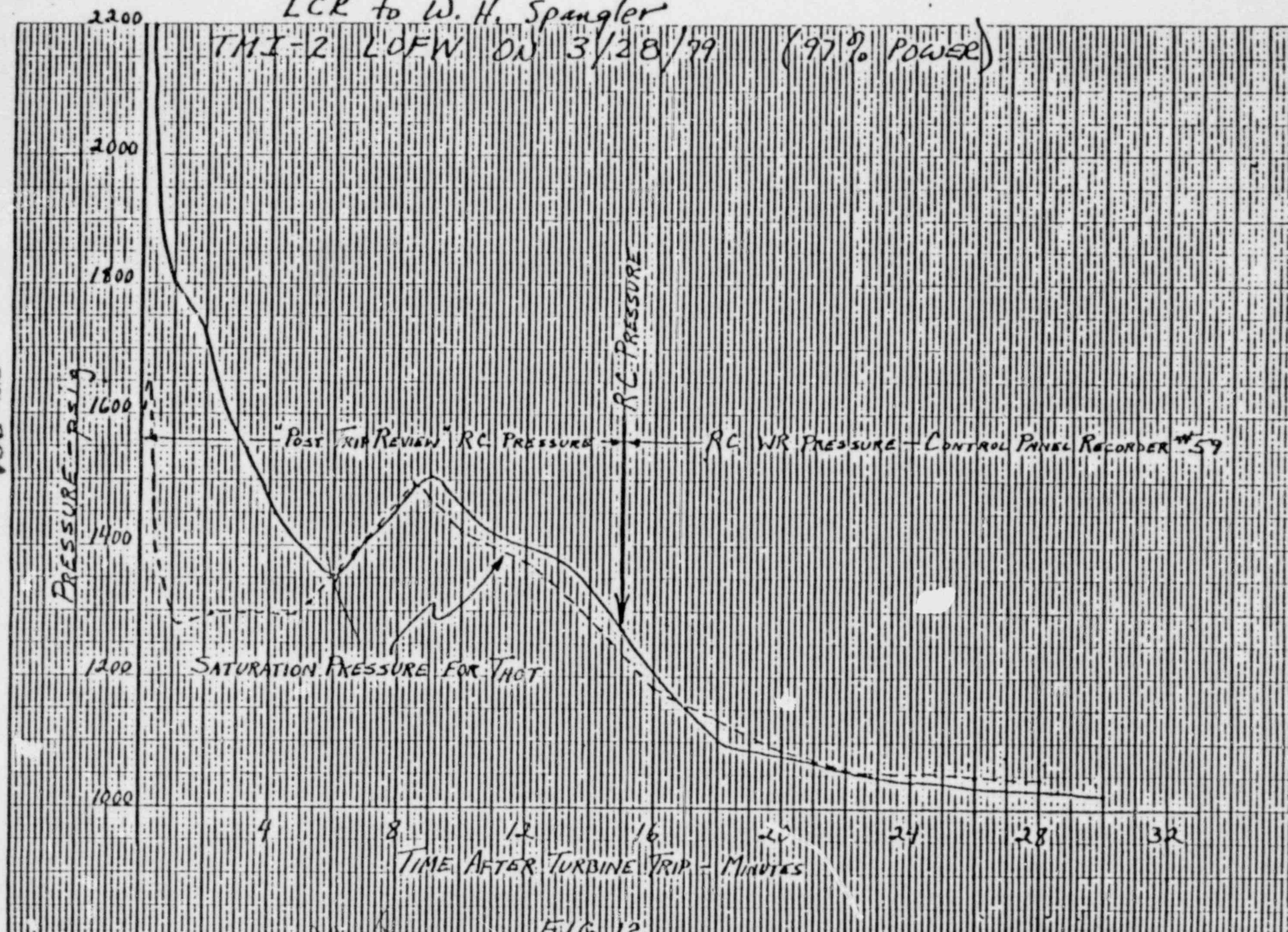
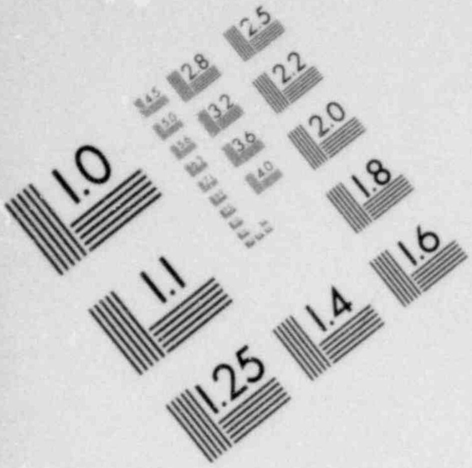


FIG 12

67-361



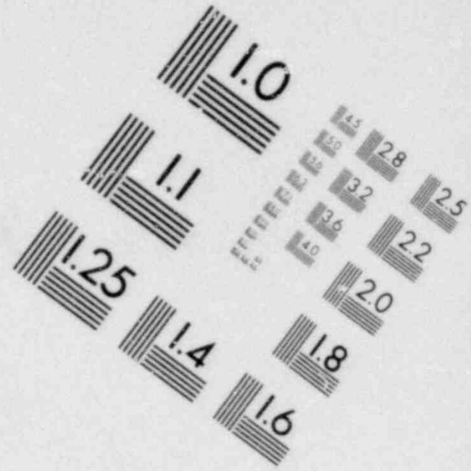
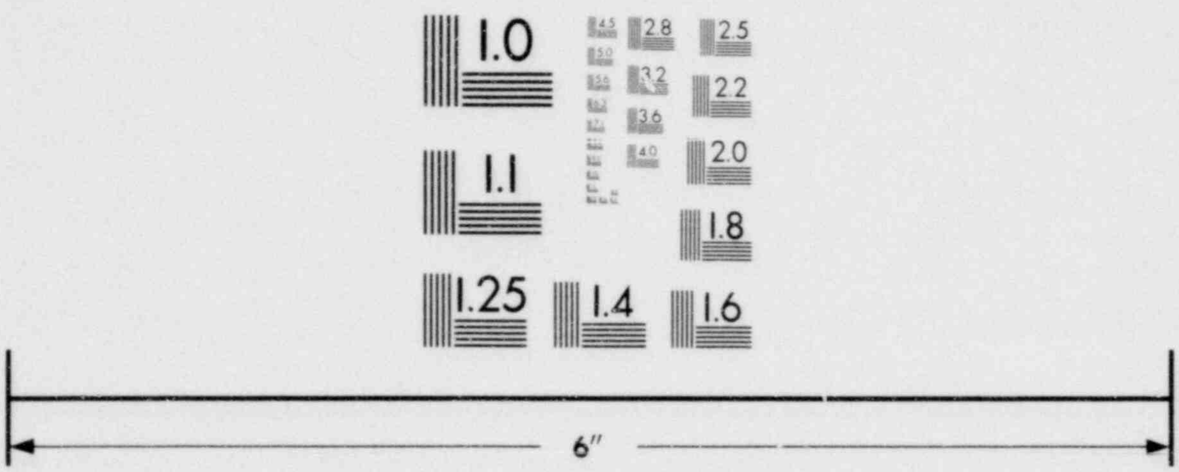
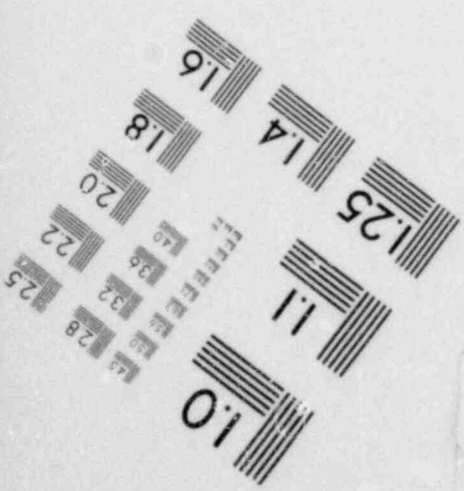
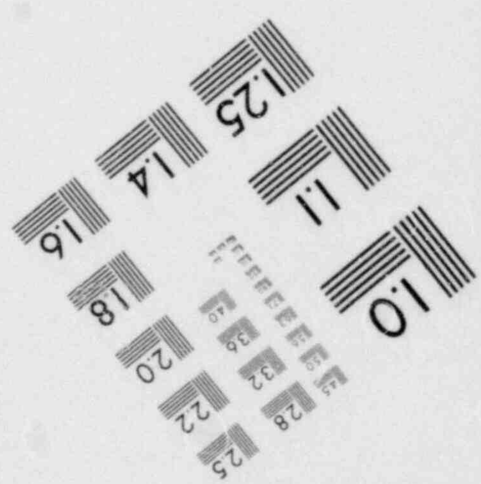


IMAGE EVALUATION TEST TARGET (MT-3)







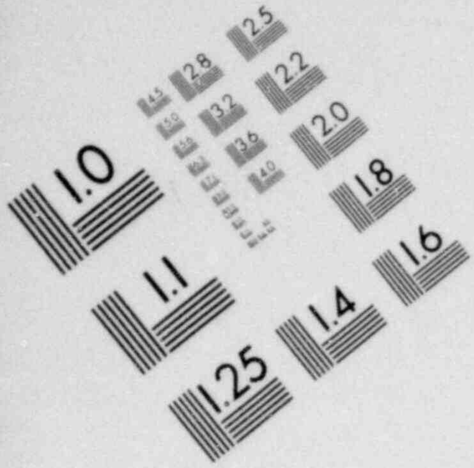
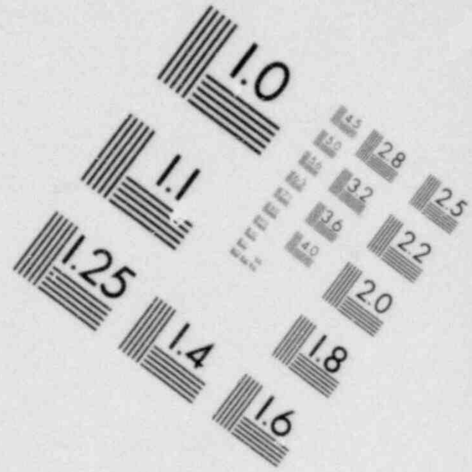
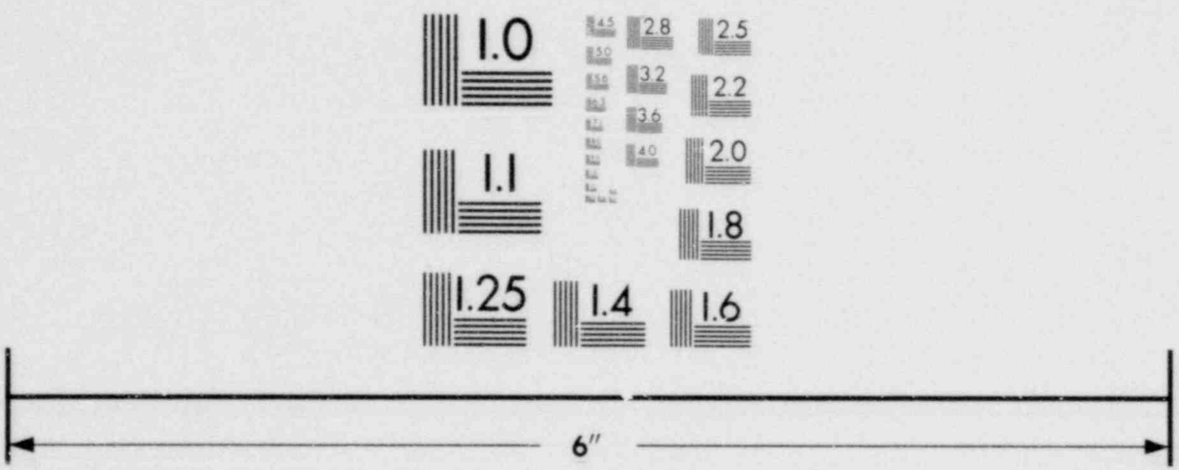



IMAGE EVALUATION
TEST TARGET (MT-3)



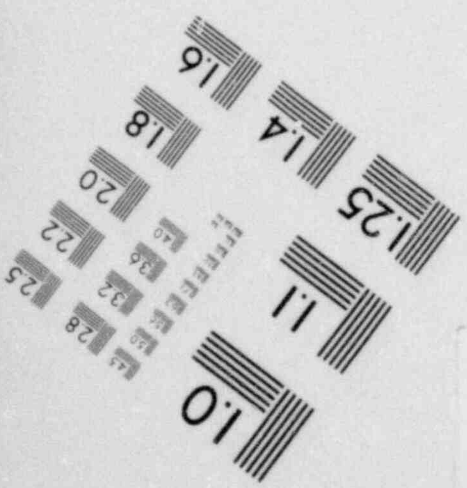
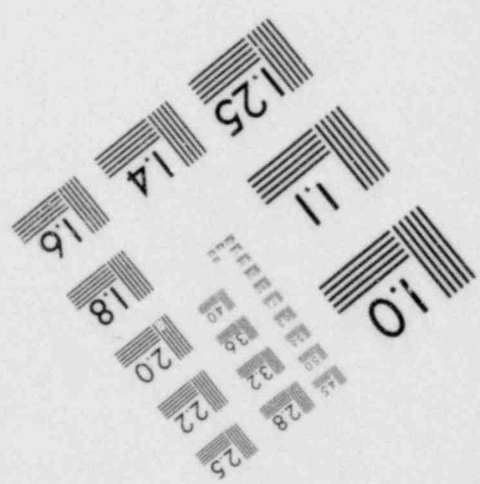



IMAGE EVALUATION TEST TARGET (MT-3)

6″

LCR to WH Spangler 0350 3/30/79

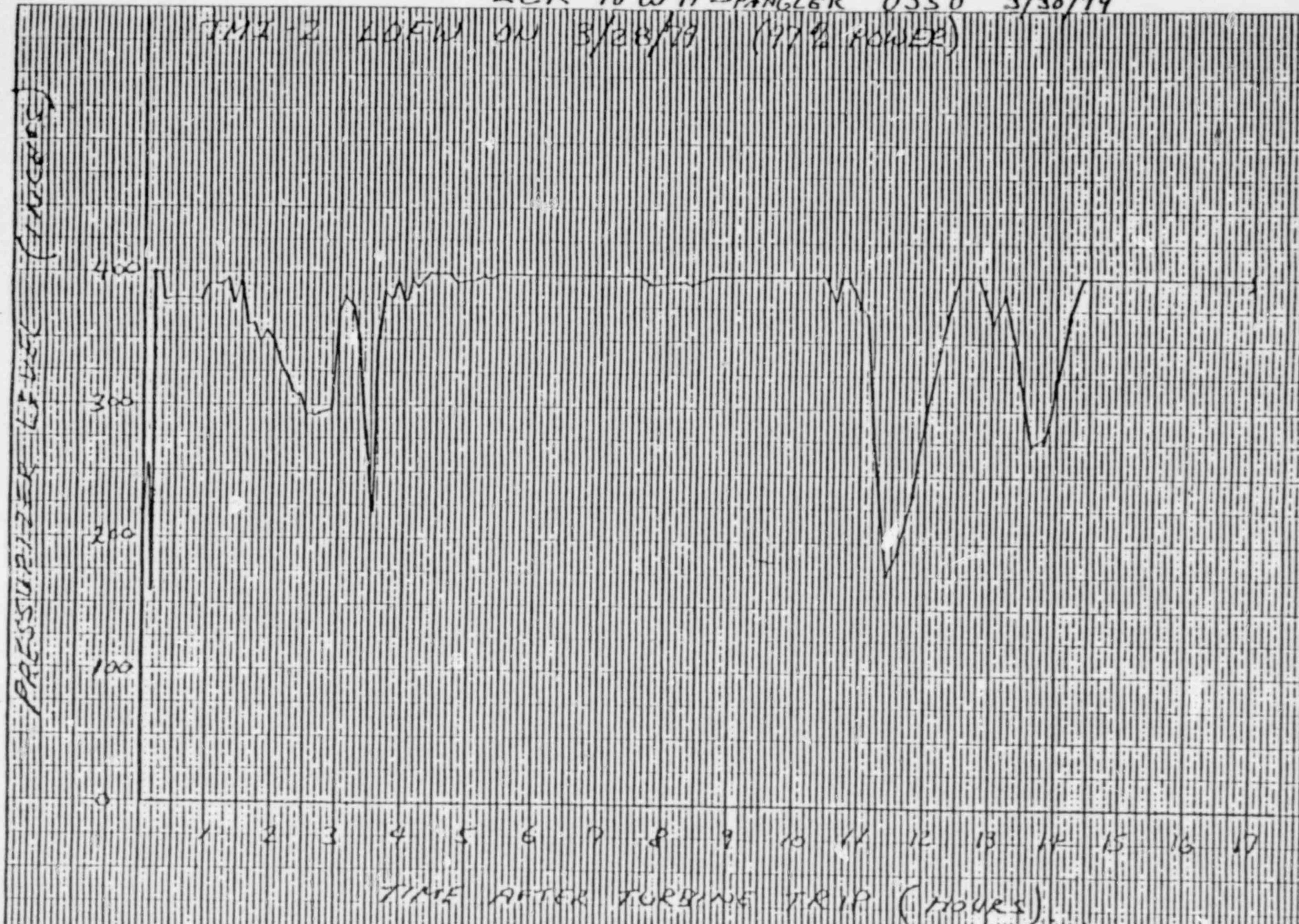


FIG 13

100 89

K·E 10 X 10 TO ½ INCH 7 X 10 INCHES KEUFFEL & ESSER CO. MADE IN U.S.A. 46 1320

200-89

LCR to WH SPANGLER 0830 3/30/79

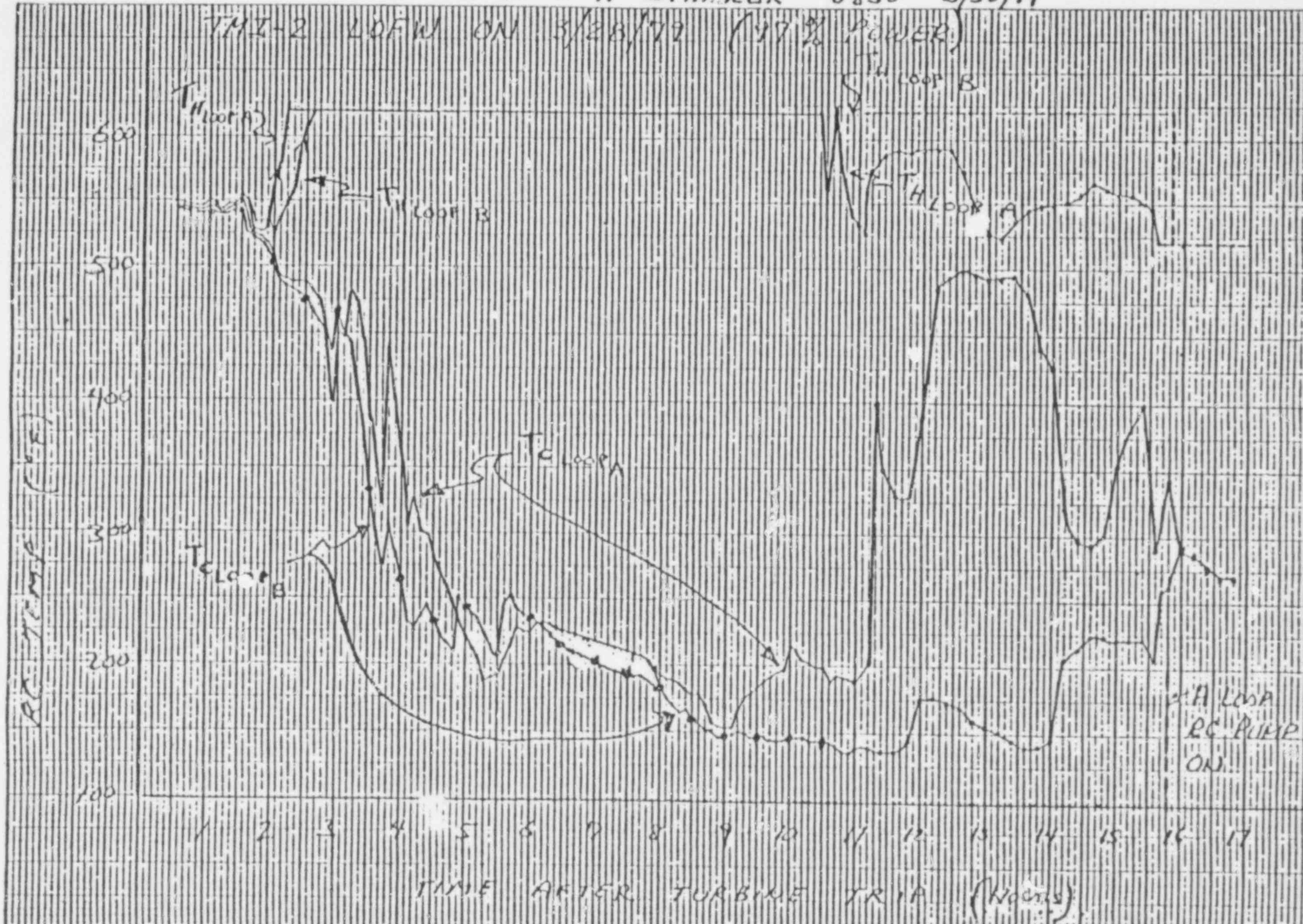


FIG. 14

LCR to W H SPANGLER 0840 3/30/79

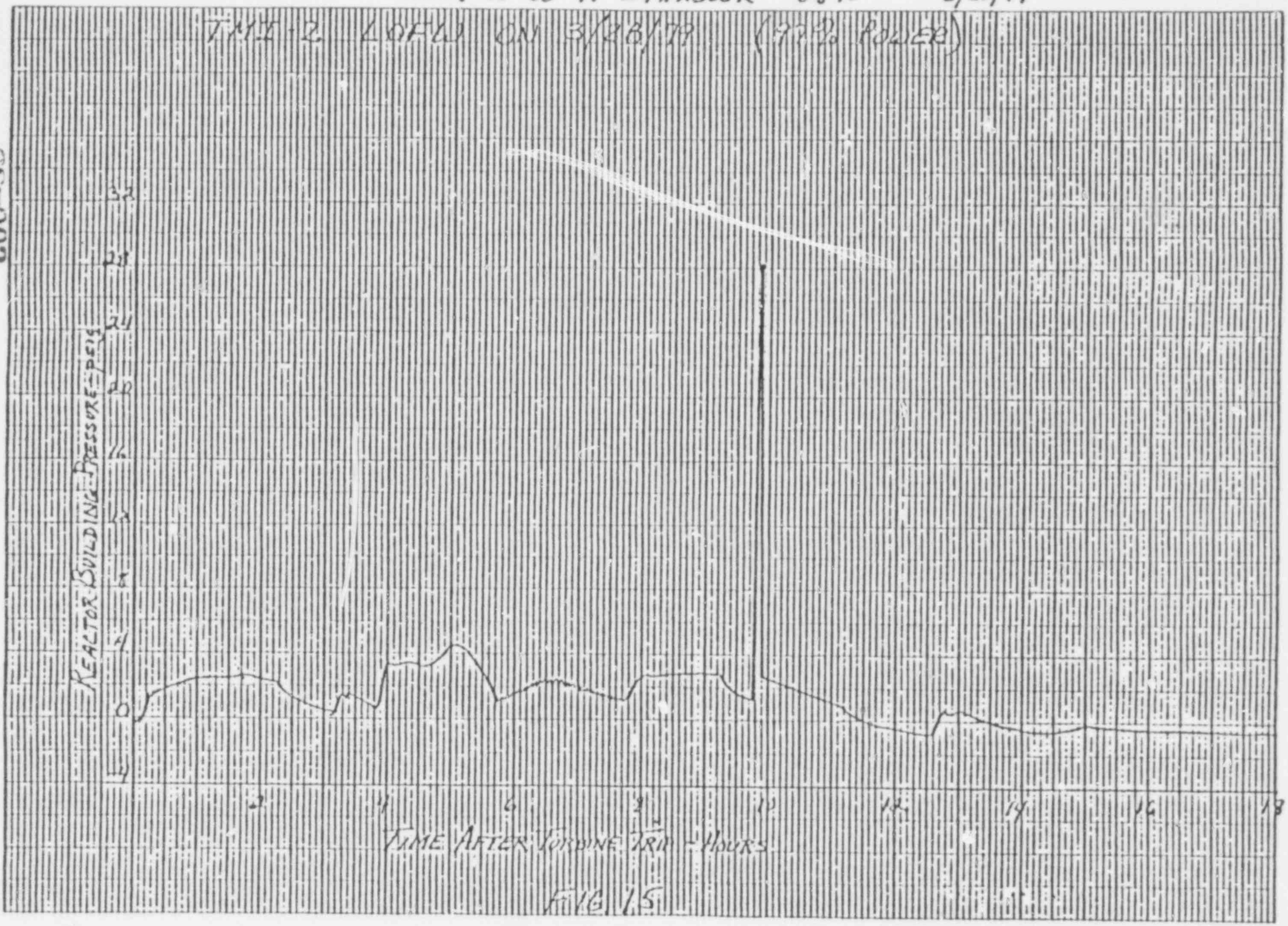


FIG 15

LCR to WH SPANGLER 0845 3/30/79

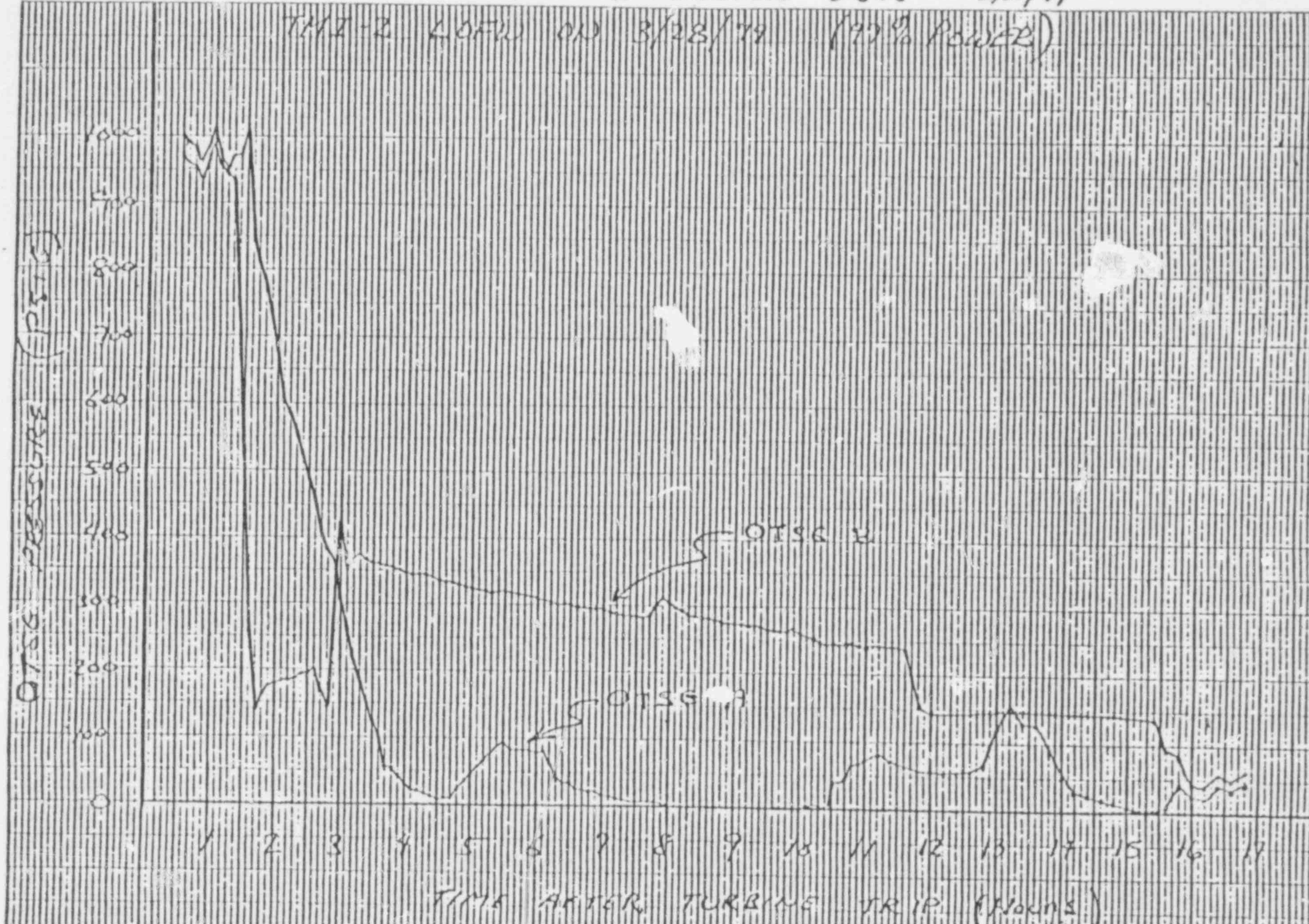
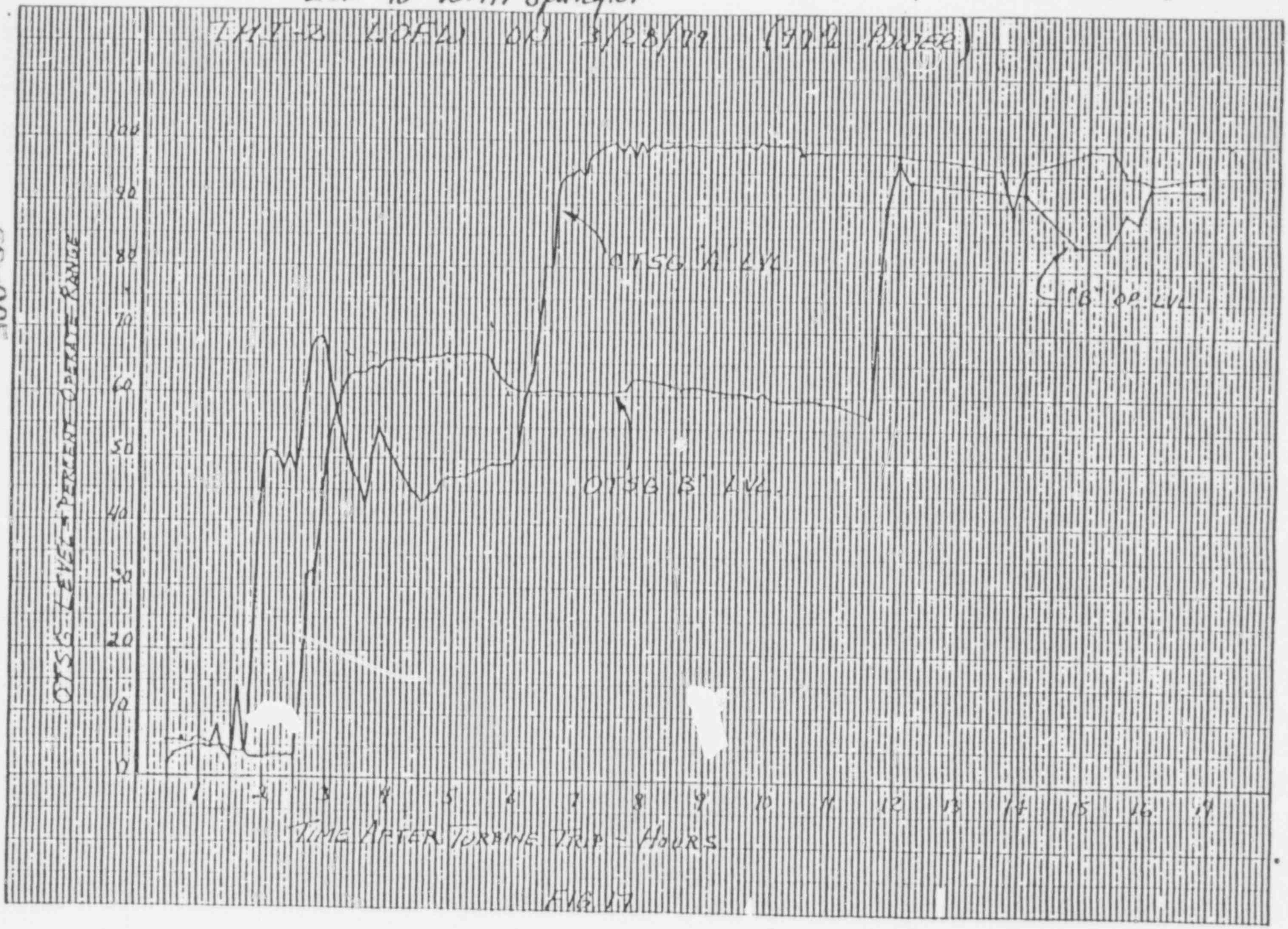


FIG. 16

K+E 10 X 10 TO ½ INCH 7 X 10 INCHES KEUFFEL & ESSER CO. 46 1320

LCR to W. H. Spangler



68-005

LCR to W.H. Spangler

FIG 18

68 006

LCR to W.H. Spangler

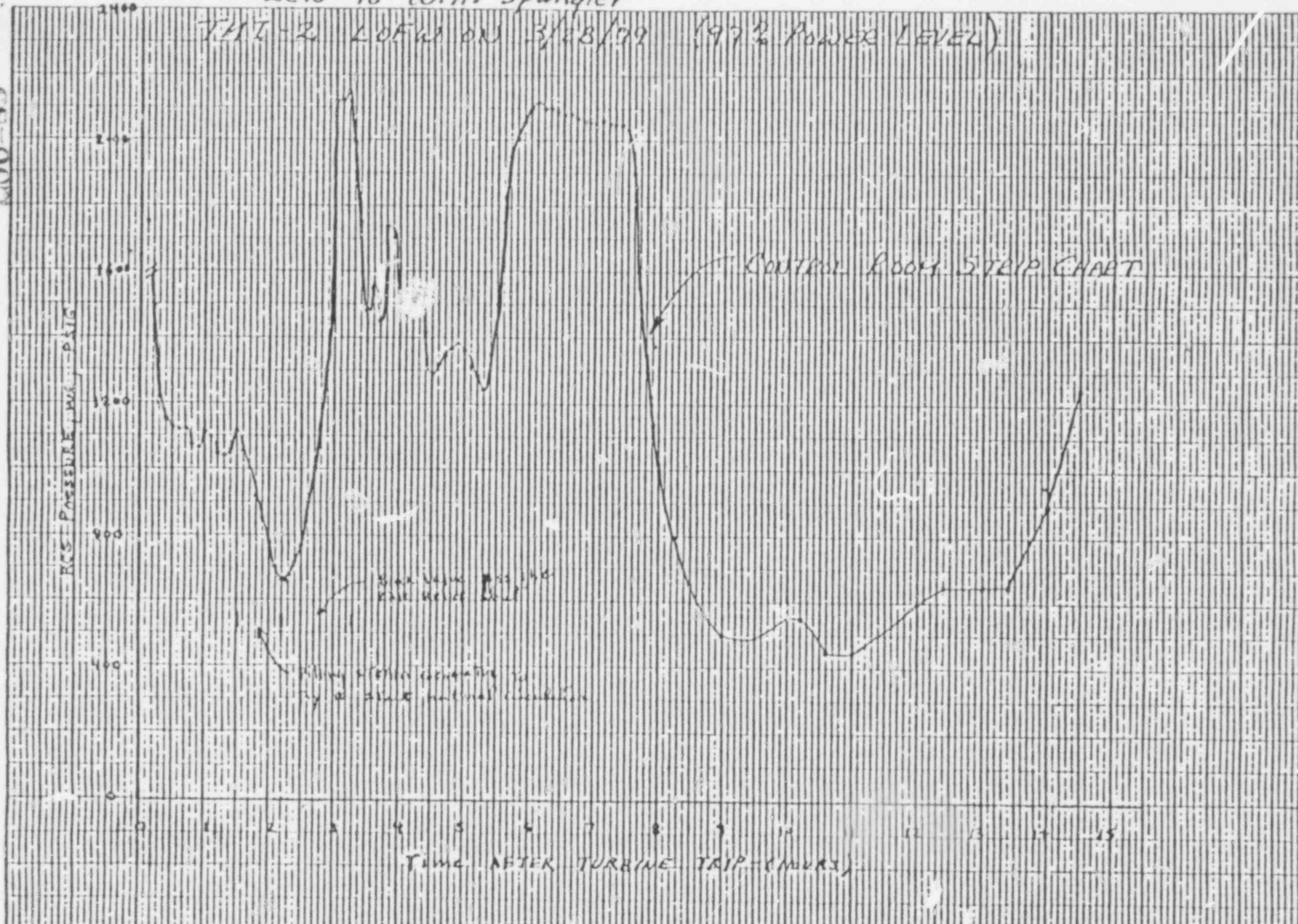


FIG 19

800 089

K·E 10 X 10 TO ½ INCH 7 X 10 INCHES KEUFFEL & ESSER CO. MADE IN U.S.A.   46 1320

ICP to W. H. Spangler

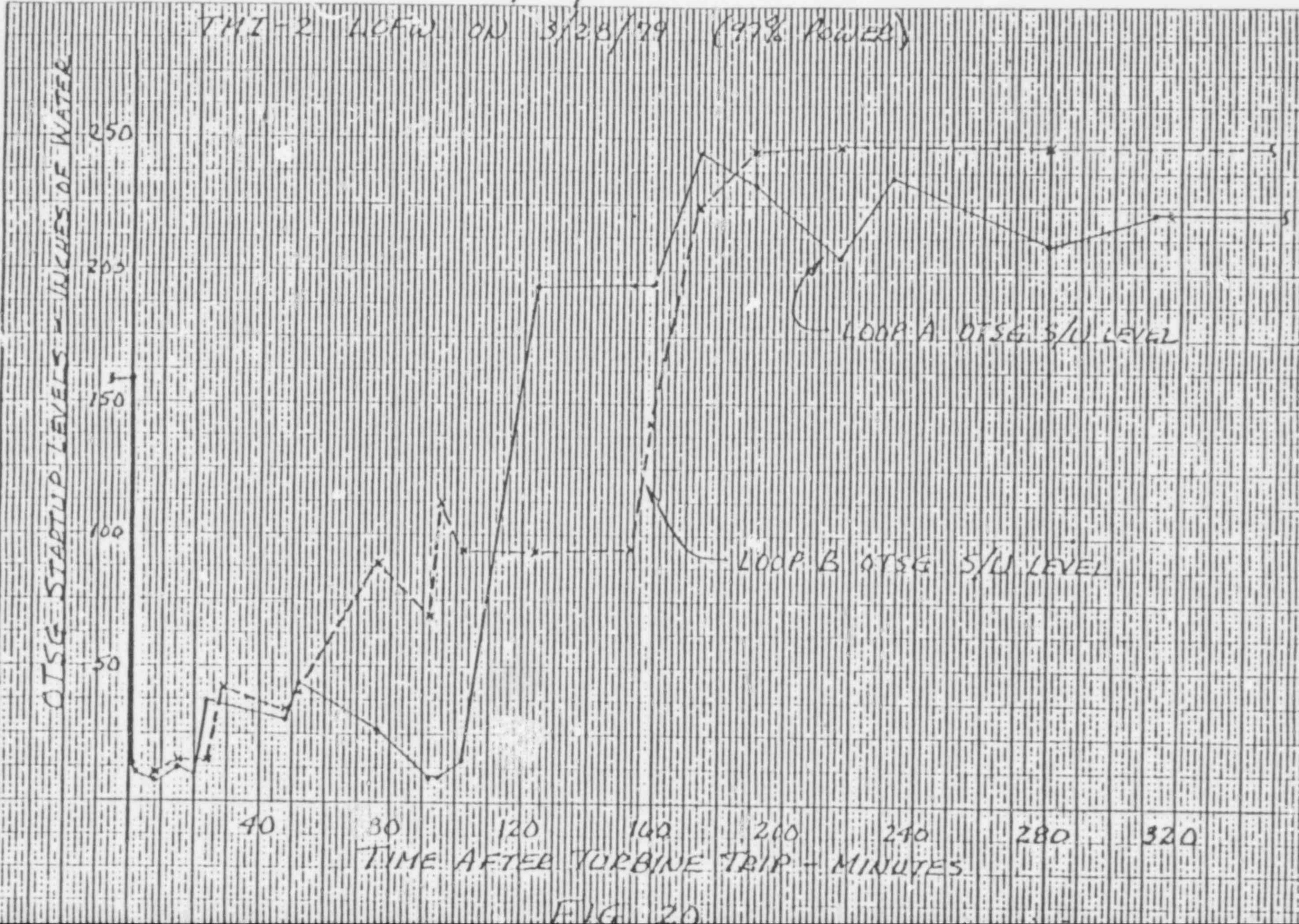
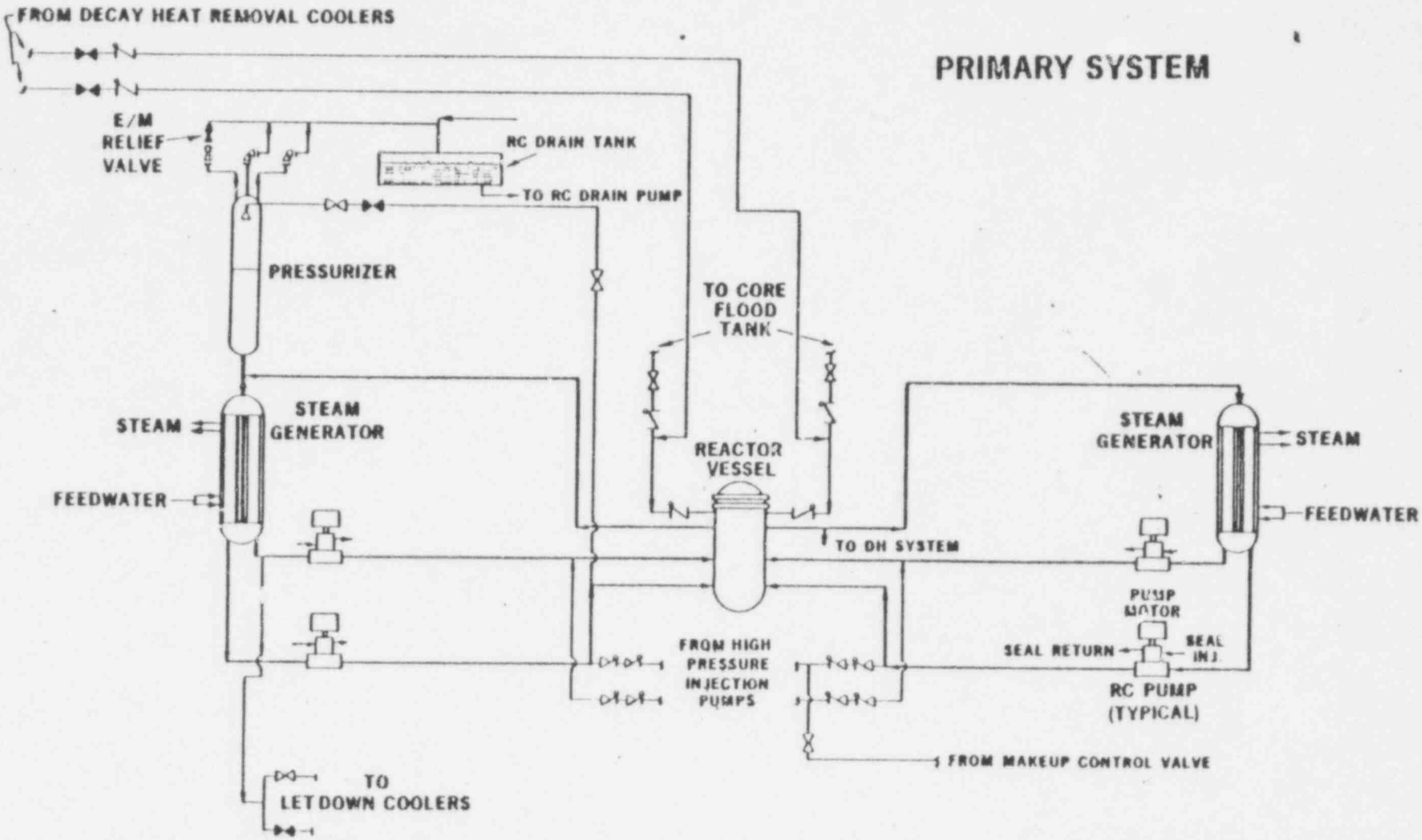


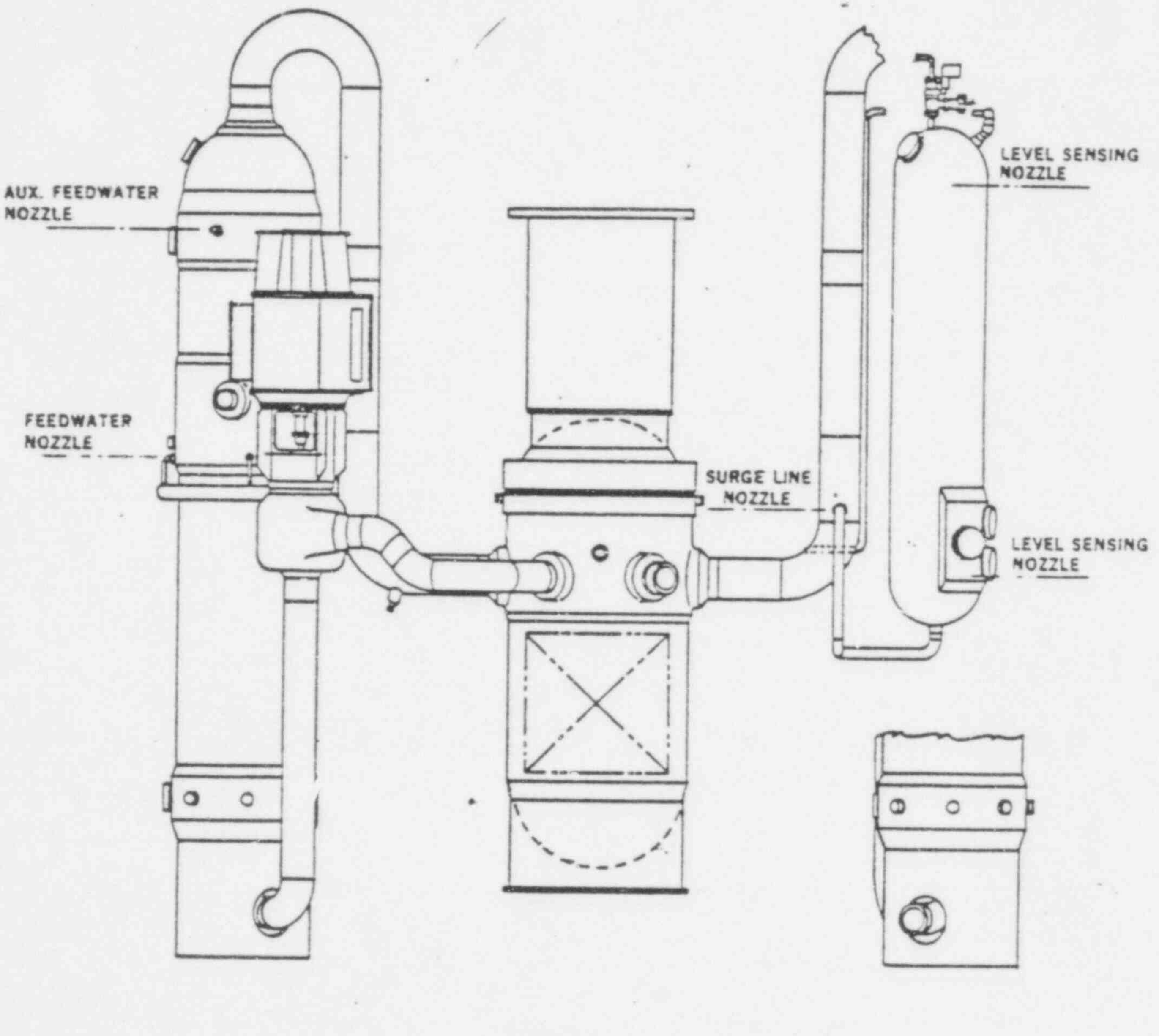
FIG. 20

800 89

PRIMARY SYSTEM



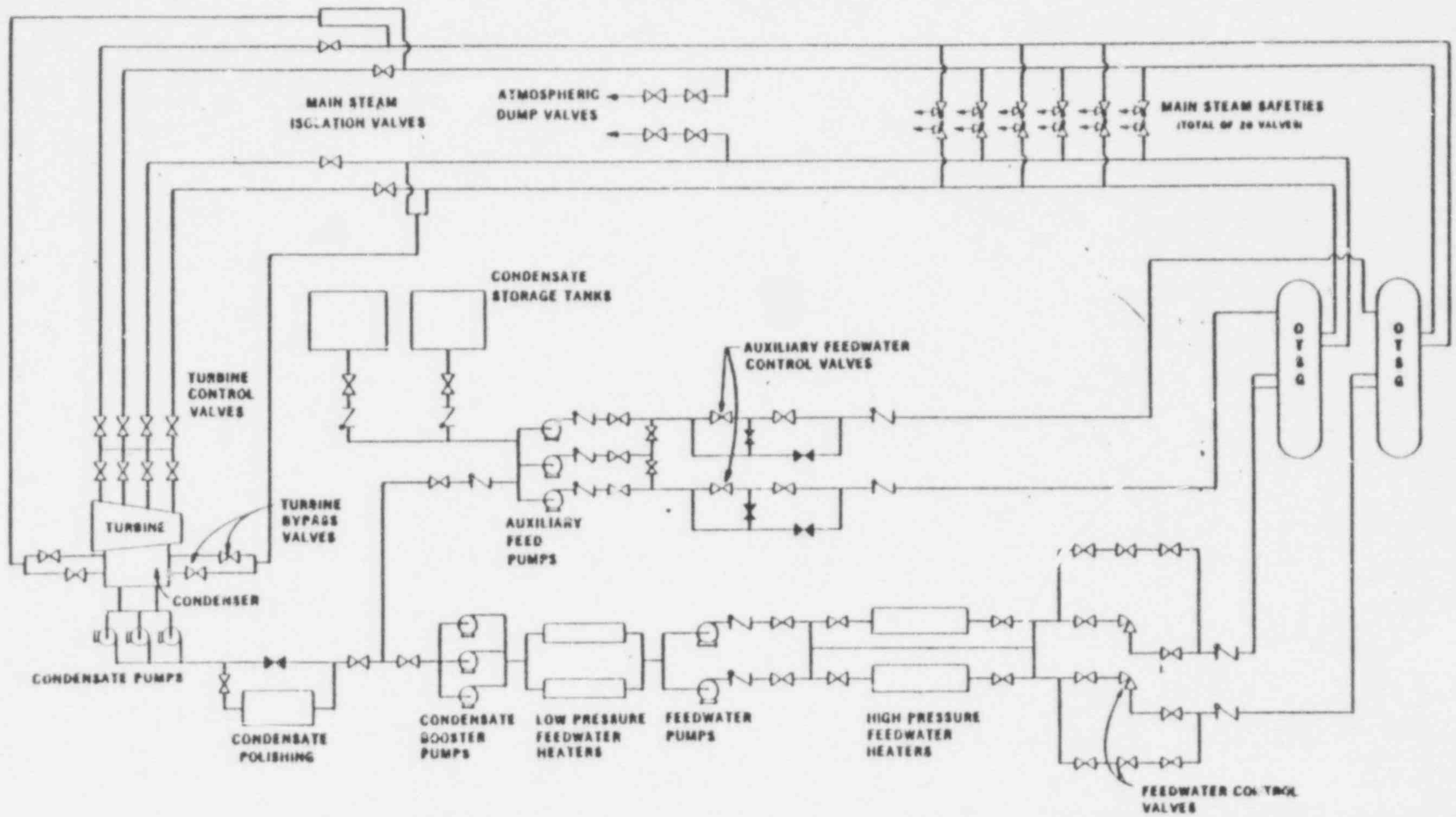
NUCLEAR STEAM SYSTEM



68-010

31

SECONDARY SYSTEM



68 011

SIX SIGNIFICANT FACTORS

DELAYED AUXILIARY FEEDWATER

- PILOT-OPERATED PRESSURIZER RELIEF VALVE NOT RESEATING AND LACK OF RECOGNITION OF THIS EVENT
- SECURING HIGH PRESSURE INJECTION PREMATURELY
- CONTAINMENT ISOLATION
- INAPPROPRIATE EMPHASIS ON PRESSURIZER LEVEL INDICATION
- SECURING REACTOR COOLANT PUMPS

PRINCIPLES FOR CONSIDERING FUTURE ACTIONS

- ASSURANCE THAT SYSTEMS IMPORTANT TO SAFETY ARE AVAILABLE
- FOCUS ON FUNDAMENTAL PHYSICAL PROCESSES WHICH ASSURE CORE COOLING
- CONSIDER ALL ACTIONS IN THE CONTEXT OF TOTAL PLANT SAFETY

TMI-2 INCIDENT TRAINING

SCOPE

- DISCUSSION OF TMI-2 TRANSIENT
- SIMULATOR DEMONSTRATION
- HANDS-ON OPERATOR INCIDENT RECOVERY TRAINING
- ALL REACTOR OPERATORS

DURATION 1 DAY

START DATE APRIL 9, 1979

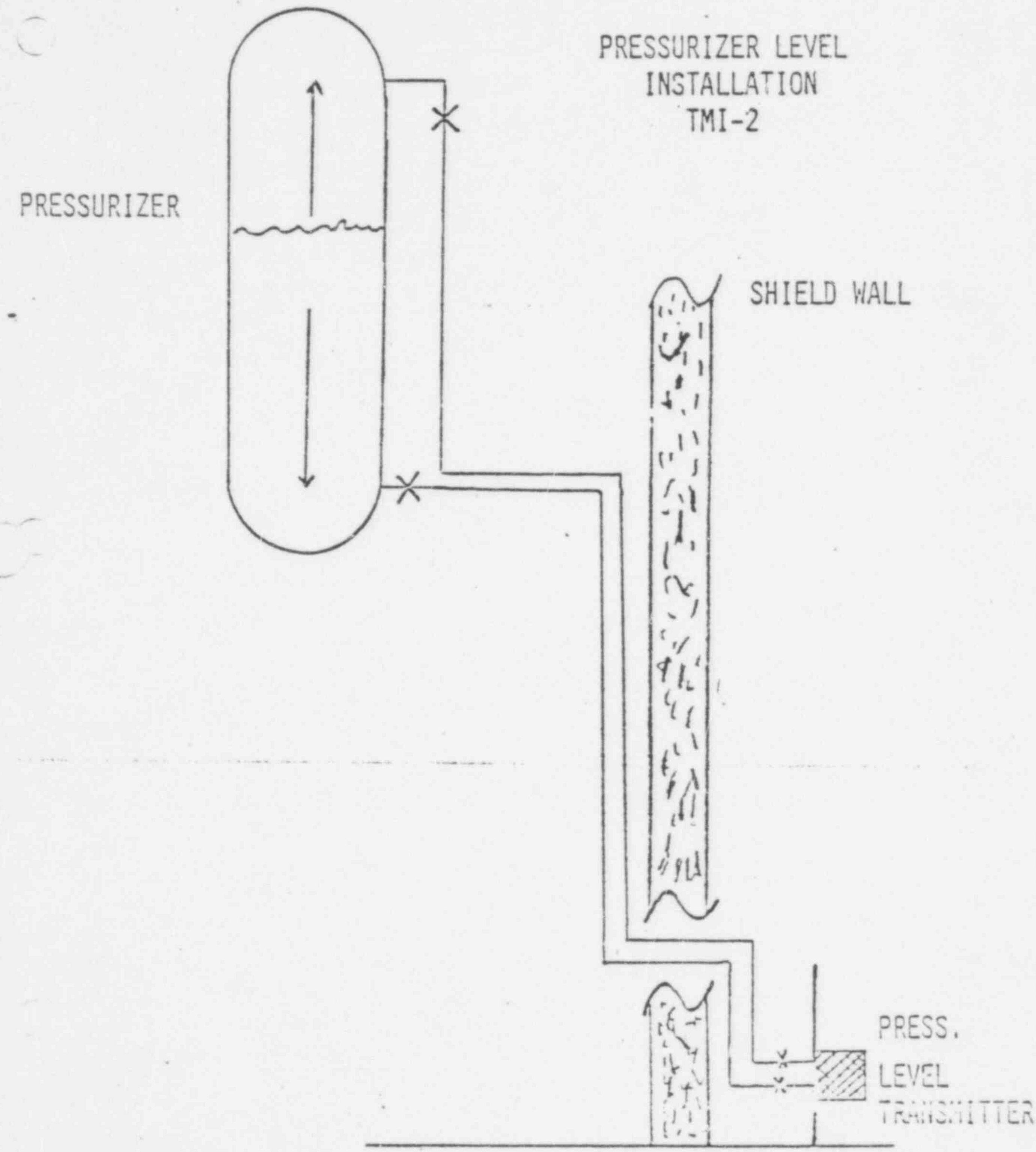
68 014

35

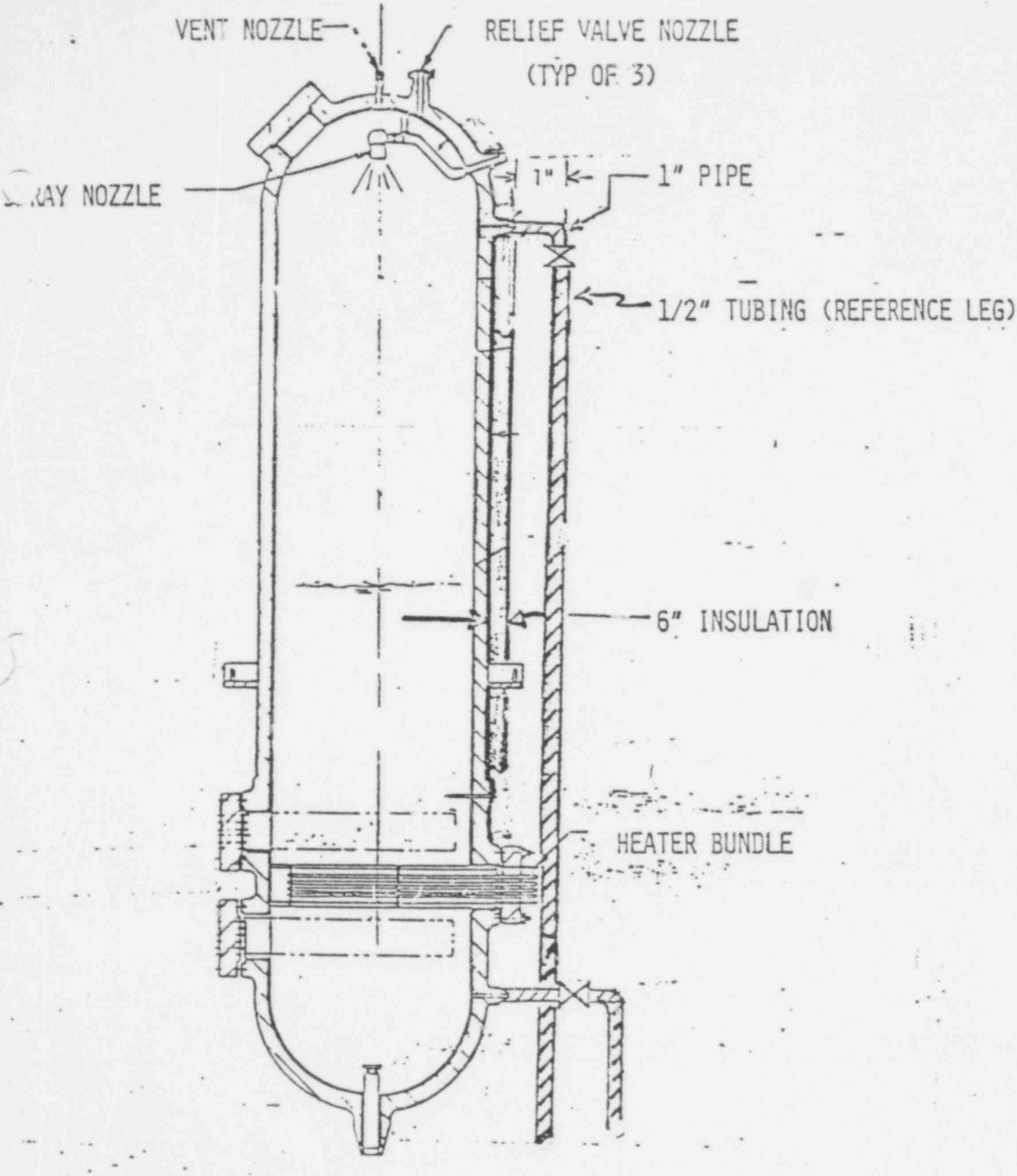
TMI-2 OCCURRENCE - TECHNICAL REVIEW COMMITTEE

CHARTER

- REVIEW TECHNICAL ASPECTS OF THE TMI-2 OCCURRENCE
- DEVELOP RECOMMENDATIONS FOR EQUIPMENT IMPROVEMENTS, OPERATOR INTERFACE, RECOVERY REQUIREMENTS AND INCIDENT SUPPORT.
- ASSESS IMPACT OF THE TMI-2 OCCURRENCE AND POTENTIAL RESULTING CHANGES IN REGULATORY REQUIREMENTS ON NUCLEAR POWER GENERATION DIVISION TECHNICAL ACTIVITIES.


PRESSURIZER LEVEL
INSTALLATION
TMI-2
PRESSURIZER
SHIELD WALL
PRESS.
LEVEL
TRANSMITTER

68-016

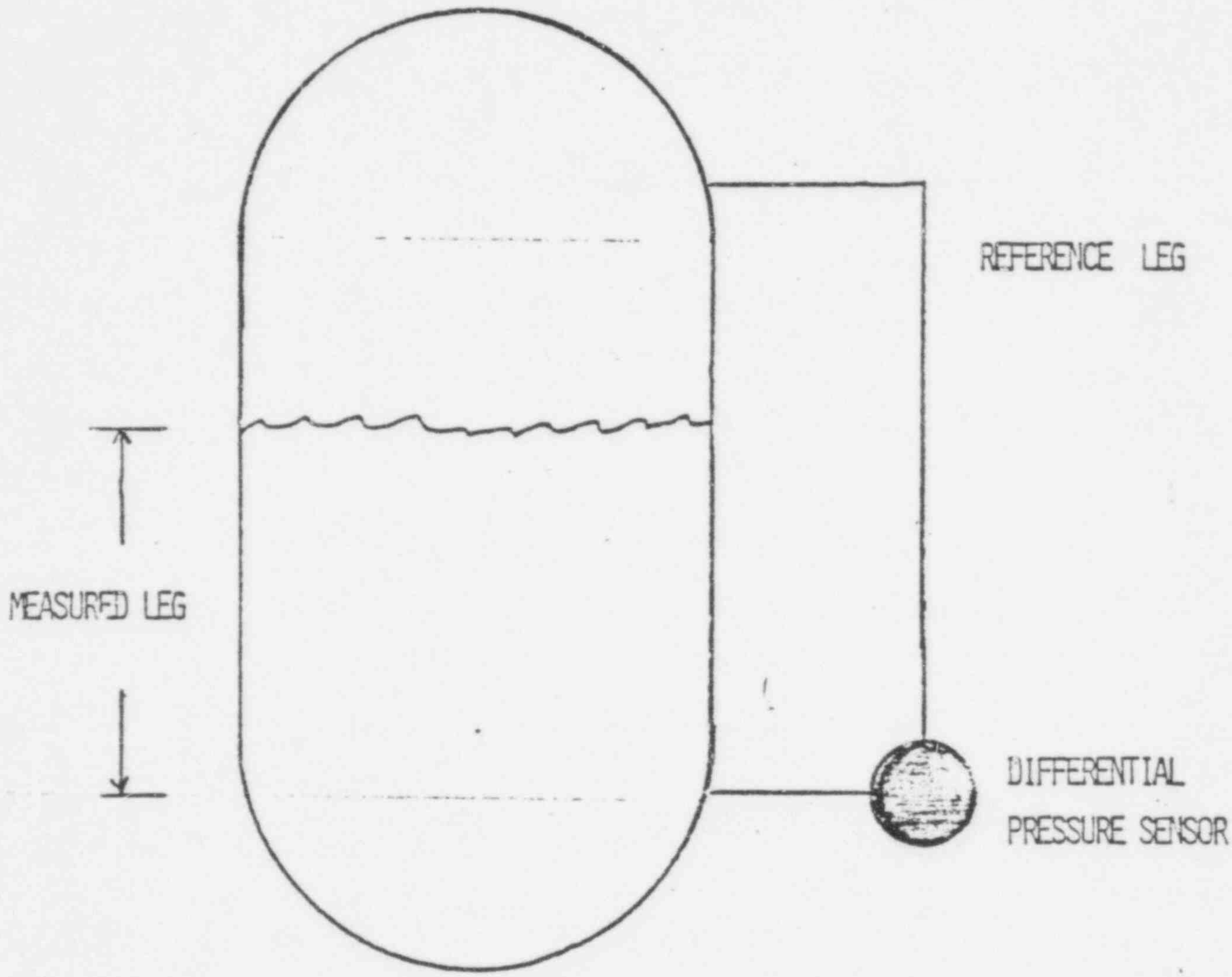


PRESSURIZER

THREE MILE ISLAND NUCLEAR STATION UNIT 2

68-017

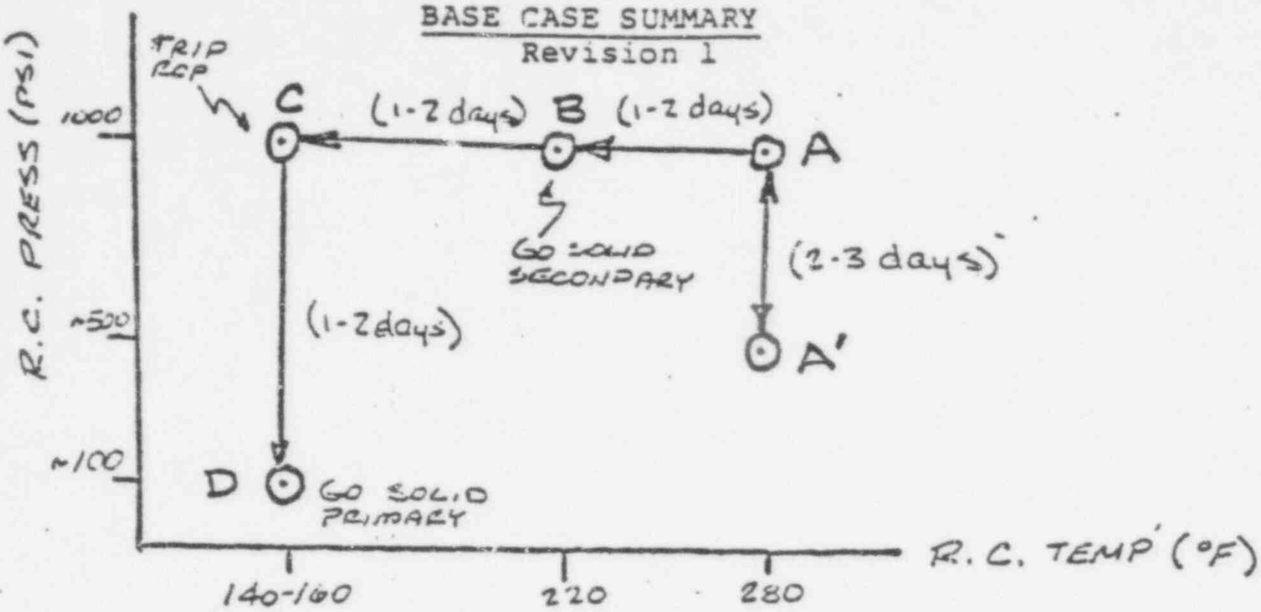
MEASURING PRINCIPLE



68 018

4/6/79
1100 hrs.

TMI RECOVERY
BASE CASE SUMMARY
Revision 1



(1) Degas at A; Lower Pressure (A→A') while degassing, then return to A.

(2) Continue Design/Installation of static and active systems for primary makeup/pressure control and secondary cooling system for "B" S/G.

(3) Reduce temperature (A→B) by steaming on "A" S/G

(4) Take "A" S/G solid - drop primary temp. to minimum (B→C)

(5) Trip RC Pump "A" - Establish natural convection - Establish cooling to "B" S/G if available.

(6) Drop primary pressure to selected value (C→D)

(7) Take primary system solid - Control pressure & makeup with static or new active system

END POINT

Primary - Natural Circ, solid liquid, Long-term P/V Control

Secondary - Solid water, Long-term Heat Dump System

Approved for Issue:

R. Arnold

RA:clb

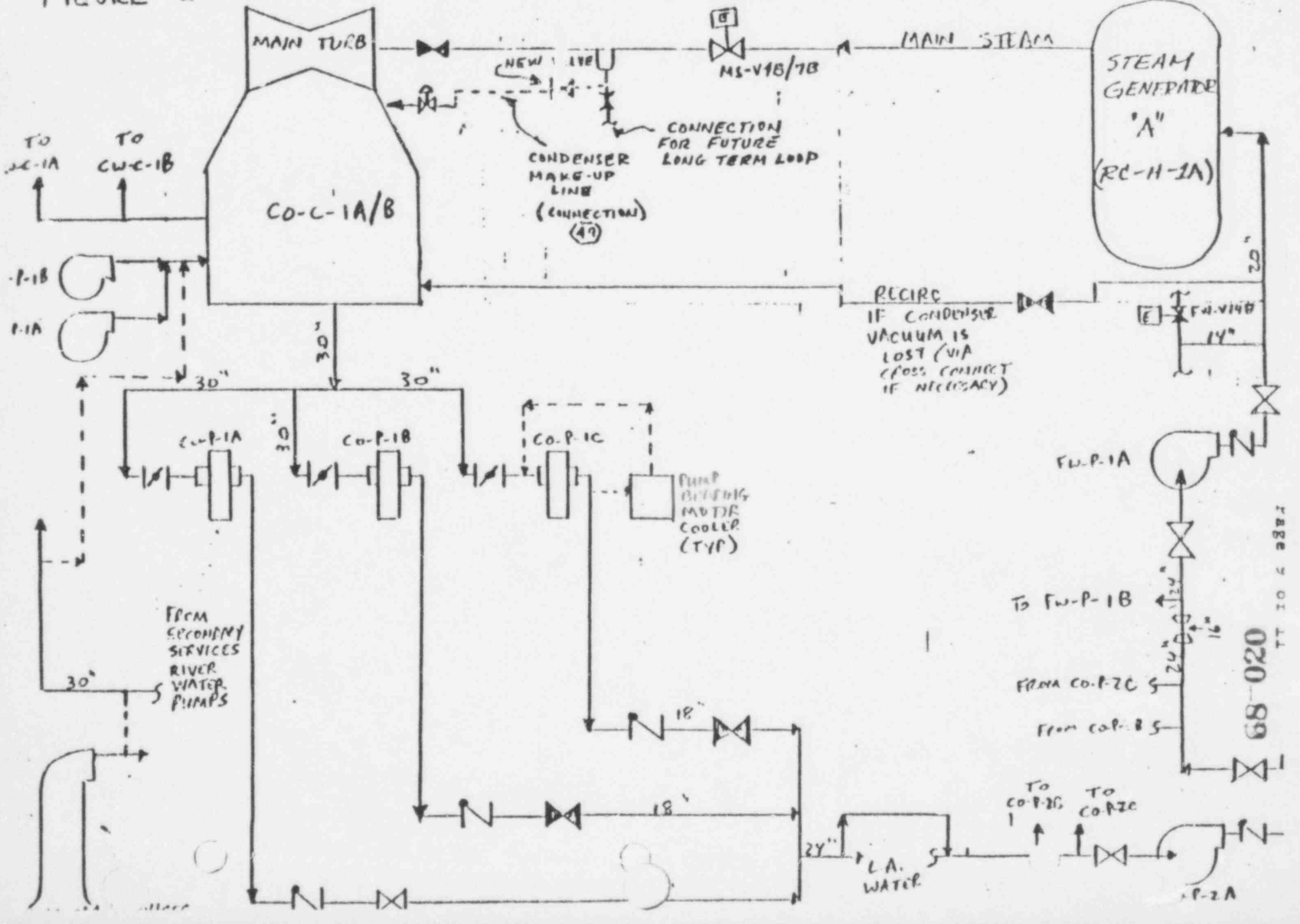
68-019

40

SHORT TERM- STEAM GENERATOR "A"

REV. 1 4/17/79
17:00

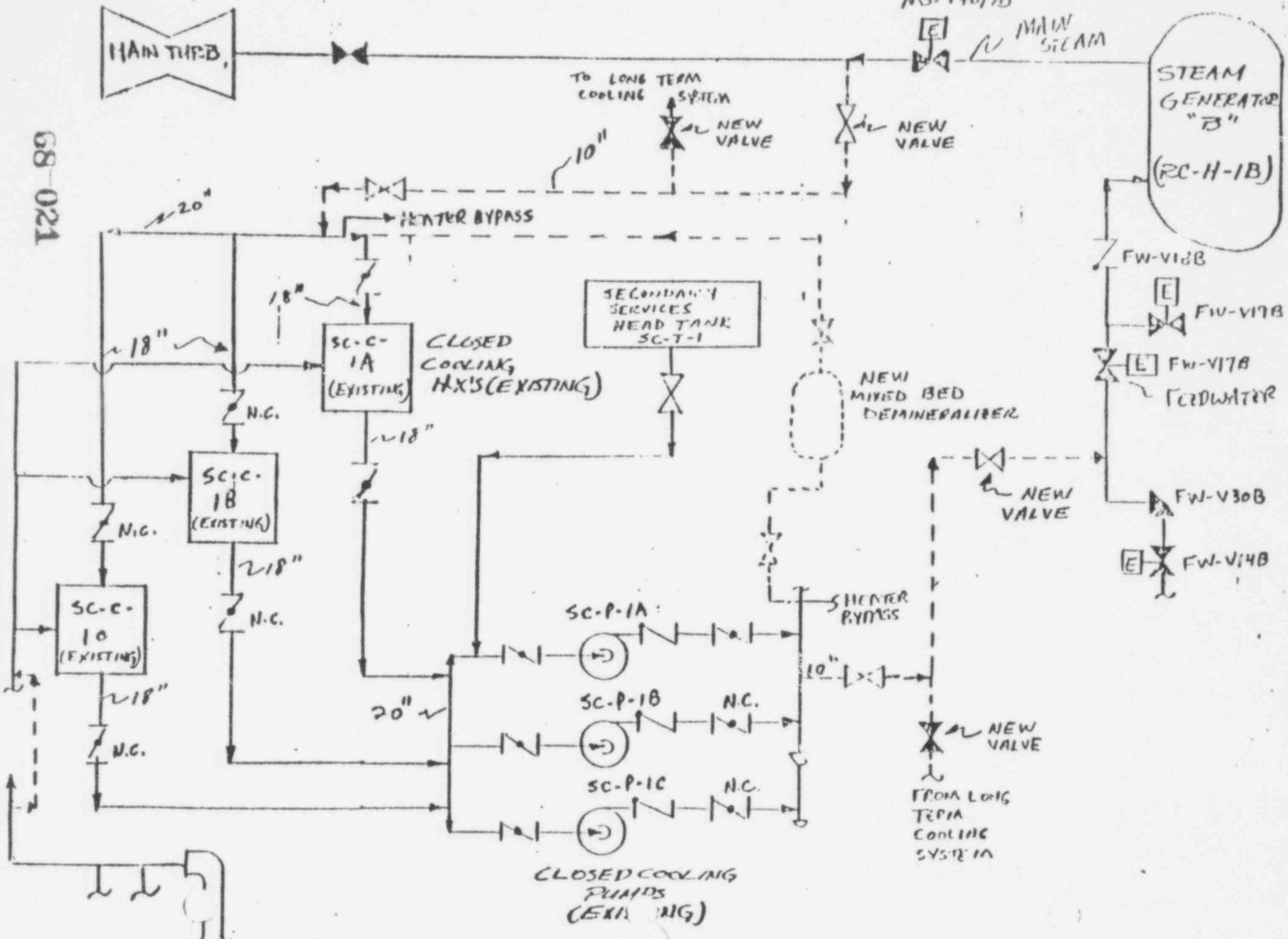
FIGURE 1



68-020

SHORT TERM- STEAM GENERATOR B

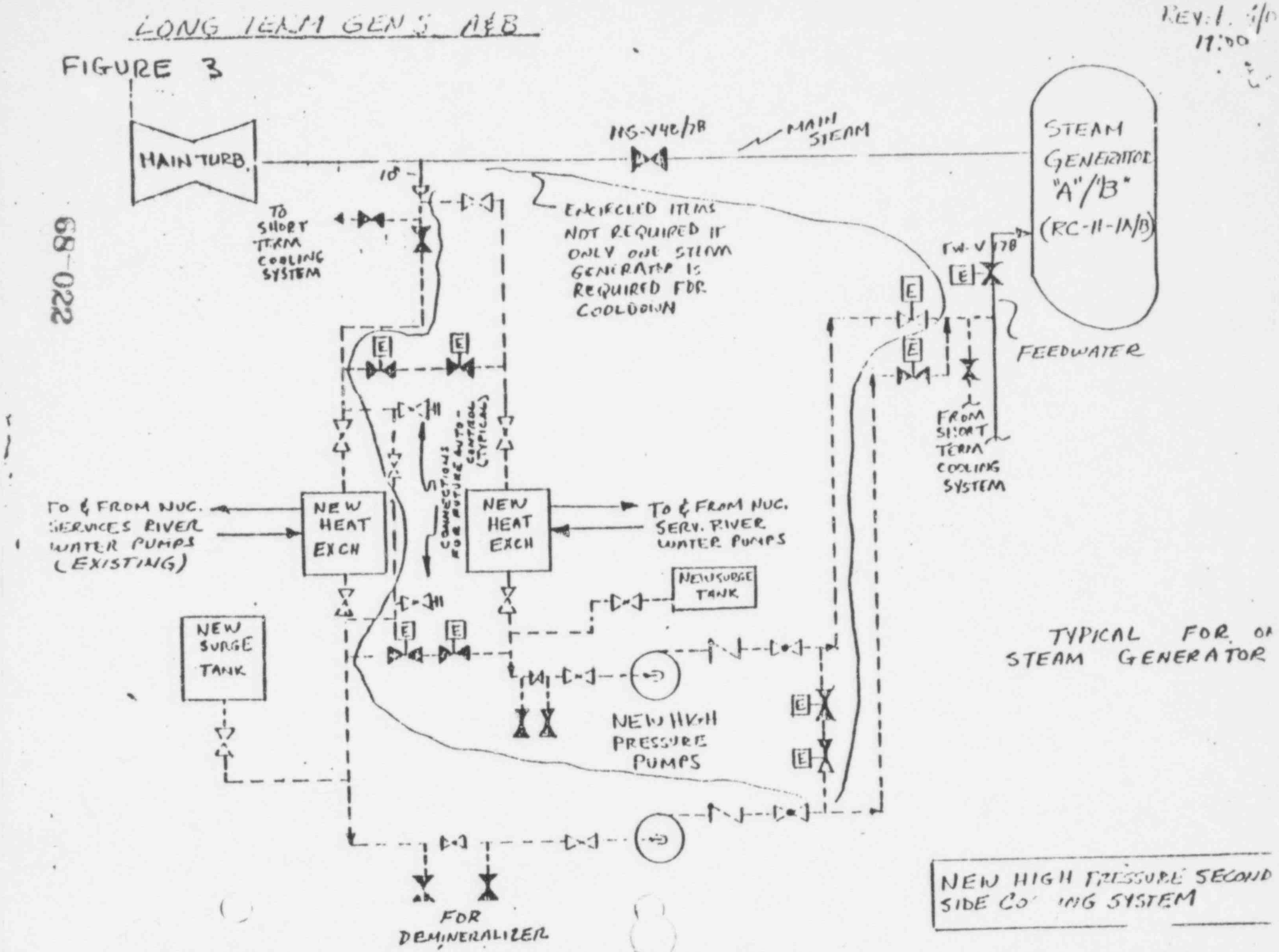
FIGURE 2



68-021

LONG TERM GEN'S AEB

FIGURE 3



TYPICAL FOR ONE STEAM GENERATOR

NEW HIGH PRESSURE SECOND SIDE CO[illegible]ING SYSTEM

68-022

NUCLEAR REGULATORY COMMISSION

ADVISORY COMMITTEE ON REACTOR SAFEGUARDS

IN THE MATTER OF:

SPECIAL MEETING

Place - Washington, D.C.

Date - Tuesday, 17 April 1979 **Pages** 335-466

Telephone:
(202) 347-3700

ACE - FEDERAL REPORTERS, INC.

Official Reporters

444 North Capitol Street
Washington, D.C. 20001

68-023

NATIONWIDE COVERAGE - DAILY

7904230171

PUBLIC NOTICE BY THE

UNITED STATES NUCLEAR REGULATORY COMM. ION'S

ADVISORY COMMITTEE ON REACTOR SAFEGUARDS

Tuesday, 17 April 1979

The contents of this stenographic transcript of the proceedings of the United States Nuclear Regulatory Commission's Advisory Committee on Reactor Safeguards (ACRS), as reported herein, is an uncorrected record of the discussions recorded at the meeting held on the above date.

No member of the ACRS Staff and no participant at this meeting accepts any responsibility for errors or inaccuracies of statement or data contained in this transcript.

Ace-Federal Reporters, Inc.

68 024

CR 4126

UNITED STATES OF AMERICA

NUCLEAR REGULATORY COMMISSION

Advisory Committee on Reactor Safeguards

Special Meeting

Room 1046, 1717 H Street, N.W.,
Washington, D.C.

Tuesday, 17 April 1979

The Special Meeting was called to order, pursuant to adjournment, at 8:30 a.m., Dr. Max W. Carbon presiding.

PRESENT:

Dr. Max W. Carbon, Chairman
Dr. Milton S. Plesset
Mr. Harold Etherington
Dr. Stephen Lawroski
Mr. William M. Mathis
Dr. David Okrent
Mr. Jeremiah J. Ray
Dr. Paul G. Shewmon
Dr. Chester P. Siess

Also Present:

Raymond F. Fraley, Designated Federal Employee
James F. Jacobs

(Recording of the special meeting was commenced at 9:15 a.m.)

68-025

P R O C E E D I N G S

DR. SIESS. Assuming it was analyzed.

I'm not sure that this particular sequence was analyzed, but it's different, what I think we're interested in. And one aspect of different is worse, or potentially worse, what we're concerned with.

MR. MATHIS: Well, I support Dave's position, except I'd like to move into it a little bit earlier and say that we should concentrate on those items of instrumentation that will assist the operator and give him detection of when he is getting into some trouble and thereby hopefully prevent any kind of an accident. Let's worry about it before the fact rather than after.

DR. OKRENT: I'm in favor of both areas. The thermocouple one was an effort to help him not get into worse difficulty. In any event, as you can certainly tell, I certainly favor them getting a better handle on it before it degrades.

DR. SHEWMON: I guess my feeling is we can write one so vague and general that we'd be another five years having to define it to our satisfaction before we did something--

DR. OKRENT: I think it's true that the Staff can take another five years. I don't know why they took that long this time, in fact, because the matter I think was clearly defined the first time and they persisted in not looking at this I think for some while and finally, after it being some

eb2

years a generic item, started to accept it. And then I didn't understand why they put it in terms of reactors to be built.

I think it is time that we took a fairly strong recommendation on the situation.

DR. SIESS: I agree. I'm just trying not to hang it on Reg. Guide 1.97, which is already hung up.

DR. OKRENT: I tried to say we shouldn't recommend it in terms of 1.97 in the beginning of my comments.

DR. CARBON: Fine. Go on to the next.

DR. SHEWMON: I don't think there is general agreement until we see what we're talking about.

DR. CARBON: Well, to try something.

DR. SIESS: We have 1.97 in the folder. I don't think it will do what we want.

DR. OKRENT: Now an area where I'm left -- what's the word? -- well-versed and feel little bit less sure in my own mind is the following:

For things like, for example, the need for natural circulation or for things like the need for systems that have to work if you lose main feedwater or so forth, one can ask the question whether there can be steps taken in the current operation to reduce the frequency of challenge of systems that have to work.

Now one question I raised yesterday was whether, for example by using base load or base load most of the time

eb3

rather than load following, that would lead to a signif-cant difference in this sort of situation. Again I don't have any direct knowledge, any specifics and so forth.

There may be other things one could do to decrease the frequency of challenge. I do have the feeling that there were quite a few challenges arising from the feedwater incidents, for example, but they weren't related to the question of base load or load following. Maybe certain kind of challenges do go that way.

I'm not in a position to make a recommendation. It looks to me like we might suggest an early study of this area; that is, whether the number of challenges to these systems can be appreciably reduced. It's a somewhat vague kind of a suggestion, but maybe Harold or somebody can offer comments on it.

DR. SHEWMON: Have you heard of any evidence that you think would be particularly onerous or could upset the system?

MR. ETHERINGTON: No, no particular problems.

DR. SHEWMON: I haven't either.

MR. RAY: I'm not versed with the widespread application of reactors in the entire industry but the couple that I know don't follow loads. They go on because of the overwhelming economy of the operation at base load and they don't swing. The economy of operation of a power system would dictate that kind of operation.

eb4

If the day ever came, using the past tense, where you had 90 percent of your capacity on the system then you would have to have load-follow characteristics and capabilities, but I would think that in general it would be cheaper to use one kind of peaking capacity to do that, and that would be much more flexible from an operating viewpoint.

Certainly the Staff would have information that could tell us whether or not there is a predominant operation within the industry of load-following with nuclear plants.

DR. SHEWMON: I think the question of operator preparation for these things is certainly a point that comes up. Do we feel that's so much within the purview of the Staff and so much on everybody's mind at this point that we would rather watch and listen than make recommendations in the area? It's certainly nothing we have to bring to anybody's attention I guess, where some of these others are points that we feel have been neglected and might continue to be neglected.

DR. CARBON: Well, I don't know. I'm mixed up on the last trend of this point here.

I think Dave's basic point has to do with looking toward challenges.

DR. OKRENT: The frequency of challenges. Well, let me put it this way--

DR. CARBON: And that's independent of--

DR. SHEWMON: I wasn't speaking to that point. I

eb5

thought we had left that. I don't know that there is considerable support for the concern, but then he may well be right. I was bringing up a different point.

DR. CARBON: Well, back for a minute on it, it seems to me very reasonable to lock into whether challenges frequently occur and if there are, to try to reduce them. It may be that in some of the cases there could be simple changes made that would reduce the frequency of challenge.

MR. MATHIS: Well, most of the challenges to the various systems come from the method of testing. They are challenged and tested so frequently we wear them out in a lot of cases.

DR. SHEWMON: And then they're out of service when you need them.

I think what Dave ..s suggesting here is just not in the experience of the people. I haven't heard of it; Harold doesn't, off-hand. Certainly the maintenance and checking operations has continually been brought up as a source of danger to the system, usually the source of excursions.

DR. OKRENT: Well, I don't want the load-follow question to cloud the issue. The real question in my own mind is whether there should be a look at the frequency of challenge because certainly to think about things probabilistically, if you consider driving a car, for example, if every time you came to a stop light, somebody came through the other way, when you had the green somebody came through late and charged through, most of the time you might see him and stop and either have him miss you, but there could be an occasion when you didn't and he hit you. So that's a question of frequency of challenge.

And it's similar for any time when you have to react in haste, or whatever it is, in order to meet a challenge.

Again, maybe this is an item that we might flag as one that might be put down for relatively early review by the Committee and ask that the NRC Staff be thinking about it so that when we have time in the not too distant future to talk on it, say, there has been some preliminary thinking done.

It may be that out of the task force that they're talking about that I guess Tedesco is dealing with that they'll develop some ideas in specific areas.

DR. SIESS: What kind of challenge are you talking about? Loss of feedwater in particular, or anticipated transients in general?

DR. OKRENT: Well, I really thing both. Loss of feedwater is in vogue at the moment but I think the question warrants a more general look.

DR. SIESS: There has been a pretty extensive challenge now of anticipated challenges.

DR. OKRENT: But that was related to a challenge on the defective system, the scram system.

DR. SIESS: But there are other historical ones,

eb7

what anticipated transients to think about and whether they represent a single category in terms of what happens, or different ones, and they could certainly look at those and see how they might be affected by a load-following mode versus base load.

DR. LAWROSKI: I want to bring up another suggestion for the Committee.

DR. CARBON: Are there more thoughts on this particular one?

MR. RAY: Maybe in view of Dave's last comment, it's an item that would be worthy of addition to our list of items.

DR. CARBON: It could be.

MR. RAY: The B categories. You'll remember we had A, B, and C.

DR. SHEWMON: Generic?

MR. RAY: The list that was made up at the last meeting. Today we acted only on the letter to the Commission.

MR. LIPINSKI: In connection with looking at the challenge rate, we should also consider the difference between once-through steam generators and recirculating steam generators in doing these studies, and the effect on loss of heat sink.

The other one that was alluded to yesterday was to mitigate the transients on loss of heat sink by not delaying the scram. In the particular case where you lose your heat

eb8

sink and delay the scram, the area under the power curve represents the energy that has to be absorbed by the primary system. This gets translated into system temperature increase, volume increase, pressure rise and level rise, pressure increase and if the pressurizer doesn't have enough volume, then you pass water through the valves.

So the benefits of scramming early on loss of feedwater or turbine trip should be included in this.

DR. CARBON: Let's go on.

DR. OKRENT: Why don't we let Steve Lawroski have a turn?

DR. LAWROSKI: I'm going to raise-- The point that I yesterday mentioned was one of my concerns, and that is the matter of the releases of iodine. It's been some time since plans were laid at Three Mile Island to get another charcoal filter in operation, bu I thi. : ve might suggest -- and I would like to have the Committee consider whether or not we should suggest to the Staff that it re-examine the situation with respect to iodine removal.

It seems that the performance of the equipment in this regard there has been marginal, and we would have been considerably worse off had we not had as good a containment as appears to be there. I don't know who built that but it apparently has stayed tight; otherwise we might have been seeing larger-- I know it is being maintained negative, but the

Ace-Federal Reporters, Inc.

eb9

fact that it is tight makes it easier to do so at negative pressure.

But I think we ought to look again to see why it is that the charcoal filters presumably lost their capacity for removing the iodine because of moisture.

DR. SHEWMON: How are these things normally designed? Certainly in a water cooled reactor there is very likely to be water and steam running around.

DR. LAWROSKI: Yes. That's why I'm concerned. If you should encounter moisture, I don't know what measures are taken to get around that.

MR. RAY: Steve, would some kind of a chemical bank through which you pass this--

DR. LAWROSKI: I don't know. But the releases here have-- Well, one attempt to mitigate them was to add some hydroxide of thiosulfate to the liquid wastes which presumably were both in the aux. building and I guess in the reactor building which had sizable quantities of radioiodine.

But we ought to look, I think, again at whether we really have as good information as we should for contending with iodine. It's one of the more important, if not the most important, fission product to prevent from releasing.

MR. RAY: Certainly this would be a good research item.

DR. LAWROSKI: I don't know that the details involve

eb10

this particular one.

MR. CROCKER: The filters that are on the vents from the containment normally do have a preheater to make sure that there is no moisture getting into the charcoal filter banks. My understanding is that the iodine from the TMI accident is from the sump water that actually got pumped out into the auxiliary building, and in the process of cleaning it up now, we are having trouble with the iodine releases.

The filter banks in the auxiliary building, while there is charcoal there, I do not believe they normally contain a preheater to get rid of moisture. You wouldn't expec to have moisture up in the 70 to 80 percent range out in the auxiliary building normally.

DR. SHEWMON: The heated water doesn't get rid of it. Is it particulate water, droplets, that are particularly bothersome? The relative humidity would change? You might in essence destory any droplets but you don't get rid of water by heating it.

MR. CROCKER: No, the idea is the charcoal filter banks-- The moisture apparently gets on the charcoal and it will not absorb the iodine, so the idea is to preheat the air coming through or the gases coming through so you can get rid of the moisture.

DR. SHEWMON: It's getting rid of it that bothers me. You think it then does not absorb when it is hot air but

eb11

the iodine still does if it's at higher temperature, which is apparently what happens?

MR. CROCKER: I'm getting considerably out of my field but I think that's correct.

DR. OKRENT: I'm a little curious about this. If they hadn't gotten water into the auxiliary building but if they had gone onto the RHR mode and recirculated water with pumps in the auxiliary building, we have heard expressions of concern that there might be leaks over a period of time and you might have gotten into a position where you had both iodine in the atmosphere in that building and moisture from another source.

So we could have gotten to this situation possibly down another route. So I think the question that Lawroski raises in terms of the auxiliary building and what provisions it has should be followed. In fact, there is clearly a longer term need to look at whether the RHR system as currently designed is less of a desirable, you know, fallback or,in fact, I suppose I might say the first line of defense than the Staff and everyone else has been defining it as.

In other words, if you're really concerned about leakage arising from the RHR system and not that we're reluctant to use it on a short or long term, now what is this all about?

So I'd like to take Lawroski's question and Crocker's answer and suggest there is a broader area. I'm sure the Staff

eb12

is conscious of this, I have no doubt. But it's something I think the Committee may also want to look at. I'm not suggesting we make a recommendation today, however.

MR. FRALEY: There's another point, that the radioactivity was contained inside the containment and in some ways it's fortunate that it's a concrete containment that provided considerable shielding for activities onsite.

It may be that for other kinds of containment it's more important to get that activity inside the containment down so that you can do onsite activities after an accident of this nature. I think that needs some thought.

DR. OKRENT: I think we always have shielding now.

DR. SIESS: We don't have any containments without concrete.

DR. OKRENT: San Onofre 1 used to be a steel shell but it is changed now.

DR. SIESS: Those thicknesses vary.

MR. FRALEY: But we normally concentrate on the control room. We do not examine carefully other onsite activities that may be needed, like hooking up the hydrogen burners.

DR. LAWROSKI: But not being able to get that iodine out of that volume of gas has hampered activities on the site and getting on with what needs to be learned about the accident.

DR. SHEWMON: My comment is tangential. I don't know

eb13

whether to raise it or not, but it seems to me that something which was very clearly absent the first week or two days of the accident was adequate chemical knowledge or capability in the Staff of even knowing where to go to ask the right question, or even what the right question was.

I don't know whether it's a research project or not. Certainly an organization and staffing and some research capability in the area of water chemistry and things of this sort would have been a fair help in mental anguish to the public and the statements made.

DR. CARBON: Are there further comments on Steve's point here?

Dave, I know, has more points. Would other people like to inject some at this point?

Let me turn to the consultants and see if there are any points they would want to raise.

MR. LIPINSKI: I have a long list of items if you'd like me to run through them.

DR. CARBON: Why don't you start?

MR. LIPINSKI: We've talked about the instrumentation to follow the course of an accident. We discussed the requirements for meeting full range. We also made the point during the early phases of an accident environmental considerations are not that important, therefore, this business of full range is.

Consideration of new instrumentation, new instruments, reactor water level was one of the missing parameters. Now containment water level is a missing parameter.

As to whether natural circulation is present, that can be developed by proper instrumentation to give direct readout to the operator.

The suggestion of giving the operator a chart to tell him where he is with respect to T saturation, he can actually have a presentation given to him based on the margin from the hottest point in the core with respect to the actual system pressure, and then naturally core outlet temperatures are very beneficial. But as has been pointed out, they're not put there for the operator only to get core operating performance information. That should be a requirement for operator information with respect to reactor performance.

I have already made reference to the benefit of an early scram on loss of heat sink.

In connection with the instrumentation to follow the course of the accident, we have seen miscellaneous charts presented, taken from various points in the control room in an attempt to try to do a point-to-point correlation between charts to see what the sequence of events were.

There are systems in operation called sequence-of-events recorders where you take selected variables, select a sampling rate, and record these continuously prior to an

eb15

accident. If an accident does not occur, the information is erased, and new information is continued to be recorded.

If the variables go out of bound the system is triggered, you retain the data and you continue to record after the accident is initiated. It's kind of like a flight recorder in an airplane. You can then recover this information and get a time sequence correlation of events to help determine what it is that took place.

Such a system is in operation on the EBR 2 reactor in Idaho.

This particular event caused on of the steam generators to fail. I think the reliability of the heat source should be reassessed. The system only has two steam generators. Fortunately one is still working.

In the case of the Clinch River reactor, the three heat transport systems were considered insufficient for residual heat removal. That system is required to have the separate heat removal system.

Now I should draw a correlation. You can blow sodium once through a system and dump it into the containment because that's your design basis. So the water reactor does have a benefit in terms of the coolant. But the gener l question of heat dump reliability I think should be reassessed as to whether the numbers that come up in this exercise are adequate.

eb16

There was a problem with the gas bubble in the reactor. There should be a remote operate event on top of the reactor vessel such that if there's any gas bubble formation in that vessel you have the opportunity to release it from the control room.

Similarly, at the highest point in the system natural recirculation should be established. There should be some control to vent that system if gas does form at the highest point.

We talked about the safety power-operated valve not having direct position indications. It's only inferred from solenoid operation.

All the safety valves in the system should have direct position indication of their stems. That has to be inferred in terms of what their status is. In this particular case the downstream thermocouple does provide additional information. Even though the position indicator would say the valve is closed, it still may simmer. Consequently, the thermocouple provide additional information.

We have discussed this once in a previous meeting in terms of status indication of all emergency equipment. The emergency equipment is different from the plant protection system equipment. In the case of the gravity-driven rods if we have a power failure, generally we have an automatic actuation of that system.

eb17

The emergency equipment is designed with a reverse feature. You must apply energy to actuate the final device, be it a valve or a motor.

We discussed previously when breakers have been left open on safety systems. All the safety equipment should have indicators on it such that you can determine the status of the safety system from the control room as to its availability such that if a signal calls for actuation, you have some degree of assurance that that system has been set up and it will actuate when called on.

DR. OKRENT: What about block valves?

MR. LIPINSKI: I would put indicators on all valves that had to do with the operation of the safety system. It should be indicated that they are not in proper position for safety system actuation, and this would include breakers. If the switch is not in the proper position it should be so indicated.

You can carry this further with interlocks to prevent operation, and this is also something that should be considered. Indication is a minimum. As to whether you interlock is another consideration.

Dave has already made the point on the failure end of the plant control system and the challenge rate that is given to the plant protection system and the engineered safety features. I'd simply like to reemphasize that this is an important consideration.

Now, in designing safety systems the single failure criterion is invoked and what this does is improves the reliability of the safety system and insures the availability of a safety system when it's called on.

When we do our transient analysis I think a similar rule should be invoked such that when you do your transient analysis you should also then invoke a single failure to see what the effect is.

Now we've concentrated on having safety systems available to perform their function but we have not looked at them to see what the effect is if we can't prevent them from continuing to perform their function; namely, if a valve doesn't close or if water does not stop being injected, then I think this should be a consideration in our transient analyses.

As we always look in a forward direction, the question is if we cannot prevent a system, once it has been activated, this should also be a consideration.

DR. SHEWMON: Let me stop and back you up one.

On that one, what we assume or push upon the applicant is to make it safe and if they have it hung with enough hangers and have, where we put it in the plant, it's certified as safety grade, then it's assumed to work invariably. Is that the philosophy?

MR. LIPINSKI: No. The philosophy is if it is

eb19

safety grade, then you'll get it when you want it. But the reverse is not necessarily true, that having had it, can you get rid of it? And in this particular case, with the relief valve open, it went in the proper direction to the initial benefit but not being able to close it got us into trouble.

DR. SHEWMON: Let me back you up one further.

You had one on challenge rate of the plant protection system. Can you be more explicit on what you suggest there?

MR. LIPINSKI: Well, as was pointed out, there are no criteria that say that if a control system fails more frequently than a certain number then it is unacceptable. I've been involved with the Canadians. They do have such a number that says that if the control system has higher than a certain failure rate it is totally unacceptable, and they've got to take measures to reduce the failure rate to the prescribed number.

DR. SHEWMON: Is the failure rate the result of it not performing satisfactorily on a periodic check?

MR. LIPINSKI: No. It's in the event that you get safety actuation or the system goes out of limits when it's called on to do so. In other words, feedwater can go in both directions. You can have excess of feedwater and you can have loss of feedwater, and if it does this as a result of a failure it's classed as a failure. It's not performing as it's intended.

And if it does it more frequently than a prescribed

eb20

number, then you must take measures to correct it. And they have prescriptions as to what the numbers are.

DR. SHEWMON: You're talking about plant protection systems now, or are you talking about normal equipment?

MR. LIPINSKI: We're talking about control systems that challenge the safety systems. The Canadians do have numbers that apply to their control systems such that if the control systems malfunction more frequently than prescribed, action must be taken.

We do not have such numbers. I think consideration should be given to performance requirements on control systems.

DR. SIESS: Are these performance criteria based on actual operation experience or on calculated failure rates?

MR. LIPINSKI: No, the criteris as to whether you're conforming or not is based on actual operating experience because they have a calculated number that sets the prescription. But then after you go into operation, if your statistics of failure exceed that number then you must correct your system.

DR. SIESS: And the limit is on over-all control system failures or--

MR. LIPINSKI: It depends on the particular system.

DR. SIESS: I mean do they have a separate limit on feedwater malfunctions and another one on some other control function?

MR. LIPINSKI: This I couldn't say. I'm familiar with the fact that they do have limits on the control system. Just how they are apportioned between the systems I couldn't say.

DR. SHEWMON: Could we get a copy of the documents, or whatever they call their Reg. Guide or something that he's referring to?

MR. FRALEY: The Canadians?

DR. SHEWMON: Yes.

MR. LIPINSKI: The information I have is in the form of a set of Vugraphs that were given at a meeting with the presentation. I can forward them to the Committee. As to whether you can get the equipment information also I don't know.

MR. FRALEY: If you'll give me the information I'll find out.

MR. LIPINSKI: Okay.

DR. LAWROSKI: You said one of the steam generators failed as the result of this. Have we had that ascertained?

MR. FRALEY: I think it has been unclear whether that's the generator that's actually leaking. It apparently is available as a heat removal source if it is not degraded, but there is some concern about leakage which is an off-again, on-again kind of thing. It may be leaking and it may not.

DR. CARBON: If Walt is finished, let's take a ten-minute break.

eb22

(Recess.)

DR. CARBON: Let's go ahead with our discussion.

Steve, you wanted to make a couple of points?

DR. LAWROSKI: Yes.

In addition to having remote capability, for example venting the reactor vessel that Lipinski mentioned, there are other things that he has probably included, but people continue to examine this accident and see what should be done should another one like it ever occur, in order to be better prepared. And that would include such things, for example, as looking into provisions for remotely being able to sample -- being able to sample remotely some of the important systems like the primary system, for example. There had to be real limitations on the number of samples taken because of the concern for over-exposure.

We're pretty well set up with plants to take sampling under normal operations but very poorly, not only with respect to primary coolant but some of the other things, for example getting good samples of the containment, and perhaps there are other things.

Another item that-- I'm sure this will receive a great deal of attention by industry and I hope by the NRC as well, and that's the matter that apparently has been so long neglected despite the experiences of the Chalk River accident some years ago, the SL-1, namely the lack of emergency equipment

eb23

having been carefully planned for and provided to be able -- and have it available for dispatching.

That equipment should include such things as -- I will just cite an example -- robots that are available with capabilities that are fairly broad in what they can do. I think a great deal more needs to be done. And of course the matter of emergency planning, if Dr. Moeller were here, he would certainly comment on. But I think this is something we're going to need to discuss at some length, and we'll need to follow up to see what industry and the NRC have developed, to see whether we consider it adequate or not.

DR. SHEWMON: Could I comment on one of those?

On the remote sampling, the sampling of both containment and primary cooling system are entirely set up for normal operating conditions only? Is that it?

DR. LAWROSKI: Pretty much so. I think I'm correct in saying that. It has required quite-- It was quite difficult to arrange for the primary coolant samples. I believe we have gotten -- what? -- a total of two so far, Larry?

MR. CROCKER: I'm trying to get a reading on the latest right now. I don't know how many they've taken, Dr. Lawroski.

DR. LAWROSKI: This may mean something like long lines that are shielded and that one is capable of taking out a large volume before you get the representative sample.

68-048

eb24

DR. SHEWMON: I fully agree. I just hadn't realized whether--

DR. LAWROSKI: Isn't that true? I'll ask Mr. McMillan if that isn't so?

MR. MC MILLAN: I think I'm correct in saying that there have been two depressurized samples taken of the reactor coolant system. And over the weekend they took a pressurized sample in order to get an evaluation of the gas.

DR. SHEWMON: The question is the design procedure for accident conditions.

MR. MC MILLAN: It's for normal operations, sampling the reactor coolant to determine the gas concentrations and determine the pH levels and the impurities in the reactor coolant system. They did take samples here through that sampling system. And as you point out, they do have to circulate this sample for some time in order to make sure they're getting a representative sample.

They can do that while they move away from the sampling site but in order to get the sample, get it into a bottle and get it into a flask, there is a radiation exposure in an accident condition with the levels they presently have.

The first sample they took had a contact radiation level of 1,000 r per hundred milliliter sample. The subsequent one, taken I guess ten days later, that radiation level had dropped off to about 17 r, but it was a 40 milliliter sample,

eb25

somewhat smaller than the original.

But that still is a significant radiation level and the system is not built to do post-accident sampling.

DR. LAWROSKI: The long delay in being able to get another primary coolant sample meant that we weren't as early knowledgeable about whether or not, for example, core melting had occurred.

1.070

MR. MC MILLAN: I think that's right. Of course there was a great deal of interest on our part as to what the dissolved gas level was in the sample and therefore, the need to take a pressurized sample. And that has only been accomplished over the past weekend.

DR. OKRENT: While Mr. McMillan is standing, do you happen to know when there was an indication on some instrument that looked at the primary system liquid itself, that the activity in the primary system has gone well beyond what one would consider normal so that it indicated either that many fuel elements had perforated or something equivalent to that? Is that information now available to B&W?

MR. MC MILLAN: Specifically I don't know the answer to your question. I don't know when they first got an indication of the high radiation levels in the coolant.

The first place where that would be-- The first opportunity you'd have would be to notice the high levels in the letdown system let down into the makeup tank and then back into

eb26

the reactor coolant system. And I believe the first indication would have been in high radiation levels in the gas base of the makeup tank. I don't know specifically when that was first observed, but we can find that out.

DR. OKRENT: There's been a long-standing generic item concerning instrumentation to provide early warning of gross failure of a fuel element. I was just wondering whether the instrumentation that would normally be associated with the primary system and its appendages gave early, definitive indication that something like this had occurred and whether this information was clearly available to the operator and so forth, whether it was on a basis that you could translate it from the fact that you had perforation to you had fission products moving out into the coolant outside the gap.

Again this could have been intelligence telling you, at least let's say after two hours, you shouldn't assume you had your original geometry or something like this. It could have given perhaps earlier warning.

But what I'm trying to ascertain now is what the system was and in fact whether it gave information directly to the operator.

MR. MC MILLAN: I simply don't know the answer to the question. I think that's something that ought to be determined. In fact, I can't answer it.

DR. OKRENT: While we're talking about topics I

eb27

would call attention to that. It's a generic item which, for many years, again the Staff seemed not to be able to find a real reason to pursue. Maybe now they will re-look at it

MR. MC MILLAN: I think maybe I ought to say something in response to that, and that is in the post-accident evaluation of the sequence of events that took place and the assessment of what the condition of the core was, it's the consensus of those who have looked at it that the significant damage to the core occurred in the time frame in the two- to four-hour period after the accident was initiated. That's in the range of 6:00 a.m. to 8:00 a.m. on the morning of March 28th.

That you'll recall is in the time period after the reactor coolant pumps were secured.

I don't believe, from what I have been able to assess of the situation, that at that point the operator-- Let me say that differently.

I believe at that point in the incident the operator recognized he had a serious problem on his hands, and the evidence of additional indications of high fission product levels in the letdown I don't think would have caused him to do anything different. But obviously that's speculation on my part.

DR. CARBON: Dave, I was making a note while you were discussing this. Would you repeat for me the--

DR. OKRENT: I was just saying for a long time there

eb28

has been a question about whether it could be useful to have instrumentation that would give early warning of gross fission product release, if you will, from a small portion of the core, or something equivalent to this.

And while I'm not able to say what the operator knew or what he could have done, I think, for example, if there had been knowledge at four hours that the fission product leve. corresponded to not just gap activity but from the fuel being at substantially higher temperatures than you would normally have expected, again that would have given some intelligence to people that they didn't have.

Again, this event has occurred. I hope there are no future events of similar seriousness, but I myself don't know why we don't use tools that exist like thermocouples and devices that can measure radiation that could give useful information. I have for a long time not understood this. And after a postmortem like this, I find it even less understandable.

MR. LIPINSKI: There is one other source of information and that is the neutron flux in this reactor. It's normally a quiet signal. At the presence of boiling in the core you do have boiling that can be detected in the flux signal, and it was an appropriate signal processing. This can be an indication that boiling is taking place in the core.

I've not seen the flux traces as to what was

eb29

displayed on them, but this is another possibility.

DR. LAWROSKI: The covering of the core has always been given special importance. Could you tell us how much this was emphasized in the training of personnel in the instructions?

1b

1C agbl

MR. MC MILLAN: Dr. Lawroski, I'm going to have to plead ignorance on that particular point. I'd be happy to try to get an answer to that from the people who are specifically involved in our training program.

I think you're asking in detail what we instruct the operator as to the importance of maintaining the cooling configuration, forced circulation or, in the absence of forced circulation, making sure he has subcooled water in the core. And that really ought to be answered by somebody who is on the firing line day-to-day with the operators, and I prefer to handle it that way.

DR. LAWROSKI: I'd like to see, if there is a tabulation, what are the parameters that he might avail himself of to provide assurance that he, indeed, has the core covered.

MR. MC MILLAN: Okay.

DR. CARBON: And in that connection, would you include not only a list of the parameters, but an idea of the priorities or the importance that is attached to each one?

I mean, sometimes a person can be given a list of a couple of hundred items, but some of them surely get high attention, high priority, high emphasis. And if you could clarify or spell out that aspect, it would be useful.

MR. MC MILLAN: Okay. We'll do that.

DR. SHEWMON: I would like to ask the Staff if there's

agb2

another chronology which lists when activity spikes were either in the letdown tank or what information was available on the activity.

In looking over the chronology, it was obviously developed by somebody who has a profound interest in thermo-hydrology but much smaller interest in activity levels. Yet some of this is available in the -- a lot of it is available in the control room, I would expect. Am I not looking at the right list or doesn't the list exist or what?

MR. CROCKER: The only list I have seen are the ones the Committee has available to it. I can check and see if we do have something else on the radiation level chronology.

DR. SHEWMON: In the plant or in the letdown level accumulator, wherever it comes. There have to be failed fuel detectors on the primary circuit. These things certainly read up there in the control room.

MR. CROCKER: Yes.

DR. SHEWMON: And when it goes off-scale, it might not give Dr. Okrent all he would like, but it sure does let the operator know that something is out of normal.

MR. CROCKER: I can check that back through and see what we can get for you.

DR. LAWROSKI: Still on the same topic, essentially the same question I would like to see posed that we have asked Mr. McMillan to provide, but now ask of the Staff.

agb3

Because it's not only for B&W reactors that the core must be covered but for all reactors, therefore, what have they done in connection with looking at the qualification of license operators in this regard.

MR. CROCKER: I can get that for the Committee, Dr. Lawroski.

DR. CARBON: Can you get as well specific information on the Three Mile Island operator training?

MR. CROCKER: I'm sure we have it, yes. We'd probably have to back it back out of the system. But it must be available, Dr. Carbon.

DR. CARBON: Good.

Jerry?

MR. RAY: Max, you may recall in our last meeting we discussed the idea of an on-line computer to assist the operator as to what the status of his plant was. After Harry Walter's suggestions of the need for monitoring information to the operator and the last several points that Dave has brought up, I think that we -- I would suggest that we take a very active aggressive attitude toward this and recommend an on-line computer be added to the plants at the earliest possible date.

Now this can be used to survey, if you will, on command from the operator all of the plant status items: the valves that are supposed to be closed in normal operation,

agb4

the valves that should opened for normal operation and so on.

Temperatures, thermocouples in the core could be transmitted into the computer and at his option, he could press a button that would test, if you will, and survey all his valve positions for that configuration of plant.

The computer could be programmed as to what would be normal for this plant's condition and respond after having checked the transmitter or the converter, if you will, at the various points for desired information and give him a positive indication.

He could very quickly, in effect, as many times during his shift as he wanted, check whether or not some abnormality has caused maloperation of automatic controls and closed the valve that should be open and so on.

To the extent that you might formulate, by the various engineering disciplines, the transient development or the consequences of a change of status within the core or within the pressurizer or within the steam generator, to the extent that that can be formulated and incorporated into the computer program or the brain of the computer, as it were, he can check whether or not he's on the verge of an emergency.

All of this has been done in the electric power transmission systems. There are on-line automatic monitor and control computers which the system operator -- and it's particularly useful in large scale interconnections of systems.

agb5

He has meters in his station, all of the current transmission lines, the generation out of generating plants, individual units as well as total plants, it's all available to him.

And incidentally, the breaker positions are brought into that position. And he has a dedicated series of cathode ray tubes that are colored, set up on a console.

One could survey the high tension, and does. The high tension may be the 500 Kv system, another one the underlying transmission system, the 230 Kv and so on. But as many times as he needs to tell him the information that's critical to specific portions of his system.

He also has the transmission substation delineation in the single line, if you will, of all the major transmission subs.

Well now, the limit here is how much he can formulate and incorporate into the computer program. And the last time we did talk about this, we relegated the status of such a suggestion to D. I think it should be an A.

It's a simple matter. For instance, in the electric systems, the computer has been endowed with a program which will calculate the load flow on the system and it also knows what the emergency capabilities -- the normal capabilities and the emergency capabilities of the various transmission elements for particularly the more important ones, the backbone of the system.

And when anything happens on the system that would

agb6

overload that line, it immediately telegraphs this into the computer and an alarm sounds and he looks up at the CRT that has that delineation on it and he sees a red figure that tells him what the load is, and the fact that, if it isn't relieved, something is going to reswitch the system, reconfigure it, as it were, and he's going to have a burndown and so therefore he goes to work.

Now he can also ask it what the proper configuration should be to eliminate that overload, he doesn't have to remember that, the computer knows that. And if he has a line that trips, he can ask the computer what's my next emergency that I should be concerned about and, therefore, what should I monitor and watch.

These things have been done. And there really is no reason why we should wait. To the degree that we want monitoring of valve positions or temperatures in the thermocouple -- thermocouple temperatures from the core and so on, it's just a matter of putting the right components into the system to pick this up and crank it into the computer.

DR. CARBON: Thank you.

Dave?

DR. OKRENT: As you know, I'm interested in the topic Jerry Ray just mentioned. I think myself that there are some things that one could do early, there are other things that will take a reasonable amount of time before they can be

agb7

implemented.

But I think we should consider the possibility of staged use of computer guidance, computer aids to the operator.

The topics I had remaining on my list, in no particular order. One that I think I will mention now as something that perhaps we would like to hear from the Staff at a future time is whether our experience at Three Mile Island raises any questions for sites that have shared facilities.

And, as an example which may or may not be relevant, I think sometimes there may be a shared auxiliary building. Assuming that there is, and assuming that they had an accident in one plant that required recirculation of an active fluid into the auxiliary building with the kinds of concerns from leakage and so forth that there have been on the Three Mile Island 2 system, have some impact that I think -- that may not be a good example.

1.320

But at any rate, it seems to me that some looking at shared facilities probably warrants attention, but I'm not suggesting that that's an immediate item. I just wanted to mention that.

Another item that I would like to raise for Committee consideration is a little bit related to points raised by Lawroski and Lipinski, namely, should we recommend an initiation of what we might call contingency studies. These can take various forms. And we've heard a couple of specific types of such things mentioned.

I, for one, think worthwhile for both the industry and the NRC to give this some early attention and to see what kinds of things are developed out of such studies and see what kind of things one might want to recommend for implementation in, say, various stages, various periods of time.

But I think different people looking at this matter from their own perspective will have ideas that when we have them all before us for consideration will be more useful than from a single perspective. I have certain suggestions, but I know there are others that I would think of.

So I don't know whether at this meeting or a meeting soon, but I would suggest that the Committee seriously consider recommending all contingency studies at a relatively early time so we can see what makes sense to do.

DR. CARBON: I personally share that view to a strong extent.

DR. OKRENT: I don't have too many more things on my list.

Carl Michaelson mentioned, I think it was yesterday and he has mentioned it before, that one sometimes has to be careful about the isolation of breaks. I think he's mentioned that you can have a problem in isolating small breaks under some situation.

It might be a possibility for isolating initially

agb9

a medium sized break, I don't know. I don't know whether that requires any special kind of training or information or so forth that we're now able to define, but I think we ought to ask the NRC Staff to think on this, to let us hear in the not too distant future whether they see any unusual circumstances that could arise from this kind of situation.

It might be a situation that occurred because the operator was doing what he was supposed to do by procedures. It might be a situation where the operator thought it was a good idea, there were no procedures, and he didn't necessarily have the information or really all of the analytical capability right on-hand to foresee what the consequences might be.

And maybe this has all been studied and people have ascertained that there are no untoward results. But I, for one, would like to see this given at least a sort of a short-term review if it hasn't been done.

And then if significant areas arise out of a short-term review, then they can look at it in a more sophisticated way. In other words, I would prefer not to see three years of study using the TRAC code before I got any information on the subject.

I would recommend, if it has not already been looked at adequately, that we get a sort of elementary examination to see what are the important questions.

I don't know whether Carl has anything to add in

agbl0

that area.

MR. MICHAELSON: I was going to comment on that area in just a little bit.

DR. OKRENT: Okay.

I think the only other comment or question that I have is one, again, that the Committee may want to think on, and that's whether we want to recommend that the NRC get its own capability for simulation of what I will call anomalous transients for the kinds of reactors it's licensing.

These would be transients that go beyond what the operator is trained for on the commercially-available simulators and so forth, and this would be aside from anything that the industry might decide to do on its own volition. I think we heard that they have not done a large amount of such studies, or at least those we've spoken to. But it seems to me that this could be an area for early consideration by the NRC.

And you know, in discussions about the safety research program, people asked are there things you can do with a million or two million dollars if you could find it from the LOCA ECCS program. Well, here's one area -- or maybe four million dollars, I don't know.

DR. CARBON: That covers them, then?

DR. OKRENT: Yes.

DR. CARBON: Carl, can I call on you for comments?

MR. MICHAELSON: There were a few items that I did want to discuss here.

First of all, I would like to continue to endorse the ACRS letter that was sent a week or so ago. I think -- at least from what I've heard here so far seems to substantiate the concerns that were expressed in this letter.

So, getting on to more specific questions which are now coming up, one of which Harold Etherington has pursued, is the question of natural circulation. I think this is a very important question for the operating plants.

I have some questions or concerns about it that really need to be considered. They may have come out just a little earlier this morning. For instance, the availability of the pressurizer heaters on the diesel generators. I think it's important that the pressurizer heaters be on the diesel generators because after loss of off-site power, it's imperative to retain pressurizer control as long as possible.

I would think the NRC would like to go and check real quick to find out which plants can put their pressurizer heaters on the diesels. I would also recommend that they be put on in dual banks, namely, a portion of the heaters on one generator and another portion on another generator.

This really isn't all that difficult to do and it can be very helpful.

DR. SHEWMON: What sort of power are we talking about there?

agbl2

MR. ETHERINGTON: 1800 kilowatts, I believe, isn't it?

MR. MICHAELSON: 1600 to 1800 kilowatts. It's a substantial load. You might be able to show by analysis that maybe you don't need all that.

MR. ETHERINGTON: That's in several banks or so.

MR. MICHAELSON: That's right, seven or eight banks or so. It may be shown by analysis that you don't need to retain all of them for the retention of the condition that you want. It takes some analysis.

I think it should be looked at, though, because if the plant is not prepared to go on the diesels then, as soon as the pressurizer proceeds to cool off, you can start creating difficulties.

This natural circulation is a fairly complex question. I think that became apparent from some of the B&W discussion that we had at Three Mile Island. It's a quite complex condition, and it's very important that you retain an adequate thermal center, an adequately high thermal center.

So to do this, it's important to know what the temperature conditions are around the loop. And I think Mr. Etherington has pointed out now that you don't want, of course, to approach the saturation condition.

I would question whether or not the thermocouples in the hot leg are really necessarily indicative of whether or

agbl3

or not natural circulation is in progress. You can, for instance, lose natural circulation and have the thermocouples in a hot leg level off very nicely at what appears to be below saturation conditions when, in reality, the core is getting very hot and the voids are forming in the core and the top of the reactor vessel.

So it's important to look at more than just the hot leg. The temperature on top of the core is a very good thing to compare, and I think this was brought out a little earlier this morning, that you really want to monitor the top of the core as well as the hot leg.

DR. SHEWMON: Let me stay with that for a minute, Carl. The flow meters don't work down there. You're telling me that it takes a fair amount of sophistication, at least, to get it from the thermocouples around and you could be confused.

Just how does an operator tell unambiguously that he has established and maintained natural circulation?

MR. MICHALESON: Well really he can tell it with reasonable certainty if the thermocouples at the exit of the core, which are basically on top of the fuel, are really the same as the thermocouples in the hot leg and that the cold leg thermocouples indicate an appropriate delta-T which he could be instructed to know how much it should be. If you've got that situation, things should be all right.

DR. SHEWMON: How far down from the pressure a gb14

temperature are the hot leg temperature indicators?

MR. MICHAELSON: The hot leg, it's up from the pressure vessel.

DR. SHEWMON: From the top of the core. How far apart are the thermocouples? Is one well out of the way of the other?

MR. MICHAELSON: Generally, the thermocouples for the exit temperatures are up along the hot leg and vertical section up near the flow meters somewhere generally and well removed from the core.

And of course then we have the temperatures immediately above the core, at least as far as we know, on the B&W plants. And we have the cold leg temperature below the pump a little bit. I'm not sure exactly, I think it's a foot or so.

So it's important, I think, to instruct the operators. And I assume that this is already going on, but I think it is well to reiterate that the instructions must be written for natural circulation and they must include monitoring all the things that might help to assure the operator -- not again mislead him because he may be only watching, say, the exit temperature up near the flow meter and again get misled.

A couple of other points on natural circulation. Of course, we certainly do need some good procedures. But the next question one has to ask then is, well, what about single

agb15

failures during natural circulation, should we assume that natural circulation will be done without single failure analysis? We also have to ask, how about unwanted actions during the natural circulation course? These are actions generated by spurious opening of valves or things of this sort.

These are questions which I think some guidance needs to be provided on.

Going to another subject, that's the question of these very small breaks that one can experience, such as with open relief valves. It's quite important, I think, to get on with the analysis of these very small breaks as soon as possible and I think that's what the ACRS letter basically was saying.

I think to verify how well this is being done, it would be ideal to have this as an early agenda item to find out just where we're really at before making further judgments on operating plants.

In this regard, of course, there's the question of the suitability of hot leg instrumentation, which I assume is being pursued now for both its practicality and its usefulness.

Another consideration relative to this is the one that you brought up, Dr. Okrent, the question of operator intervention in an undesirable fashion.

An example, for instance, is he may have a very small break loss of coolant accident in progress and he finally figures out where the break is and has the capability, in some

agbl6

cases, to isolate it. For instance, a letdown line break can be so isolated.

If he isolates it after he has lost his natural circulation, which is usually very early in the game, but before he has established a proper evaporation condensation mode of operation, to terminate it at that point means he must somehow get back to natural circulation since he is not yet functioning using the steam generators as condensers.

Unless this situation is analyzed, it would be highly desirable for him not to intervene and interrupt the break, particularly if your analysis shows if you don't interrupt the break that you can then take care of it in the condensing mode. So it really needs to be considered.

DR. PLESSET: While you're on that, it seems to me that there should be no problems in principle or difficulty in making these small break analyses. Do you agree with that?

MR. MICHAELSON: Yes.

DR. PLESSET: Sometimes large breaks give you a lot of trouble.

MR. MICHAELSON: These are so slow moving --

DR. PLESSET: Yes.

MR. MICHAELSON: -- that you could do them by step-wise calculations, sort of on the back of an envelope.

DR. PLESSET: Right.

MR. MICHAELSON: They're not highly sophisticated.

agb17

At least I don't believe they would be highly sophisticated calculations.

DR. PLESSET: I would tend to agree with you. So it's not a difficult task to do these thoroughly and to cover a spectrum of possibilities.

MR. MICHAELSON: I would not think so. A computer would be desirable mainly to mechanize the process, so you could look at a lot of possibilities. But as far as the degree of difficulty, I think it is strictly -- you could do it strictly by static calculations a step at a time.

Again for the very small break analysis, it's quite important to have procedures to either, you know, make sure that the operator is adequately instructed as to whether or not he could intervene in the process and that could be verified by calculation.

If the calculations show that intervening at any point in time is an acceptable process, then certainly instruct the operator to isolate the break if he can figure out where it is and has the capability to isolate it.

One subject which hasn't been mentioned too much but I think is one which we perhaps need to think about a little bit relative to an event of this sort, and that is the possibility for hydraulic instabilities that you can get into.

Here we're talking now about a core dryout situation wherein cold water was being injected into a superheated steam.

agb18

This can create some rather severe flash condensing phenomena, when you inject cold water into steam.

And we haven't really kicked that one around too much, but I don't want to lose sight of it because it can cause warping of the core barrel and things of this sort. So perhaps at least it's worth thinking about.

I'd like to --

DR. OKRENT: Excuse me. In that regard, is there any prior problem in the secondary generator? Are they designed for dryout and then cold water coming in and so forth?

MR. MICHAELSON: I don't know the details of that. I would think that would be a good question, though, to ask the appropriate people, yes.

I was more concerned about the safety injection in close proximity to the annulus of the reactor and the fact that late in the game we appeared to have dried out this region and it was occupied by superheated steam, since the core vent valves can open under this condition and, therefore, one might be concerned.

And this would depend very much on the injection rate, which might, on occasion, have been very low and then turned up with very high values.

We don't know yet the time history of how this thing went out in time when they starting doing a large number of maneuvers.

agb19

But in such maneuvers wherein you essentially shut off the cold water and then later inject it very rapidly, it is a good setup for flash condensing the steam in the region, and that creates then some good knocking.

DR. SHEWMON: I don't understand. It seems to me you're talking about flash evaporation as much as flash condensing. You're at one end of the scale and I'm at the other.

MR. MICHAELSON: Right. You could do both, of course. In this case you have a pipe filled with high pressure high temperature steam in which you suddenly splash cold water, which then creates an ideal condensing media.

It's like a spray tower, I guess, in a way, because the water is coming in vertically and splashing around --

DR. SHEWMON: You're using that as sort of a pressure reduction and inversion?

MR. MICHAELSON: This is what you have to look at. People have gotten into the situations wherein they have steam filled pipes in which they inject cold water, feedwater lines particularly, they've done this sort of thing.

They allowed the water to disappear from the feedwater line and then bring a slug of cold water in, and it creates hydraulic instability. You get flash condensing of steam.

And I'm just saying again this is something that one ought not lose sight of to make sure it is not instrumental,

agb20

the effect here. Because there is no provision to gently inject this into the pipe, or to try to keep it from rapidly condensing the steam.

DR. PLESSET: You could get first a collapse and then a re-expansion.

MR. MICHAELSON: As I understand it, it's primarily the collapsed steam that does that.

DR. SHEWMON: Do you get a water hammer? Is it first cousin to that?

DR. PLESSET: Yes.

MR. MICHAELSON: You trap steam bubbles in a water line, for instance, in the process of drying out and refilling, and the rapid condensation creates a little problem.

I want to go on to another subject which was kicked around just a little bit ago. I guess I'm going to have to be the devil's advocate on this one, because I can't fully agree with the idea of using status monitoring in an extensive sense.

In a process system, a fluid hydraulic process system, it's very difficult -- it's possible but extremely difficult to monitor all the kinds of things that can prevent the system from working, keeping in mind you're talking about instrument valves, you're talking about the process valves themselves, you're talking about seal water coolers on pumps, water coolers on motors, literally hundreds of valves which would have to be monitored if you want to assure yourself that

agb21

every aspect of this system is ready to run.

I've looked at it myself a little bit because I think, again, it's an ideal thing to think about. But when you start looking at the practicality of it, it's realy hard to justify.

You can create safety problems, of course, by unusual degrees of complexity, which this would entail, and it's just not practical on, say, a half inch instrument valve to try to figure out how to put a limit switch on it to monitor its position. The limit switch is bigger than the valve.

It just creates a number of problems and then you have to multiply them by thousands, and it gets very complex to do. So I think at that point you have to trust administrative procedures.

DR. LAWROSKI: Wouldn't you be farther ahead to at least get the DC valves displayed and --

MR. MICHAELSON: By all means, all main line process valves should have status monitoring, that includes maintenance valves particularly, because those are the kind the LERs indicate people forget to open when they finish their maintenance.

But to go down into the ancillary systems, and attempt to monitor their status is very difficult on fluid systems. It's relatively easy on electrical portions. But on the mechanical portions, it becomes quite difficult.

DR. CARBON: Any other questions of Carl?

agb22

Is Dr. Stratton here at the moment?

Do other members of the Committee have topics they'd like to bring up here? We've covered a fairly extensive list.

MR. FRALEY: Well there are some that people are already looking at, and that is the provisions for containment isolation. And certainly the sump pump system, which I understand on some plants has a radioactive monitor which isolates them when it starts to pump radioactive water, but on this plant did not.

That is an area that needs further consideration, and the signals for isolating the containment, at which you do or don't isolate, but of course the Staff is looking hard at that.

The other thing that was mentioned was hardening some normal equipment, so that it will operate under accident or quasi-accident conditions. In fact, most of the equipment that's running is not safety-grade, although it may have been hardened with respect to certain things.

And of course that would include the upgrading of the RHR system, perhaps to higher pressure and higher capacity. Lipinski mentioned the need for improved reliability in the heat sink, and it might be accomplished by hardening the RHR system and expanding it and then you wouldn't need to rely on the steam generators.

So those are areas which I think may warrant further

agb23

attention.

DR. CARBON: I think it would be appropriate here to recount, to review, just make a list of the things we asked the Staff yesterday or this morning to provide.

I wonder if I could go around and ask, do you have such a list, Ray, or do you have part of a list?

Or, Jim, do you have a list, could you read off the list?

C2

MR. JACOBS: It's going to be hunt-and-peck and hunt-and-find.

MR. FRALEY: Why don't we take a few minute break and maybe we could organize it better.

DR. CARBON: Let's take a short break, then, and then, Jim, will you go through that, please?

(Recess.)

1d ebl

2.020

DR. CARBON: Let's go ahead with the meeting.

Jim, can you recount the things that we asked the Staff to provide us yesterday, or the comments that were made to the Staff on things that we want to see them do, with perhaps emphasis on the last points?

MR. JACOBS: I think I can. I will try to give them in the chronological order in which they were asked during the meeting.

First, it was requested that an analysis be performed on the power-operated relief valves to determine whether they can close under all of the fluid conditions they are likely to see, including steam, water, and a mixture of the two.

The Staff was asked to assure that the small break can be analyzed so that the wrong conclusions are not made by plant operators.

The Staff was asked to provide an analysis of the fission products that were found in the primary coolant samples. I understand they have analyses. They just didn't have them with them.

The Staff was asked to provide documentation on natural circulation tests and on cases where B&W plants have had to rely on natural circulation cooling.

DR. CARBON: That was requested of the Staff or of Babcock and Wilcox?

MR. JACOBS: I'm not sure who it was requested of,

eb2

but it was following Dr. Hanaeur's presentation.

The Staff was requested to provide adequate instructions to operators on danger signals and how to get the plant into natural circulation mode.

They were asked to provide additional information on the radiation levels of the Three Mile Island containment atmosphere.

They were asked to look at the difference between the traditional steam generators versus the once-through steam generator with respect to loss of heat sink.

And also they were asked to assess the benefits of early scram on turbine trip and/or loss of feedwater.

DR. CARBON: What was the last one?

MR. JACOBS: To analyze the benefits of-- I think I have this one reversed, the benefits of early scram on the loss of feedwater and turbine trip. They come simultaneously, practically.

DR. PLESSET: What was the one before that? Once through versus--

MR. JACOBS: Once through versus the traditional steam generators, and with respect to their reactions, I guess, with regard to loss of heat sink, or how you lose the heat sink.

DR. PLESSET: In transient conditions.

MR. JACOBS: Yes.

And then both Babcock and Wilcox and the Staff were

eb3

asked to assess the level of training with regard to the need to get plants -- the degree of emphasis in training on the need to keep the core covered, and that was asked both of Babcock and Wilcox and the Staff.

The Staff was also asked for identification of the emphasis with regard to the training of Three Mile Island operators specifically.

DR. CARBON: This came up this morning.

MR. JACOBS: Many of these things came up this morning.

The Staff was also asked to provide a chronology of the radiation level readings taken out of the plant during transient.

That completes my list.

DR. CARBON: The last one, would you repeat it?

MR. JACOBS: A radiation level chronology from the instrumentation during the transient at Three Mile Island.

DR. CARBON: Gentlemen, I guess I would ask at this point, again raise the question, do we want to put any of these things, recommendations, whatever, in a letter to the Commission today, or do we want simply to discuss them or to handle them at some later date?

The first question: Do we want to write a letter to the Commission?

MR. MATHIS: Max, I don't think we've got time,

eb4

really, to write a letter. Can we give our impressions to the Commissioners verbally, and maybe we'd want to follow up with a letter later on. But we have to establish some priorities.

The list we have developed so far is lengthy and we need to say Okay, what are the things that need to be done now with what we have available. And that I think could be done verbally.

DR. PLESSET: I think that's well put, and I would concur with what Bill has said.

I think we should be prepared, if we are meeting with the Commissioners, to discuss some of these things verbally if that's not too difficult for the Chairman to organize. I think we do want to write a letter but I think we need a little time to get better organized so we can do it more carefully and in a less rushed atmosphere. We don't have much time today.

DR. OKRENT: When do we meet?

DR. CARBON: We're scheduled to meet at 3:30. It's recognized that some of the people will need to leave.

MR. FRALEY: For those of you who are heading to Dulles, we're trying to get a car standing by so that you can stay as late as possible, and we'll tell you what time that is, to get you out to catch your flights.

If there is anything else we can do for anybody else to arrange special transportation so you can stay a little

eb5

later, let me know.

Mr. Etherington?

MR. ETHERINGTON: I'd like to get out as soon as I can. I'd like to get away at 4:00.

DR. PLESSET: I have to get out to Dulles a little bit ahead of that because I don't have a ticket yet.

MR. FRALEY: Mr. Muller has volunteered to do whatever is necessary so you don't need to leave any earlier.

DR. OKRENT: I was going to suggest that if we broke for lunch relatively early today, one or two of us could try to write something down. It might look like a list from which we made comments to the Commissioners; it might end up being partly something that we could transmit in writing. We don't have to reach a judgment until we see how successful people who write something down are, and where the Committee thinks it wants to be, you know, whether it thinks it wants to discuss the points orally or some of them transmit in writing.

But it might be useful to do that in any event.

DR. PLESSET: I think that's right. I think the advantage of thinking in that term is that since there are a lot of the members who aren't here, if we had something written down that Ray could use in the next few days to get in touch with the other Committee members and maybe read it to them and get suggestions, that would accelerate it quite a bit.

DR. OKRENT: But in any event, if you'd like, we

eb6

could try that. I don't know what your image of when lunch was going to be is.

DR. CARBON: Well, the image was 12:30.

DR. OKRENT: Did you have something else you were going to cover between now and 12:30? I don't recall.

DR. CARBON: No, just the continuation. This question, do we write a letter, and then presumably we do want to have a meeting with the Commissioners and we'd be prioritizing all the topics we mentioned this morning and agreeing as to which ones we want to bring to their attention, and what we would say.

DR. OKRENT: I would suggest that you move up lunch to maybe twelve o'clock or some such time, and that we have discussion and additional comments until then, and then a couple of us can try to -- or more can try to, right here in this room, if Mr. Fraley could bring a sandwich in.

DR. CARBON: Is that agreeable?

DR. LAWROSKI: I think so.

Does the Staff have anything over and above what was given to us yesterday that may be important for us to know?

DR. CARBON: Not that I'm aware of. The Staff has not said anything. I'm looking for Larry. He's out for the moment, I guess.

DR. LAWROSKI: Has anything further developed, any other developments? Are they closer to decisions about getting

eb7

this thing into cold standby, or what-not?

DR. CARBON: I have no knowledge. When Larry comes back--

DR. OKRENT: I must say I find it a little curious that we have only Larry here today. I must say-- I'll just let that stand.

DR. CARBON: Well, let's then do move lunch up to whenever it's a reasonable time.

I wonder if it would be appropriate to go through our list of items here and see which ones strike people as important in terms of bringing them to the Commissioners' attention, either by letter or in the meeting today, and get some idea of what we as a group consider to be the important topics to bring up.

Does that strike you as reasonable?

If so, let me go through the items real quickly, the things that Jim Jacobs just read off:

Analysis of power-operated relief valves to see that they close properly, and so on.

Is that one that we want to--

DR. SIESS: I don't understand it.

DR. CARBON: Can you refer again?

MR. JACOBS: It was a question asked by Dr. Plesset, and I think perhaps he can probably phrase it better than I can.

DR. PLESSET: This is a question of the pressure,

eb8

the force on an open valve when you have a flow, possibly of low quality, going through it which might prevent a valve which has a closed signal from closing.

I made estimates of this and some of those forces could be very high.

Now Hanaeur was here when I mentioned this and he said they're concerned about this and have done some analysis also in connection with ATWS.

So it's an item of some significance. I don't know whether this had anything to do with that electromat relief valve on the pressurizer because if they got some high velocity flow, particularly if it had some water in it, it might not close. I don't know. He didn't know either, and I haven't been able to find out.

DR. SIESS: This applied to power-operated relief valves like here, pilot-operated relief valves. What about safety valves?

DR. PLESSET: It's a pretty general point.

Do you know, Harold, if they've been looking at this beyond-- Has it been looked into --

MR. ETHERINGTON: No, I don't.

DR. PLESSET: -- in connection with the closing of a valve?

MR. ETHERINGTON: I haven't had any discussion on this. I think the question of water hammer, though, when a

eb9

slug of water hits is important.

DR. PLESSET: That's an additional point. It's a possible source of damage to the valves.

DR. SIESS: Can we try to categorize these as to short or long term?

DR. CARBON: Yes, we could.

DR. SIESS: I would tend to think that would be long term; you know, whether or not this valve stuck open, there are other small break LOCAs that could get you into similar situations. This is just one in the category, and it differs from other small break LOCAs in that it has occurred. And I may not be right there.

But it seems to me it's a little longer term.

Obviously if the valve, that particular valve, has got a history of sticking open, I mean power-operated and pilot-operated, both, WASH-1400 assumed 10^{-2} probability with a factor of 10 either way. And that's why they've got a block valve in front of it, I would suspect.

DR. PLESSET: Yes, but the operator might not have had a signal. The signal might have been that the solenoid was energized and that would indicate that it was closed, and it might not be able to close.

DR. SIESS: Yes. But that's a different question as to whether he knows when it's closed.

DR. PLESSET: That's also part of it.

eb10

DR. SIESS: I think that would be independent of how reliable it was.

DR. PLESSET: Well, I think we have a kind of a mix of long-term questions and some immediate short-term questions that apply to this incident, and then some general suggestions such as Carl Michaelson has made, Okrent has made, and Lipinski. And I thought that those would be more what we want to consider right now than some of the queries of the Staff. Presumably they'll come back with answers, one way or the other.

DR. SIESS: As I was listening to some of the points raised this morning I was trying to put them in three categories: prevention, mitigation, and then recovery. I think Steve had a number that related to difficulties at Three Mile in knowing the situation which relates to recovery from an accident. It wouldn't have much help in preventing or mitigating.

I don't know whether we could try to classify them that way, prevention and mitigation for similar plants.

DR. CARBON: We could give it a try. It seems to me they might fall in either category, they might be either long term or short term, but still we might bring them up today.

DR. SIESS: I would certainly be in favor of keeping our recommendations or comments to the Commission on short to medium term, and have more time to review the long-term things and sharpen up our questions on them, or broaden our questions

eb11

on them. We might go either way.

DR. CARBON: Short to medium term then.

Where do you classify this one, Milt, the one on the analysis of power-operated valves?

DR. PLESSET: Well, that's going to take some time. I'd say that's long term. Chet has pointed that out and I agree to that.

DR. CARBON: The second one then was to assure that small breaks could be analyzed so that the wrong conclusions are not made by operators.

DR. PLESSET: They could be analyzed. I think I brought this out with my exchange with Carl. The question really is can the operator deduce the proper conclusion from what happens. Is that agreeable?

DR. SIESS: It seems to me there are a number of things there. There are ultimate courses for small breaks. The point Carl made about isolating a small break at various times into the excursion might give different results, the small break that grows into a larger break, and that can occur at different times. This would be a pipe break that started off as a crack and opened up.

It might be the same problem with large breaks, large breaks that are made from small breaks by a valve that's closed and doesn't close all the way.

DR. PLESSET: I think this is an important item.

eb12

DR. SIESS: We mentioned this in our previous letter.

DR. CARBON: Yes.

DR. SIESS: Do we have copies of that previous letter?

DR. PLESSET: Did we mention it this way?

DR. SIESS: It's not in the folder.

DR. CARBON: It was handed out yesterday.

DR. SIESS: I didn't get it.

It's being handed out today, again, I see.

(Document distributed.)

MR. RAY: It's in the third paragraph of the letter.

DR. PLESSET: It's essentially in there.

DR. SIESS: We could obviously elaborate on that but I don't think we'd justify doing much elaboration now, but I don't think it would hurt, in our discussion with the Commissioners to repeat this recommendation and indicate tha e made it in that letter because we thought it was an early-term matter and we still think it is -- if we agree to that.

DR. CARBON: Is that agreeable?

(Indications of assent.)

Let's do so.

DR. PLESSET: I think we might mention the further analysis is of concern, but that's not all going to be immediate; it's going to take some time.

DR. CARBON: Number three on Jim's list was providing

eb13

analyses of fission products from primary coolant samples. I guess that would be long term.

Number four--

DR. LAWROSKI: It's more in the nature of providing appropriate samples.

DR. CARBON: Number four, documentation on natural circulation tests in cases where B&W plants have had to rely on natural circulation. I think that was primarily to B&W.

MR. ETHERINGTON: This is the kind of thing you usually ask the Staff without worrying the Commissioners about.

DR. CARBON: Number five, adequate instruction to operators on danger signals and how to get plants in natural circulation.

DR. OKRENT: The previous letter dated April 7th, in that letter we limited somewhat, and it might pay to consider specifically calling out the natural circulation question.

DR. CARBON: Is everyone agreeable to that?

DR. PLESSET: It would be nice to have the data that we asked the Staff for regarding the occasion on which it was required, or as the result of some tests, were they good tests or not.

Are we ready to do that?

DR. OKRENT: I think it wouldn't hurt to indicate the importance of the operator being better informed about

eb14

when and how to go into natural circulation, and the possible need to develop further knowledge. I think that is something we can do.

DR. CARBON: Is it agreeable to include this one, number five?

Number six I think was simply asking for information on radiation levels at the Three Mile Island containment.

DR. OKRENT: Not just the containment. The question in people's minds there was interest in what information was available when, and in what detail concerning, for example, levels in the primary coolant as well as elsewhere in the plant, as to whether or not this would give you or did give other insights into what was going on besides that which was available from other information.

It's a question of what was actually measured, and I suppose where it was displayed, which would also be relevant.

DR. CARBON: Is that one to bring up today?

DR. OKRENT: I don't think I would bring it up to the Commissioners.

DR. CARBON: Number seven was the difference between traditional steam generators and once-through steam generators with respect to the loss of heat sink in transient conditions.

DR. SIESS: The loss of which heat sink?

MR. JACOBS: The steam generator.

DR SIESS: Is this the question of the difference

eb15

in inventory?

DR. PLESSET: There are two aspects of it. For example, in load-following how does the once-through compare in its stability of behavior with the conventional steam generator? I had a broad question for the Staff as to the difference between the once-through and the conventional steam generators in transient conditions.

There's another aspect that Harold brought up and that's in connection with the steam generator as a heat sink, once-through versus the conventional. I think that's another question.

DR. CARBON: I guess that's long term, isn't it?

DR. PLESSET: I would think so, but I think it's kind of important.

DR. CARBON: Do you want to say anything about it today?

DR. OKRENT: It's something we ought to examine in Subcommittee meetings or Full Committee meetings in a little more depth I think myself.

DR. PLESSET: And get some Staff information which I was hoping was what we would have, unless Harold has something more specific about the heat sink problem.

MR. ETHERINGTON: No, what I think we need is a better basic understanding of how these function in the natural circulation mode. Is it a matter for analysis and probable

eb17

experiment?

DR. CARBON: Number eight, benefits of early scram on loss of feedwater, particularly the benefits of an early scram.

Is that the point Walt was making?

MR. LIPINSKI: Yes, loos of feedwater.

MR. SIESS: Earlier than 12 seconds?

MR. ETHERINGTON: The temperature I think rises about four degrees a second at full power, so that early scram does mean something. If you can knock six seconds off the scram time, that's 24 degrees of temperature rise. This would assume no heat removal of course.

DR. CARBON: Did you finish, Harold?

MR. ETHERINGTON: Yes.

DR. CARBON: Repeat it, would you?

(Laughter.)

MR. ETHERINGTON: If you were taking no heat out of the system this would raise the temperature of the primary system about four degrees, as I recall, but of course you are removing heat. You don't actually get that rise. It is just a measure of how much heat you would remove if you scrammed earlier.

MR. LIPINSKI: That's precisely the point. Because if it's eight seconds, it's eight full power seconds into the primary system. That has to be stored.

ab18

MR. ETHERINGTON: That's another way of putting it, yes.

MR. LIPINSKI: If you scram earlier it just buys you a little more time by getting you that additional energy by scramming.

MR. ETHERINGTON: It became important in this case because the steam generator went dry. It wouldn't be so important in the ordinary way.

MR. LIPINSKI: Here you still didn't have feedwater for eight minutes so it would only change the front end of the curve and the temperature still would have risen with time.

2.440

DR. SIESS: What kind of scram signal are you thinking about? Turbine trip or--

MR. LIPINSKI: Closure of the feedwater valve or closure of the turbine valve.

ld

1E agbl

DR. SIESS: They deliberately designed these not to trip on turbine trip.

MR. LIPINSKI: One would have to take a look at the systems to determine where the best place is to take a signal, I wouldn't want to design it right now.

DR. SIESS: Does loss of off-site power cause scram?

MR. LIPINSKI: You don't have any place to dump your load.

DR. SIESS: Does loss of off-site power cause immediate scram?

It's one of the most likely transients, the loss of feedwater, but does the loss of off-site power itself cause scram? Can B&W answer?

MR. TAYLOR: The loss of off-site power will cause you to scram because you immediately lose all four reactor coolant pumps.

MR. ETHERINGTON: Isn't it more direct than that, don't you lose power to the breakers, the scram breakers?

MR. TAYLOR: No.

DR. OKRENT: I think the point under discussion should be looked at. I think we're going to have to look at the multiple ramifications of the question and see what are the advantages and disadvantages of any proposed change of this kind.

agb2

So I don't think it's an item that we would identify to the Commissioners. I think we should somehow in the near future initiate obtaining information ourselves from the Staff on that.

DR. CARBON: Any disagreement with that?

MR. MICHAELSON: Could I comment a little bit on that?

The comment that I would like to make, Dr. Okrent, is that the very small break analysis, of course, pertains not just to B&W type plants but to Combustion and Westinghouse as well, and that is where you are involved in the U-tube type steam generator and would therefore need to look at its particular characteristics for the small breaks.

DR. OKRENT: I agree.

DR. CARBON: Going to Number Nine:

> "To assess the level of training with regard to the degree of emphasis on the need to keep the core covered information from Three Mile Island especially."

That was the request for information by us this morning.

DR. LAWROSKI: It's the importance of keeping the core covered in all reactors.

DR. PLESSET: That should be addressed to all reactors.

agb3

DR. LAWROSKI: Yes.

DR. CARBON: Do you wish to say anything today?

DR. LAWROSKI: I think it remains still very important. I'm sure the people have heard about it but it doesn't hurt to reiterate it.

DR. SIESS: What was it?

DR. LAWROSKI: The importance in the operator training of making sure that the core is always covered.

DR. OKRENT: You may not always be able to keep the core covered.

DR. LAWROSKI: Or that it gets cooled as well, if you can't keep it covered.

DR. SIESS: That's the importance difference, I think. Keeping the core covered is nice, but keeping the core cool is what we want.

DR. SIESS: If the operator were looking at temperatures rather than level indications, he'd be in an entirely different situation.

DR. LAWROSKI: He has to look at whatever information was useful to ascertain that.

DR. OKRENT: I think this is a subset of the general question that, in fact, was identified in our letter. And I for one, would like to learn what is known about these transients and what is learned in the near future and how this relates to operator training and the information that can be made available

agb4

to them.

I'm not quite sure what I would tell Commissioner Bradford if he asked now what should we go out and tell the Staff to tell the operators to do if all we said was tell the operators to keep the core covered.

(Laughter.)

DR. CARBON: Well where do we stand?

DR. PLESSET: There was one that Michaelson brought up and that's regarding --

DR. CARBON: Are you still on --

DR. PLESSET: I thought we finished with that -- I'm sorry, I thought we were finished, go ahead.

MR. RAY: Is the need here to decide what they should tell the operators, or that we emphasize the need for training, regardless of what training has been done before, emphasize now to the Commissioners that there is an urgent need that operators be training specifically in this area. I think that's the important thing.

DR. CARBON: That could be one definition of this, yes.

DR. OKRENT: Again, though, I have a feeling we have to be careful about giving an operator very strong guidance with respect to a specific situation which may lead him to react adversely to the next situation.

So I guess this is why I've been sort of urging

agb5

some rather aggressive program of looking at what I will call anomalous transients and so forth and see what are the various ranges of things that can develop and what should the instrumentation be doing and what are the various actions -- if there is then a clear pattern and the operator always can look at two instruments and from these know what to do, then it's simple. If there are some where he has to keep another factor in mind, you know, then his instructions have to be somewhat different.

This is the only hesitation I have. What is it you are going to have the people tell the operator to look for? He's been trained to handle a range of things already and we're thinking about the other things, and do they all have one pattern to them.

DR. SIESS: I agree with Dave. This is a very complicated subject. It gets down to what's the operator going to do, what's the machine going to do, what's automatic, what isn't. And it's going to require a lot of study.

It's the man/machine interaction all over again. And I think the analyses have to be made looking at things the operators could do wrong that they should be told not to do and things they should do right that they should be told to do and keep the list as simple as possible. It's not something you're going to come up with in a couple of weeks.

DR. CARBON: Shall we, then, drop this and not cover

agb6

it today?

Item Number 10, I think, was simply asking for information, the chronology of radiation level of the transient at Three Mile Island.

I then go back to the about 29 items that we listed this morning, and let's try and go through those very quickly to see what you want to do, to which you want to put high on the priority list.

The first one was natural circulation.

Harold, do we want to say more?

MR. ETHERINGTON: I personally don't, I think I've said enough.

DR. SIESS: I think we should inform the Commissioners that we have expressed a number of concerns about the ability to get to natural circulation and stay there, and that these were addressed to the Staff and B&W and I suspect some of them apply to other PWRs. But addressing it to the Staff certainly took care of that. But I think we should tell the Commissioners about that.

DR. CARBON: Does that seem reasonable?

MR. ETHERINGTON: Yes.

DR. CARBON: Good.

And Number Two?

DR. SIESS: I think it might be worthwhile to make clear that our concern about natural circulation is of two

agb7

kinds. One is natural circulation in Three Mile Island 2, which is under some abnormal conditions now and there are a number of proposals which the Staff is looking at very thoroughly, but also the question of natural circulation as the standard procedure for a number of transients.

MR. ETHERINGTON: I think Number Two has been so well analyzed I'm not really concerned about it, the Three Mile Island.

DR. SIESS: That's Number One.

I think if we just mention natural circulation, they're going to take it in the context of Three Mile Island. So I think when you make the point, make it clear that we're not that much -- that we're concerned, but we think that that is in good hands, but we're looking at the other cases where natural circulation is the expected mode of operation after certain transients.

DR. CARBON: And Number Two is whether thermocouples below the core are being utilized in an optimum way, having the temperatures available and off-scale, use of existing equipment, action in this direction.

C3

MR. RAY: What would you think of the merits of extending that to suggest that they be qualified as safety equipment? They're not qualified now as I understand it.

DR. SIESS: Do we know whether the other PWR vendors also have thermocouples at the top of the core?

agh8

MR. ETHERINGTON: Some do but they also say they're not replaceable, they expect them to last a long time, but when they go they have no intention of replacing them.

DR. SIESS: I recall that from several years back and I don't know whether things have changed or not. They were in there for pre-op testing and early tests and verificiation of analyses.

Are they replaceable?

endlE

MR. RAY: I don't see why they should be.

1F

Bill, do you know what the element in the thermocouple and its circuitry is that might be susceptible to short life? Is it the insulation?

MR. MATHIS: I'm not familiar enought with it.

MR. RAY: If it is insulation, there's a lot of development that has taken place in the cable industry with the development of insulation that is better able to live through radiation conditions and so on. How severe those are compared to Three Mile Island, I don't know.

DR. SIESS: How many thermocouples are still operating at Three Mile Island Unit 1? Can B&W answer that?

MR. TAYLOR: 49, Dr. Siess.

DR. SIESS: At Unit 1?

MR. TAYLOR: Oh, at Unit 1, I can't answer that. I don't know of any problems with them.

DR. SIESS: Are they replaceable in your reactors?

agb9

MR. TAYLOR: Yes.

DR. CARBON: Jerry, I wonder if that might not be one we could leave as a little bit longer term.

MR. RAY: Okay. It's something I think maybe some information might be obtained on the insulation of leads that would be connected in series with the thermocouple elements if that is the weak spot, and I suspect it is.

DR. CARBON: I think we could ask the Staff for that.

DR. LAWROSKI: I'm not sure I understand what you mean when you say used optimally.

MR. RAY: Let's say to endow the components that are in the thermocouple circuits with the capability to last as long as possible in the environment that is characteristic

3.030 of where they're going to be. They include containment if this is the way they're handled or if they're taken to a converter or a transmitter within containment, that that element also be qualified.

DR. CARBON: I think Steve is asking a different question. This was Dave's point.

I think what he meant was -- although he can speak for himself, I think he was saying that there are thermocouples there. Make use of them.

MR. RAY: Oh, yes. All I'm doing is expanding the requirement.

agb10

DR. CARBON: The original point in the optimum way was to get them out, get temperatures where you can read them.

MR. RAY: Use them, in other words.

DR. LAWROSKI: This is what you mean by optimum? Okay, I just wanted to be clear.

DR. CARBON: Is that correct, Dave?

DR. OKRENT: Yes.

MR. RAY: My thought was an extended requirement.

DR. CARBON: Well with regard to the optimum way sort of thing, do we want to make comments on that today?

DR. OKRENT: I think it's reasonable to recommend implementation of changes expeditiously to use such thermo-couples as are available. I would not propose any early requirement that they be safety-grade or so forth. I think we should look at that in connection with other kinds of instrumentation.

DR. SIESS: You're saying if they have them, fix them so they can use them.

DR. OKRENT: Right.

DR. SIESS: If they will read 800 or 900 degrees or 1000, have them record that or display it.

DR. OKRENT: Both record and display.

DR. SIESS: But if they're not there, don't put them in right away or --

DR. OKRENT: I wouldn't make it a regulatory a gbll

requirement.

MR. FRALEY: I would like to suggest that you also add to the same recommendation thermocouples in the tailpipes of the relief valves. I think if they shut those relief valves early in the transient, it will not be a very significant event.

B&W tells us there are thermocouples in the tailpipes. I think they're printed out on the same computer printout. I think they also ought to be made readily available to the operator and any other indications of holes in the primary coolant system, pump seals or whatever else is available.

I don't know that there are others but, whatever there is available, I think if we're able to isolate it earlier, it would much a much less serious transient. And if it does happen to the tailpipes, that's because no one told us.

DR. CARBON: Is that acceptable to everyone, that we will mention this topic and include both the core thermocouples and the tailpipe thermocouples?

This is taking a long time and I'm wondering if there's any way we could do this in a quicker fashion.

DR. OKRENT: I have a suggestion, that most of you go out to lunch and a couple of us try to write something for you to look at.

DR. CARBON: Including picking up the ones from these?

agbl2

DR. OKRENT: We'll try to make it a little bit on the long side, so that those of you unlikely to -- well you might be interested in it, in what we try to include but there would be some guess involved.

DR. PLESSET: That sounds like a first rate suggestion.

I was just going to mention one thing, Dave. This idea of the pressurizer heaters having emergency capability --

DR. OKRENT: I would assume that would be on our list.

DR. PLESSET: I thought that was a very good, a very useful suggestion.

DR. CARBON: It sounds like a good suggestion.

Does anyone want to bring anything else up before we break for lunch? Would you like to ask any people in particular to stay with you?

DR. OKRENT: My experience is that Siess is very skillful, but he has a lunch date already, I believe.

Carl and Harold Etherington, if they can stay.

DR. CARBON: You don't have a lunch date by definition.

MR. ETHERINGTON: Okay.

DR. CARBON: Carl, can you stay and Walt?

MR. LIPINSKI: Yes.

MR. MICHAELSON: Yes.

agbl3

DR. CARBON: Let's break for lunch, then, for an hour.

(Whereupon, at 12:20 p.m., the hearing in the above-entitled matter was recessed, to reconvene at 1:20 p.m., this same day.)

Ace-Federal Reporters, Inc.

68 107

1Fcont'd
agbl

3.090

AFTERNOON SESSION

(2:00 p.m.)

DR. CARBON: Let's resume the meeting.

You have in front of you a draft letter, the first page of which is typewritten, the rest of it in handwriting. The secretaries are typing the rest of it right now and maybe by the time we get through, we'll have a typed version.

I would think maybe it would be appropriate to -- certainly either for us to read through it by ourselves or perhaps, better yet, to ask someone to read through it.

Dave, would you be willing to read through it?

DR. OKRENT: If you like.

Let me say first that what we tried to do is pick out those items on which we thought the Committee might want to make a comment at this meeting, and then we tried to phrase these in the way that the Committee might put it into a letter. We didn't know whether the Committee wanted to write a letter or not. We may have erred in our choice of which topics the Committee thinks it wants to comment on.

So with those apologies....

DR. CARBON: Okay. Fine.

DR. OKRENT: "During its Special Meeting, April 16-17, 1979, the ACRS continued its review of the circumstances relating to the recent accident at the Three Mile Island Nuclear Station Unit 2.

agb2

During this review, the Committee had the benefit of discussions with representatives of the Babcock and Wilcox Company and the Regulatory Staff. The Committee provided a first interim report on April 7, 1979.

"Natural circulation is an important mode of reactor cooling, both as a planned process and as a process that may be used under abnormal circumstances. The Committee believes that greater understanding of this mode of cooling is required and that detailed analysis should be developed by Licensees or their suppliers. The analyses should be supported, as necessary, by experiment. Procedures should be developed for initiating natural circulation in a safe manner and for providing the operator with assurance that circulation has, in fact, been established. This may require installation of instrumentation to measure or indicate flow at low water velocity.

"Normal operating limits are reviewed by the Regulatory Staff in detail and are formalized in the Technical Specifications for the unit. Shutdown procedures are also reviewed by the Staff, but the Committee believes the review may not be made in the same depth as the operating limits. The Committee

agb3

suggests that consideration be given to requiring the Licensee to prepare a formal document for NRC approval, defining limits for shutdown modes."

By the way, these are not necessarily in a logical order. They were stapled together at random.

"The Committee recommends that contingency studies be made for operating nuclear power plants to ascertain what additional measures might be taken to limit the extent and consequences of a serious accident.

"The ACRS recommended that operating power reactors receive priority with regard to the definition and implementation of instrumentation which provides additional information to help diagnose and follow the course of a serious accident. This should include improved sampling procedures under accident conditions, and techniques to help provide improved guidance to off-site authorities, should this be needed. The Committee recommends that a phased implementation approach be employed so that techniques can be adopted shortly after they are judged to be appropriate.

"The ACRS recommends that a high priority be placed on the development and implementation of safety research on the behavior of light water reactors

agb4

during anomalous transients. The NRC may find it appropriate to develop a capability to simulate a wide range of postulated transient and accident conditions in order to gain increased insight into measures which can be taken to improve reactor safety.

"The ACRS wishes to reiterate its previous recommendations that a high priority be given to research to improve reactor safety.

"The exit temperature of coolant from the core is currently measured by thermocouples in many PWRs to determine core performance. The Committee recommends that these temperature measurements, as currently available, be used to guide to operator concerning core status. The range of the information displayed and recorded should include the normal operating range as well as the maximum temperatures which can be expected under accident conditions. It is also recommended that other existing instrumentation be examined for its possible use in assiting operating action during a transient.

"The use of natural circulation for decay heat removal following a loss of off-site power sources requires the maintenance of a suitable overpressure on the reactor coolant system. This

agb5

overpressure may be assured by placing the pressurizer heaters on a qualified on-site power source with a suitable arrangement of heaters and power distribution to provide redundant capability. Presently operating PWR plants should be surveyed expeditiously to determine whether such arrangements can be provided to assure this aspect of natural circulation capability.

"The plant operator should be adequately informed at all times concerning the conditions of reactor coolant system operation which might affect a capability to place the system in the natural circulation mode of operation or to sustain such a mode. Of particular importance is that information which might indicate that the reactor coolant system is approaching the saturation pressure corresponding to the core exit temperature. This impending loss of system overpressure will signal to the operator a possible loss of natural circulation capability. Such a warning may be derived from pressurizer pressure instruments and hot leg temperatures in conjunction with conventional steam tables. A suitable display of this information should be provided to the plant operator at all times. In addition, consideration should be given to use of fuel exit temperatures,

agb6

where available, as an additional indication of natural circulation."

"Consideration should be given to the desirability of additional status monitoring on various engineered safeguards features and their supporting services to help assure their availability at all times.

"The ACRS is continuing its review of the implications of this accident and will provide further advice as it is developed."

DR. CARBON: Paul?

DR. SHEWMON: There's a general question with regard to what the NRC should have available to it the next time that a grass fire develops of some sort. We don't address ourselves to that at all. There's an awful lot on operations of reactors in here.

My strong feeling is that they were quite weak with regard to anybody who understood chemically what was going on or might be going on inside the core of that reactor, And this made them come out with the statements which were, you know, which scared people and were dead wrong.

And in general, there is a weakness in the water chemistry effort because they apparently feel it is so well under control, they don't do very much on it. I don't know that -- I guess it's a heartfelt conviction at this point,

agb7

which is totally not reflected in here. And maybe they appreciate all this now, but then they probably appreciate most of what we're saying to them anyway, and so that's not a reason for taking it out.

DR. CARBON: Dave?

DR. OKRENT: Well, I think at least in part what Paul is referring to was the concern for possible oxygen buildup in the primary system, which when people looked at more carefully, they decided that recombination would go rapidly and you wouldn't get it. So that alleviated what I understand to be one of the concerns of people working 24 hours around the clock on Friday, for example, and Saturday.

I think, in fact, had people studied what I will call degraded accident conditions, they might have developed a transient where you released a certain amount of hydrogen in a reactor system that was bottled up, and they would then have been forced to ask themselves where does this hydrogen go and does it develop a bubble and do you get oxygen and so forth in the same way that, in fact, the LOCA has been studied exhaustively.

So what I'm getting at indirectly is if, in fact, there were more examination of what I have called anomalous transients and so forth and not just how to prevent them but what happens if they occur even though you have tried to prevent them, you might then have studied some of these conditions.

agb8

DR. SHEWMON: You might. But then my main point was that they said, you know, you've got all this hydrogen up there, the rate of oxygen buildup is the following, it can become explosive, you know, it's dangerous nonsense and if they had known how to ask the right question they would never have come out with those. That's partly a weakness I think they recognized.

There's the broader question of what we suggest they do so that they can, on the scene, cope with predictable consequences and marshall their forces somewhat better in that way.

I don't think any bunch of thermohydraulics people running contingency problems with any kind of a computer are ever going to come up with this kind of information that will be of any use to somebody facing another problem. It's just different kinds of people talking about different things at different times.

DR. CARBON: Would you care to put a paragraph together to be mixed in here for consideration?

DR. SHEWMON: I could, yes.

DR. CARBON: Fine.

DR. SHEWMON: There are two questions, though. There's one, the chemical capability, and the other is, do we wish at all at this point to get into advice on what sort of things they might do so that they would have a squad and a home

agb9

base group organized to advise them competently on questions of this sort the next time it comes up. There are two questions, I think.

DR. LAWROSKI: I think the latter needs more time to develop. I think it's going to take quite a bit of thinking on their part and on our part.

DR. SHEWMON: I don't say we're ready, I say it's something we have completely ignored or skipped.

DR. CARBON: Are there other comments, general comments?

DR. SIESS: I guess this is general, at least three of these items relate to natural circulation. I think we might try to consider them together, when we do.

That's the last one, the one on the pressurizer heaters and the diesel and the saturation pressure indication.

DR. OKRENT: That's true. As I tried to indicate, they were stapled at random.

DR. CARBON: Bill?

MR. MATHIS: Well the last item on the introductory portion of the letter is really a long-term kind of item. The first item of the handwritten items is also long-term.

DR. CARBON: Which was your first one?

MR. MATHIS: The last paragraph on the typewritten portion, Page Two.

agb10

DR. CARBON: Oh, yes.

And the first handwritten one, you say?

MR. MATHIS: The first handwritten one, which is Number Six.

Number Seven again is pretty much the same thing, it's long-term.

Then we get into near-term things, which I think is more a propos for today.

There are some other things, though, that really aren't in here yet. I think one of the things that Walt talked about this morning is something that could be implemented early in the game, on the indicators on valve position. And then other items --

DR. OKRENT: Excuse me. We tried to cover that on the last page, but in a general way.

MR. MATHIS: Well, some of the other specifics, maybe we don't want to hit them here, but we talked about emergency planning and these were things that would be applicable to other plants that are running today that should look at these kinds of items. Sampling capability, we talked about that in general.

DR. CARBON: Review shared facilities, that's not in here.

DR. OKRENT: We didn't know whether we wanted a little more information on that or not. We didn't know whether agbll

we should try to write one there or not. We ran out of time.

MR. MATHIS: I realize that.

DR. OKRENT: Again, if you have appropriate words there, I think you ought to try.

MR. MATHIS: I said my piece this morning. I didn't think we had time to do this. I'll quit.

DR. CARBON: Chet?

DR. SIESS: Well, are we going through the items --

DR. CARBON: I'm not sure, I got diverted here a moment and I didn't catch the last of Bill's comments.

DR. SIESS: He was mentioning items he thought might not be included, are we still on that subject?

DR. CARBON: We're still on the general.

Bill, the comments you were making about items not included, I missed part of that. Did it turn out that essentially all of them are included in a general way, or are there some that --

MR. MATHIS: Well, some of them are, Max. I didn't attempt to go through that in that much detail.

I guess the problem I still have is, is this the time and do we want to devote this much attention to what I consider longer-term items such as research and development kind of things?

I agree we need to get into that, but I question the advisability of attempting to do it today. We could

agbl2

mention it but, I mean, to put it in writing, I just don't feel we're ready.

That's the end of my comment.

DR. SHEWMON: Is that with regard to the whole letter or just with regard to some of the particular items?

MR. MATHIS: Item-by-item.

But, if you want to get into the question of whether or not we should write a letter today, then I would still vote no on a letter today.

DR. CARBON: Are there other general comments?

(No response.)

DR. CARBON: Do we want to go through item-by-item, or make a decision first on whether we're talking about writing a letter or discussing this with the Commissioners?

DR. OKRENT: I think if we're going to discuss this with the Commissioners, and if we are able to complete a letter that we think is okay except for editorial matters which we can leave to the Chairman, then I would favor us trying to do it. I don't know whether time permits.

I am not inclined to leave matters in or out on the basis of whether they are something that can be implemented immediately or not. I think I would take each item on its merits.

DR. CARBON: I'm not sure but that we could finish all of it in an hour if we chose to.

agbl3

MR. ETHERINGTON: It'll be a record if we do.

DR. SIESS: It'll be a miracle if we do.

MR. MATHIS: Could I add some other comments?

Maybe the thing to do is to put together really an outline here, and it's pretty well done, of things that we've considered, things that should be brought to their attention. Just talk to this point this afternoon and then follow up with a letter. Is there anything wrong with that approach, rather than attempting to rush into it this fast?

DR. CARBON: It could certainly be done.

DR. PLESSET: I was out of the room, I'm afraid, for a critical moment. How come this was delivered to everybody in the room essentially, because this is so far, in my view, to the kind of letter we will write that it seems unfortunate that it be given out in written form. I hope people are aware that this may not be related to what we write when we write a letter.

DR. OKRENT: I gave preliminary comment before I read it when I was asked to read it.

DR. PLESSET: That this was scratch paper?

DR. SHEWMON: I'd be interested in discussing that. Usually we are in closed session when we write letters. Today we hand out drafts yet.

DR. CARBON: It seems in compliance to what we're supposed to do, though.

agbl4

DR. SIESS: Mr. Chairman, I would like to suggest we go through this item-by-item but group the three items -- group the items as we can see it. I can see a grouping of three on natural circulation.

I think one criterion as to what we discuss with the Commissioners today versus what we might put off until the next meeting should be the degree of specificity that we have in the recommendations. Some of these are a little more general, and they tend to be what was described as terse, technical and cryptic, and I think we could improve on them with time. And I'll comment on those as we go through them.

But I propose we start with the three items that relate to natural circulation and see whether we agree on them.

DR. CARBON: It sounds fine, let's do it.

Dave, would you go through paragraph by paragraph?

endlF1

DR. OKRENT: I'll try.

1F2 wbl

DR. CARBON: And which are the three that --

DR. SIESS: Natural circulation is the first item on the first page, the second paragraph. Pressurizer heaters on page ten, and the item on page eleven. I guess eleven and twelve is the same item, and they both refer to natural circulation and I think they are related to it.

Do you agree, Harold?

MR. ETHERINGTON: Yes.

DR. OKRENT: Logically they should have been arranged in such an order.

DR. CARBON: Why don't you combine those three and go ahead, then?

DR. OKRENT: "Natural circulation is an important mode of reactor cooling, both as a planned process and as a process that may be used under abnormal circumstances. The Committee believes that greater understanding of this mode of cooling is required and that detailed analysis should be developed by licensees or their suppliers. The analyses should be supported, as necessary, by experiment. Procedures should be developed for initiating natural circulation in a safe manner and for providing the operator with assurance that circulation has, in fact, been established. This may require installation of instrumentation to measure or indicate flow at low water velocity."

wb2

DR. SIESS: You mentioned abnormal circumstances. As I understand it, natural circulation is a mode you get into on loss of offsite power. Is that an abnormal circumstance?

MR. ETHERINGTON: Is it intended to mean something more abnormal than that?

DR. SIESS: You don't have any problem with getting into natural circulation in a routine normal loss of offsite power?

MR. ETHERINGTON: You shouldn't have.

DR. SIESS: Okay.

DR. OKRENT: I think then we skip to page ten, or No. 10, it's not really page ten. I'll try to read with more volume.

> "The use of natural circulation for decay heat removal following a loss of offsite power sources requires the maintenance of a suitable overpressure on the reactor coolant system. This overpressure may be assured by placing the pressurizer heaters on a qualified onsite power source with a suitable arrangement of heaters and power distribution to provide redundant capability. Presently operating PWR plants should be surveyed expeditiously to determine whether such arrangements can be provided to assure this aspect of natural circulation capability."

wb3

DR. CARBON: Comment?

(No response)

DR. CARBON: Go on to No. 11, then.

DR. OKRENT: "The plant operator should be adequately informed at all times concerning the conditions of reactor coolant system operation which might affect a capability to place the system in the natural circulation mode of operation or to sustain such a mode. Of particular importance is that information which might indicate that the reactor coolant system is approaching the saturation pressure corresponding to the core exit temperature. This impending loss of system overpressure will signal to the operator a possible loss of natural circulation capability. Such a warning may be derived from pressurizer pressure instruments and hot leg temperatures in conjunction with conventional steam tables. A suitable display of this information should be provided to the plant operator at all times. In addition, consideration should be given to the use of fuel exit temperatures, where available, as an additional indication of natural circulation."

I guess that was fuel subassembly exit temperatures.

DR. SIESS: The last sentence seems to relate to

wb4

the comment about the core exit thermocouples.

DR, OKRENT: Yes.

DR. CARBON: Is there comment on that paragraph?

DR. SIESS: Those are the three items on natural circulation. Would it be appropriate to follow those with the one on Item 8 about core exit temperatures?

DR. OKRENT: Either that or the one -- the shutdown mode review. Take your choice. We can leave that really for editorial--

Shall I read the exit temperature one?

DR. CARBON: Hold up just a second.

Is there general agreement that these three paragraphs are important, pertinent, and so on?

DR. OKRENT: If we're not careful we'll have time left over.

DR. SHEWMON: This is on page 8 that we just got done reading?

DR. CARBON: No. Ten and eleven.

SHEWMON: Okay.

DR. OKRENT: Eleven and twelve.

DR. SHEWMON: Have you done page 8 yet?

DR. OKRENT: I was just going to start 8.

"The exit temperature of coolant from the core is currently measured by thermocouples in many PWRs to determine core performance. The Committee

wb5

recommends that these temperature measurements as currently available be used to guide the operator concerning core status. The range of information displayed and recorded should include the normal operating range as well as the maximum temperatures which can be expected under accident conditions. It is also recommended that other existing instrumentation be examined for its possible use in assisting operating action during a transient."

d 1F2

68 126

lg ebl

DR. CARBON: Is there comment?

DR. SHEWMON: I have no complaints at all down to about two-thirds of the page, and then we go into the range of information displayed. I don't know whether this is a new paragraph. If it's not a new paragraph, it seems to me the maximum temperatures which are expected under accident conditions, all of a sudden we're off to several thousands degree that that's not the kind of thermocouples we have. It's a completely different recommendation.

DR. OKRENT: You're right. Accident conditions is an ill-defined term.

I think what we mean, and which is not stated here is they should take these thermocouples up to the full range for which they are capable.

DR. SHEWMON: The full range of existing equipment, and not cut it off.

DR. OKRENT: This would give information as you can with those thermocouples and it doesn't say that the termocouples have to cover all possible temperature ranges. I think that's something that could be picked up.

DR. SIESS: Why don't we simply say "extended for an appropriate amount beyond the normal operating range."

If their capability was pretty high you might not want to go up higher because it might affect your sensitivity accuracy at the lower levels where you need them for something

eb2

else.

DR. CARBON: Walt?

MR. LIPINSKI: The conventional thermocouple up there has considerable range and if these are digitized, it is just a question of whether you want three digits, nine, nine, nine, or four digits. And if they have the capability of going up and giving the information, then I would recommend that they go full range, up to their destruction point.

DR. OKRENT: Why not say:

"The range of instrumentation information displayed should encompass the capabilities of the thermocouple."

MR. ETHERINGTON: "The range of the information." Does that mean the instrument range or....

DR. SHEWMON: Is the instrument you're talking about the thermocouple?

MR. ETHERINGTON: Does this mean the range or the scope?

DR. SIESS: Why don't you say:

"The information displayed should include the full capable range of the instrumentation of the thermocouples."

DR. OKRENT: I think we know what we mean here, and perhaps somebody would like to reword it.

DR. SIESS: Not today.

eb3

Larry Crocker is sitting here. He knows what we mean.

DR. SHEWMON: The full capable range of the thermocouples.

DR. OKRENT: Shall I go on then to the bottom of the first page?

DR. CARBON: Just a second.

Is there general agreement that this is a pertinent and important paragraph? I guess so.

Go ahead, yes.

DR. OKRENT: At the bottom then of the first page:

> "Normal operating limits are reviewed by the Regulatory Staff in detail and are formalized in the Technical Specifications for the unit. Shutdown procedures are also reviewed by the Staff, but the Committee believes the review may not be made in the same depth as the operating limits. The Committee suggests that consideration be given to requiring the licensee to prepare a formal document for NRC approval, defining limits for shutdown modes."

DR. CARBON: How about you starting off by defining what you mean by "limits for shutdown modes." I don't really know what you're talking about.

DR. OKRENT: Harold, do you want to try?

MR. ETHERINGTON: There are procedures. We know

eb4

that. And they are looked at by the Staff. But there's no formal document that says when you shouldn't transfer from one mode of cooling to another.

DR. SIESS: By "mode of cooling" you mean going to RHR?

MR. ETHERINGTON: Yes.

DR. SIESS: Because the Staff has recently been reviewing procedures for getting to cold shutdown in quite considerable detail on all the plants, and I was trying to relate this to those studies. They've been looking at the ability to get to cold shutdown using only safety grade equipment, but I guess the limits aren't in there.

MR. ETHERINGTON: I would suggest we drop this particular item.

DR. SIESS: I would suggest we drop it until we have time to discuss it further and sharpen it up, which I don't think we can do in the time we have today, --

DR. CARBON: Is there agreement on that?

DR. SIESS: -- although if we finish up as Dave says in the next ten minutes, we can come back to it.

DR. SHEWMON: Is this the whole paragraph, or the last sentence?

DR. SIESS: The whole paragraph.

DR. OKRENT: We'll put it in deferred status.

DR. SIESS: Okay.

eb5

DR. PLESSET: That's called limbo.

DR. OKRENT: Now let's see if there's some logical order to the remaining items.

There is one at the very back, number 14:

"Consideration should be given to the desirability of additional status monitoring on various engineered safeguard features and their supporting services to help assure their availability at all times."

DR.SHEWMON: That has to do with computers and so called human-machine interface problems, the man-machine interface problems, and so on?

DR. OKRENT: This could apply to important valves, breakers, or so forth, that might not now have status indicated automatically in the control room. I think Michaelson made the point that we want to be careful about trying to do it with all systems.

DR. SHEWMON: Does "status monitoring" imply more subtle things like status of the system vis-a-vis the saturation pressure and temperature?

DR. OKRENT: No. I think in this case what is intended is is the valve open or closed; equipment.

c4

DR. OKRENT: It's an effort to respond to this matter which was discussed, but we didn't try to give a detailed recommendation.

eb6

MR. RAY: If you will tolerate a little word engineering I would suggest you put either the word "facility" or "equipment status monitoring," to avoid the misunderstanding.

DR. OKRENT: How about "additional equipment"?

MR. RAY: Okay.

DR. OKRENT: "Equipment status monitoring."

MR. RAY: Whether or not you want to indicate now the idea of a computer is immaterial. It's just that if you did mention it now you might stimulate some development at an earlier date than would otherwise be the case.

DR. OKRENT: My proposal is the letter be called a Second Interim Report, and then propose a third one.

DR. SHEWMON: I don't understand that as a response to the question of whether we should put the word "computer" in the paragraph.

DR. OKRENT: I was being facetious. Some of these things we can do without computers and some of them will require computers.

DR. SIESS: If there's too much on the computer they don't see it.

DR. CARBON: Is there general agreement on this paragraph? It says "additional equipment status monitoring." Insert the word "equipment."

Let's go on to the next one.

DR. OKRENT: In no particular order. I suppose we

eb7

can look at number two now.

"The Committee recommends that contingency studies be made for operating nuclear power plants to ascertain what additional measures might be taken to limit the extent and consequences of a serious accident."

DR. SIESS: That's one that I think needs to be expanded on to where it is clearer. I don't think anybody would know where to start with just "contingency studies," unless it is-- I mean if it is urgent enough that we want to mention it now I think we could be more specific, and if it is not that urgent, we can wait until it can be made more specific.

I don't know whether this covers emergency plans, offsite state plans, or what.

Mr. Chairman, I move we defer this until it can be expanded, which may be later today or it may be at the next meeting.

DR. SHEWMON: Is there agreement?

Let's defer it.

DR. OKRENT: The next one, which is called six:

"The ACRS recommends that operating power reactors receive priority with regard to the definition and implementation of instrumentation which provides additional information to help diagnose and follow the course of a serious accident. This should

eb8

include improved sampling procedures under accident conditions and techniques to help provide improved guidance to offsite authorities, should this be needed. The Committee recommends that a phased implementation approach be employed so that techniques can be adopted shortly after they are judged to be appropriate."

DR. CARBON: Is there comment?

DR. SIESS: I guess I still have the problem of whether if somebody got this just in writing, whether they would know how it relates to Reg. Guide 1.97, whether they would start thinking that, or would they look beyond it.

The first sentence, you know, doesn't get you off of 1.97. The second sentence tends to move you quite a ways away from it because the two examples that are mentioned are not related at all to what is in there.

DR. OKRENT: The two examples I think augment what is now in 1.97.

I don't feel, in order to make this recommendation, we have to solve problems, in other words come up with a whole list of instrumentation.

DR. SIESS: No, but is this an endorsement of 1.97 and then going a little beyond it? Is that your thought?

DR. OKRENT: I don t know what the word "endorsement" means in that context.

eb9

DR. SIESS: Is this in addition to, rather than instead of 1.97?

DR. OKRENT: I think myself that specifically 1.97 can be improved upon. In other words, we could do better than 1.97. In fact I'm sure of it.

DR. SIESS: I agree.

DR. OKRENT: So now I don't know whether it's in addition or instead of.

In fact, one of the things that I mentioned earlier was the R^3C Committee sort of took the position that they would apply it not only to plants being constructed but operating plants should be looked at on a case-by-case basis. But what this tries to do is to say operating reactors get priority, and if you have things you decide are useful, don't wait until you have the whole story.

DR. SIESS: In practice, only position C-3 is getting the treatment you mentioned. There is nothing being done about position C-1 and C-2. They've got a Task Action Plan which is trying to figure out what should be done, and it is only the wide-range instrumentation that they're requiring even on new plants.

DR. OKRENT: I don't really think it's all that hard to figure out something you can do with the existing technology. That's all.

DR. SIESS: No, it's just that hard to do it in

eb10

accordance with the provisions of the Regulatory Guide, which is very formal.

DR. OKRENT: That's why I do not wish to endorse the Regulatory Guide *per se*.

DR. SIESS: That's what I'm trying to understand.

I think I can go along with this paragraph a lot better than I can go along with Reg. Guide 1.97, as long as this paragraph doesn't mean do what is in 1.97 and then go beyond it.

DR. OKRENT: I don't think it says that.

DR. CARBON: Is there general agreement on it? Fine. Go on.

DR. OKRENT: I guess we didn't read what is on page 7, or number 7.

DR. SIESS: Incidentally, a couple of items we have already discussed, like core exit thermocouples and saturation pressure monitor sort of follow from this, too.

DR. OKRENT: We regard to core exit temperature, we made the recommendation that you've got to use it. This is now in terms of things that they should add.

DR. SIESS: And it sets a different kind of priority, I think.

DR. OKRENT: Yes.

"The ACRS recommends that a high priority be placed on the development and implementation of

eb11

safety research on the behavior of light water reactors during anomalous transients. The NRC may find it appropriate to develop a capability to simulate a wide range of postulated transient and accident conditions in order to gain increased insight into measures which can be taken to improve reactor safety.

"The ACRS wishes to reiterate its previous recommendations that a high priority be given to research to improve reactor safety."

Henry Meyers is sitting in the room and I will just jog his memory that we didn't get money last year and we didn't get money this year, so even if it's not in the letter, still it's encouraging.

DR. CARBON: Is there general agreement on this? Is the last sentence intended to be part of the--

DR. OKRENT: It doesn't have to be; either way.

DR. PLESSET: Leave it out.

DR. OKRENT: It's related. This is in fact-- It could be interpreted as an aspect of one of the things that was to be done in the research to improve reactor safety. There's a topic called man-machine interaction. That's why I included it, sort of as part of the same thought.

DR. CARBON: I have no objection to--

DR. SIESS: I think if we wrote a letter we could

eb12

include that and say:

"....research to improve reactor safety
which includes at least one item especially pertinent
to this problem."

DR. OKRENT: Well, in fact it includes what I would call contingency matters. What are contengency matters? Fully vented containment is one.

DR. SIESS: That helps me understand it.

DR. OKRENT: Good.

MR. RAY: I suggest we leave it in.

DR. SIESS: Which one? The last sentence?

MR. RAY: Yes.

DR. SIESS: As a separate paragraph, or add it into the previous paragraph?

MR. RAY: Yes.

DR. SHEWMON: I have trouble with it. We sort of write a report each year on this saying we're in favor of reactor safety. Why reiterate it?

DR. OKRENT: Unless something has happened recently, the last time I heard, they were still waiting to have some Committees in Congress approve the allocation of money or something, and there was only half of a rather modest amount.

DR. SHEWMON: But the whole research program is to improve reactor safety.

DR. SIESS: Let's not get into that.

eb13

DR. SHEWMON: Well, then why get into this whole paragraph? That's what I'm trying to understand.

DR. SIESS: The distinction has been made between confirmatory research and research to improve reactor safety, and it's not at all clear what the Congress meant or what the NRC meant, and I don't think this is a suitable time to debate it.

But research to improve reactor safety has a very specific meaning within the Commission now, and in the law, and it's a separate line item in the budget.

DR. CARBON: Is there general agreement to leave it in?

DR. LAWROSKI: I think it should be left in.

DR. SHEWMON: I second.

DR. CARBON: To leave it in?

DR. SHEWMON: You said to do what?

DR. LAWROSKI: Leave it in.

DR. SHEWMON: Oh.

MR. RAY: I second.

DR. CARBON: Unless Paul wishes otherwise, I will just assume there is a consensus, but if you want I'll take a vote.

Let's leave it in and go ahead. The last sentence becomes part of the preceding paragraph.

DR. OKRENT: Now Paul, you wrote a paragraph, didn't

eb14

you?

Can we have it?

DR. SHEWMON: THere are two things that are new in front of you. Mine is the second sheet. I will edit it slightly.

"The NRC should re-examine their organization and capability in the area of chemistry, especially water chemistry. It has very limited research expertise in this area to call on in time of need. This was obvious from the misinformation that was the basis for disturbing speculation and possible hydrogen-oxygen explosions in the reactor pressure vessel a few days into the accident."

DR. LAWROSKI: Water chemistry has had a connotation that doesn't include this. It's primarily aimed, as you well know, Paul, at treatment to help minimize corrosion.

DR. SHEWMON: I think they're weak there, too, but that's a separate point.

DR. LAWROSKI: This matter of misinformation, I think the misinformation was the lack of somebody -- I don't know whether it was in Bethesda when -- I'm only getting this third hand, I believe. Maybe it is even fourth hand, that in asking for some information, the requesters failed to indicate that the system was under some, you know, 1,000 or 1,500 psi. Without that information of course you'll get the radiolysis

eb15

rate of water.

DR. SHEWMON: That's my point. You have to have a certain amount of sophistication that's needed to ask the right questions about it.

DR. LAWROSKI: I don't know whether that was a lack of expertise or just the failure to--

DR. SHEWMON: You don't know whether it was organization or capability, to go back to the first line. We agreed, though, that there was misinformation.

DR. LAWROSKI: Yes-- Well, I don't know that I would define it as misinformation as opposed to lack of information.

But in addition, this is a sort of a small sample of what should be included in the subject. I think the whole matter of how to fix iodine in the water and so on might be at least as important as the example cited here. And of course if we're going to talk about all power reactors, there's a little bit of the familiar stress corrosion.

DR. SHEWMON: That gets back to water chemistry.

DR. LAWROSKI: Yes, that's water chemistry again. I think this needs to be reworked considerably.

DR. SIESS: Steve, fixing iodine in the water, would that come under the heading of the contintency studies mentioned elsewhere if we started listing them?

DR. LAWROSKI: It could.

eb16

DR. SIESS: It's mitigation-recovery related.

DR. LAWROSKI: Yes. And of course there's the other aspect of iodine, to learn better when the charcoal filters will work with adequate decontamination factors, and when they won't. We heard a little bit from Larry Crocker. I'm not sure that there's not a lot more to it.

We also have the whole matter of recombination.

DR. OKRENT: I think Shewmon is correct, that we didn't really talk about what we might call response capability for the NRC to an accident. I think myself that it's a rather complex question.

Should there be another serious accident likely to be different in nature and pose another set of questions, I'm not sure what one would decide constitutes a reasonable definition of adequacy. I don't know whether we are going to assume that they should know each power reactor as intimately as the reactor designer, the vendor and so forth, so that they can say Well, all these pumps are off a switch to the other pump, and so forth and so on, or if you get into a degraded condition. I think it's an important area to think on, and I don't think it's going to have a simple answer myself.

I would myself suggest that we identify this one for early discussion. I don't know whether that will mean early resolution from our point a view, except a general recommendation, but certainly for early discussion, and an

eb17

effort to be detailed in our discussion just to see sort of what is the nature of the problem and what do we think is practical, and so forth.

DR. SHEWMON: We've shifted the problem from chemistry to response capabilities, which covers a very broad waterfront again. And if that's the pleasure of the Committee we can do it, but we started out on one term and ended up on another.

DR. SIESS: But the thrust of your paragraph is that it had limited expertise to call on in time of need. I think they managed to call on a great deal of expertise from throughout the country, maybe not as rapidly as we would have liked.

I think the Commission and the NRC Staff are well aware of the deficiencies in their response capability, the term "deficiency," I would say, not expertise deficiency. And they're going to be giving it an awful lot of thought. And until we can give them some help on it, I think we ought to defer it. I think they know they've got a problem.

If we can make any constructive suggestions, fine, but I don't think we need to tell them they've got a problem. Everybody else has.

DR. LAWROSKI: Some of the people involved in this question in NRC, I know for a fact that they know from their experience connected with the Navy PWR experience, that they knew that, by the weekend, as you were talking about, that the

eb18

rate of radiolysis was such that the rate of recombination was rather modest. And they knew that.

DR. SHEWMON: I asked how did the laws of chemistry change.

DR LAWROSKI: But I think it gets into the broader question.

MR. RAY: I don't have any trouble with the thought of deferring it, but if there is a deficiency in the area of water chemistry, whether it's water chemistry as we know it for treatment in order to avoid contamination of tubes and so on, or whether it is to remove iodine from fluid, or whether it is to not make misstatements as in here, I think it ought to be addressed as early as you can and not let it go, in terms of a research project to be done later or initiated earlier because it is apt to drop through a crack.

And I think if there's any organization that should have it in the area of this type of chemistry it's NRC. Defer it, yes, but give it a priority so that at your next meeting you can pick it up.

DR. CARBON: It sounds like it's the general consensus to defer it to perhaps about our next meeting, or some early time. If so, let's go ahead.

DR. LAWROSKI: My only point, Jerry, is that the example cited is what I would call a second derivative.

DR. SHEWMON: Write a better example then.

eb19

DR. CARBON: Is there another paragraph to the letter?

DR. OKRENT: No, there are two that we put aside in case you had time. At the bottom of the first page there was one concerning shutdown procedures. Now do you want to look at it again?

DR. CARBON: Let me defer that question for a moment and take up a little logistics, I guess.

We have a meeting with the Commissioners at 3:30 and as we left it last time, lots of people would have to leave about 4:00, and I guess the meeting would essentially end then. But is there any new information then, Ray, with respect to when people can get to the airport? You were talking about special cars and all that kind of thing.

MR. FRALEY: I think five members have to leave at four o'clock.

DR. CARBON: So there's no change.

DR. SIESS: How many does that leave then?

DR. CARBON: After four o'clock, you and myself and Paul and Jerry, four of us, with one, two, three, four, five I guess leaving.

DR. SIESS: Who will be here after four?

(Show of hands.)

DR. CARBON: Four of us after four, Chet and Paul and Jerry and myself.

eb20

DR. SIESS: How can we have a meeting with the Commissioners with only four of the members?

DR. CARBON: We have a half-hour meeting then, from 3:30 to 4:00.

Another bit of logistics. We won't have a meeting afterwards, so I think we have to clear these things up now.

We had aimed toward a Subcommittee meeting here in Washington next Monday and Tuesday. As I had indicated earlier, it is turning out to be completely impossible, I believe, to get hotel reservations or to get us here, even if there were hotels. So unless I'm mistaken, we've all agreed to defer the meeting one week, which will make it two weeks from yesterday, whatever date that is, April 30th and May 1st.

DR. SHEWMON: What's the Subcommittee?

DR. CARBON: Dave Okrent is the Chairman, and Chet and Milt.

DR. SHEWMON: The Three Mile Island Subcommittee?

DR. CARBON: That's right.

MR. FRALEY: It's the Subcommittee on Long-Term Implications of the Three Mile Island Accident.

DR. CARBON: One question that may come up this afternoon, and I would seek your thoughts on it:

What is our stand with regard to contingency plans for going onto natural circulation at Three Mile Island?

Harold, could you summarize?

eb21

MR. ETHERINGTON: I don't quite know what you mean. We have no plans.

DR. CARBON: I mean what is our thinking about their plans.

MR. ETHERINGTON: The thing is being so completely considered by a high-grade technical group and everything I heard was in line with our thinking. I think we need have no concern at all.

DR. CARBON: Does anyone have any other views than that?

MR. RAY: I would endorse Harold's statement.

DR. PLESSET: They're very concerned, aren't they, Harold?

MR. ETHERINGTON: Yes.

DR. CARBON: I believe that takes care of the odds and ends, so to speak, particularly the logistics, and we'd be prepared to go back to the two paragraphs that we left out.

DR. SIESS: Mr. Chairman, it's conceivable the Commission might ask us if we have any comments on the I&E bulletins that were sent to Westinghouse, Combustion Engineering and all PWR plants. Are we prepared to answer?

DR. PLESSET: You're prepared evidently.

DR. SIESS: There are minor, but not significant differences. They address the same thing but they are more tailored to particular plants in the other PWRs. On the BWRs they just said "Take a look at things like this."

Isn't that right?

MR. CROCKER: Yes, sir.

DR. SIESS: I could tell you what the differences are but I would have to dig it out.

We do think it was a good idea to be a little more specific in relation to the other vendors, and ask them to come up with some answers, which is what these did.

The first round, they only got the B&W notice for information. The second round they got it with the response request. I think that was appropriate.

2A wbl

DR. LAWROSKI: I just wanted to report that I'm not in disagreement with Paul. I agree with him that there is good evidence that the NRC's expertise in water chemistry leaves something to be desired. And I'll try to work up a paragraph on this subject that will cover this.

DR. CARBON: Fine.

Dave.

DR. OKRENT: Let's, if we can, look at the two paragraphs that were deferred. Let me propose that we take the shorter one first and discuss a couple of different kind of contingency matters.

Let me offer this comment: I myself don't think that the probability of another serious accident occurring in the coming year is very large. So from that point of view you might say that this is not a high priority matter.

On the other hand, my experience is that it takes time for people to address this matter if you can get their attention. I think it's time we got people's attention and that they do start addressing the question of contingency measures seriously to see what it is one can do. You don't always have days in which to react for various postulated accidents. And so in some cases it's only what you've done beforehand that you would have available.

In fact, the partial availability of the auxiliary building is an example.

68 149

wb2

So I would think that it's appropriate to have the operating power plants look at this matter, and it doesn't matter too much area they start looking at as long as they end up picking up the several areas that are involved. And if the Staff also starts thinking about this with them at an early time I think there are some measures that one could do for operating plants that if a situation arises that could be useful. And they need not be terribly expensive if you've thought about them before.

DR. CARBON: The thought here is for both the operators and the Staff to be looking at these?

DR. OKRENT: I would think so.

DR. SIESS: What are we going to do with this paragraph? If we're going to tell the Commissioners, you know, if it is something to tell them today where it can be explained I've got no problem. If it's going in writing in three lines, I've got a problem. I need the kind of explanation Dave just gave and some for-instances.

I think it can be tied into the research on improved safety and so forth.

So what are we going to do when we meet with the Commissioners? Is somebody going to read these off to them? Are you going to read them, Max?

DR. CARBON: I guess, tentatively, yes, I will read them. Unless it would be more appropriate for Dave.

wb3

DR, OKRENT: Oh, no.

DR.SIESS: And do we think we might put these in a letter next month when we've had a chance to congitate a little bit?

DR. CARBON: I would believe from what the group has said that we'd want to put many of them into a letter.

I would also believe that we have considerable freedom to add to and supplement.

DR. SIESS: I'm just a little concerned about oral advice, even with a transcript being kept.

MR. FRALEY: We would have this typed up in final form and you could read it to the Commissioners and make it available, just as you would an ACRS letter.

DR. PLESSET: Available to whom?

MR. FRALEY: To anyone.

MR. ETHERINGTON: With an indication as to the basis for the letter that may be written next time?

MR. FRALEY: An indication of what it is that we read to the Commissioners at this meeting.

MR. ETHERINGTON: No; but would we tell the Commissioners that we're going to write you this letter?

MR. FRALEY: I'm not addressing that.

(Laughter)

MR. RAY: Why don't you refer to it as a list of things discussed at your meeting?

wb4

DR. CARBON: Or a list of the things we discussed and we're in reasonable consensus that these are important points that we wanted to call to their attention.

DR. SIESS: It's not a list of things, it's a list of recommendations.

DR. OKRENT: And how about the other paragraph?

DR. SIESS: I'd have no problem with it. In fact I think it's a much cleaner way to do it. Even the Commissioners could pull out the paragraphs we've agreed on in here. And they need very little editing, and it's not important anyway.

Do you want a motion?

DR. SIESS: The paragraphs that I think we have agreed on and I will include in the motion are the first and second paragraphs on the first page of the blue material; the second and third paragraphs on the second page, and the last two lines as part of the third paragraph; all the material on page 3 which carries over to page 4, and all the material on page 4, but obviously the next to the last paragraph there becomes the last paragraph of the letter.

I have a suggestion, and I'll be glad to give it to the Staff: it's not that important; except as to the first four paragraphs.

Did everybody locate the ones?

I'd like to move the final on this letter.

wb5

VOICE: Second.

DR. CARBON: Is there discussion?

Those in favor of the motion indicate by a show of hands.

(Show of hands)

DR. CARBON: Six.

All opposed, by hand.

(Show of hands)

DR. CARBON: Two. It's six to two.

I guess I don't remember Roberts' Rules of Order correctly, but I think that's valid, isn't it?

DR. SIESS: No. It's a substantive issue and we have to have a majority of the full committee.

DR. OKRENT: Right.

DR. SIESS: I assume that the noes were no in a letter at this time rather than noes on the positions in the letter.

MR. MATHIS: Right.

DR. SIESS: Is there objection to reading these to the Commission?

DR. SHEWMON: No.

MR. MATHIS: No.

DR. SIESS: Mr. Chairman, I would interpret the vote as that these represent the position of the Committee and that they can be transmitted to the Commission.

68 153

wb6

DR. CARBON: We have fourteen members currently.

DR.SIESS: So we have a majority. All present agree this is the position, and the majority agreed that you can present it to the Commission.

MR. RAY: If I could be the devil's advocate for a minute, suppose the Commissioners ask you what you're going to do with these? Are you going to send me a letter or not? What's the answer?

DR. CARBON: I guess my answer is I don't know.

MR. ETHERINGTON: We'd like to but our rules don't permit.

(Laughter)

DR. SIESS: The objection was simply to a letter at this time, I believe.

MR. RAY: That's right. And I would suggest that would be that we're going to have another meeting shortly at which time these will receive final discussion.

DR. CARBON: I still don't know, but....

MR. RAY: But you're not going to admit it.

DR. CARBON: Are there further topics anyone wishes to bring up?

Bill?

MR. MATHIS: Mr. Chairman, there's been a lot of discussion, mainly yesterday, on the subject of operator training which is a topic we have not addressed here. Do we

wb7

wish to comment on that this afternoon? Or are we apt to be questioned on it by the Commissioners? Do we have a position; let's put it that way.

DR. CARBON: I don't personally recognize a position. I recognize many people are quite concerned, interested in the subject. But what our position is I'm not sure.

Do you want to pursue it beyond that?

MR. MATHIS: No. I just tossed it out on the table, that's all.

DR. CARBON: I guess we'll adjourn this meeting th en, and we will meet with the Commissioners upstairs to three-thirty.

(Whereupon, at 3:20 p.m., the special meeting was adjourned.)

68 155