NUCLEAR REGULATORY COMMISSION

ADVISORY COMMITTEE ON REACTOR SAFEGUARDS

IN THE MATTER OF:

230th GENERAL MEETING

Place - Washington, D. C.

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ADVISORY COMMITTEE ON REACTOR SAFEGUARDS

Friday, 15 June 1979

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UNITED STATES OF AMERICA

NUCLEAR REGULATORY COMMISSION

ADVISORY COMMITTEE ON REACTOR SAFEGUARDS

230th GENERAL MEETING

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

Friday, 15 June 1979

The 230th General Meeting of the Advisory Committee on Reactor Safeguards was reconvened, pursuant to adjournment, at 8:30 a.m.

PRESENT:

DR. MAX W. CARBON, Chairman
DR. MILTON S. PLESSET, Vice Chairman
MR. MYER BENDER, Member
MR. JESSE EBERSOLE, Member
MR. HAROLD ETHERINGTON, Member
PROF. WILLIAM KERR, Member
DR. STEPHEN LAWROSKI, Member
DR. J. CARSON MARK, Member
MR. WILLIAM M. MATHIS, Member
DR. DADE W. MOELLER, Member
MR. JEREMIAH J. RAY, Member
DR. PAUL SHEWMON, Member
DR. CHESTER P. SIESS, Member

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PROCEEDINGS

(8:30 a.m.)

DR. CARBON: The meeting will now come to order. This is the second day of the 230th meeting of the Advisory Committee on Reactor Safeguards.

The specific items for today's session are: Discussions with representatives of the Metropolitan Edison Company, and Babcock & Wilcox Company regarding the TMI 2 accident; discussions with the NRC staff regarding the recent operating experience; the modified basis for the development of state and local government radiological response plans in support of lightwater nuclear power plants; and the future schedule.

The Committee will also consider proposed ACRS comments or recommendations regarding the accident and its implications at Three Mile Island Unit 2, and proposed ACRS action on the proposed power level increase of Millstone Nuclear Power Station Unit 2.

Mr. R. Muller is the designated federal employee for this portion of the meeting. A transcript is being kept, and it is requested that each speaker first identify himself and speak with sufficient clarity and volume that he can be readily heard.

Our opening session this morning is with the Metropolitan Edison Company. I would call to the committee's attention that we have had a recent discussion with the company, and we have given them several questions which we have asked them to respond to to a considerable extent in writing.

In order to save time, you will find that there is material at your chairs which has been passed out this morning which is in that vein -- written material and response to our requests.

I guess at this time I'd call on Mr. Arnold to lead off for Metropolitan Edison-GPU.

MR. ARNOLD: Thank you, Mr. Chairman.

I'm not sure if my microphone is working or not. Mr. Chairman, I'd like to start off by introducing the people that we have here from GPU and Metropolitan Edison Company.

To my right is Herman Deickamp, President of General Public Utilities. Immediately to my right is Bob Keaton, who is the Manager of Systems Engineering in the GPU Service Corporation.

To my left is Jack Herbein, who is the Vice President of Generation for Metropolitan Edison Company.

In the second row, immediately behind Bob Keaton is Gary Miller, who is the Manager of the Three Mile Island Nuclear Station. To his left is Bill Zewe, a shift supervisor on Three Mile Island and the shift supervisor on watch at the time of the accident.

To Bill's left is Ed Wallace. Ed is the Licensing Manager for GPU Service Corporation. And to Ed's left -- excuse me, I misspoke. To the right, in each case, is Dick Dubeil. Dick is the Supervisor of Radiation Protection Chemistry for the Three Mile Island Station.

We do have a number of prepared remarks, and we will attempt to incorporate in those prepared remarks as many of the questions as conveniently fit in with the material that is being presented on the prior part of the agenda.

I would like to sort of digress from introductory remarks to address one of the questions that is in this list of some 30 that were attached to the agenda. That question relates to the number of employees with nuclear experience in the technical functions group.

Let me see if I can identify the number for you. This is Question No. 24, and we provided a little bit more than the question calls for.

The technical functions group has 128 employees with nuclear experience. The average number of years for those 128 employees is 14 years. And I've clarified that that's 14 years working in the nuclear field.

There are a number of employees in other departments who also have extensive experience in the nuclear industry. So that the total within the GPU Service Corporation is 171 employees with experience in the nuclear industry, and the overall average number of years of experience is 15.

We're providing a similar summary for the Metropolitan Edison Company. The Metropolitan Edison Company has a total of 362 employees with nuclear experience. The average number of years in the nuclear field for those 362 employees is 6.7.

We are prepared, Mr. Chairman, to proceed immediately to item 2 of the agenda, "various possible generic improvements to various aspects of plant design."

For that presentation I would like to ask Bob Keaton to address the issues.

MR. KEATON: Mr. Chairman, in addressing the issue of what we see as possible generic improvements arising out of our experiences in the Three Mile Island accident, I would like to start by making two caveats.

The first is that the list of items that I'm going to discuss with you, we in no sense represent as a complete list. We are still learning from the experience. We have a significant amount of activity underway at GPU and Met Ed trying to make sure that we understand all aspects of what happened, and we fully anticipate that as a result of this ongoing work, that we will have additional items which we would like to add to the list.

The second is that the items which are on these lists we do not present at this point in time as firm recommendations, but simply as items which, based upon our experience so far, would appear to merit further investigation. In some cases, they are items which we are proceeding right now to implement on the Three Mile Island Unit No. 1, but in other cases they are simply items which we think should be further evaluated.

(Slide.)

The first portion of this agenda item addresses possible improvements to operational instrumentation, and this slide here lists the items which we find would have been helpful, based upon our experiences.

In the case of in-core thermocouples, of course Three Mile Island Unit 2 had approximately 52 thermocouples which were hooked up to the plant computer. What we see is that additional temperatures, both additional fuel assemblies being monitored and possibly additional elevations within the fuel assemblies, would have given us additional and useful information.

537 068

Furthermore, as we discussed with you at the subcommittee meeting, the computer program which was monitoring these thermocouples truncated the readings to the point that a reading over 700 degrees Fahrenheit simply printed out as a question mark on the computer, which would certainly recommend that in the future any such computer monitoring of thermocouples be adequate to give readings over the entire range of the thermocouple, and not some truncated range.

We also have found that added thermocouples or other temperature sensors on the reactor coolant system could be of use to us in certain circumstances. This does not appear to us to be highly important for normal plant operation, but under the circumstances, where the system was operating on natural circulation, there were many times when we would have liked to have had a better understanding of the temperature distribution around the system, rather than at two or three distinct points, which is what we presently have.

An item which has received a great deal of attention is that some of the critical valves at Three Mile Island, the position indication in the control room is representative of the command signal going to the valve, rather than the actual position of the valve. And in particular that was true of the power-operated relief valve on the pressurizer.

We would strongly urge that for critical valves that the actual position of the valve be indicated, rather than the communication. We further feel the need for additional position indication on relief and safety valves. This is the second time for Three Mile Island in which we have had a situation in which a relief or safety valve stuck open, and a clear position indication on the valve would be of great help.

Furthermore, along the same line, some method of measuring the flow downstream from relief and safety valves would be valuable.

We are suggesting that an additional indication that might be of use to the operator is an instrument which measures directly the relationship between the current system pressure and the saturation pressure associated with that temperature.

There are certain designs on these instrumentations in progress that we are evaluating for TMI Unit No. 1.

Reactor vessel and steam generator level is an item which we think merits evaluation, but we are not prepared to make any recommendation on that one at the moment.

537 010

We are attempting, as part of some of the analytical work that we have in-house, to determine analytically the possible value of such signals, but we're not prepared to make a recommendation.

An on-line boron monitor is something which could have been of considerable use to us at TMI, and is certainly an item that we think merits further investigation.

As I think you are all aware, the containment system at Three Mile Island Unit 2 had containment isolation signals simply on the reactor building pressure exceeding 4 pounds. We would recommend, as a minimum, that the use of certain radiation monitors be considered for perhaps not total containment isolation, but rather the selective isolation of certain lines depending upon what was the location of the radiation signal.

In the case of hydrogen recombiner at Unit 2, we were in the position, when we were ready to use it, of not knowing really what the hydrogen concentration was in the stream going to the recombiner. And there was some concern that the hydrogen concentration could be high enough that starting the operation of the recombiner could light off a flame which would propagate back into the containment building.

As a result, we went through some system modifications that allowed us to dilute that incoming air. This could have been avoided by simply having a hydrogen monitor at the input to the recombiner. These are commercially available.

In the case of permissive interlocks, there are of course a number of permissive interlocks on Three Mile Island, as there are on any nuclear station. In looking back over our experiences, it does not appear clear to us that additional ones might not be merited. And we would highly recommend a careful evaluation of the desirability of some additional interlocks be looked at.

Finally, we were, at Three Mile Island, able to make good use of some of the noise analysis equipment which was installed on the system, particularly during the period of time when we were trying to expel the gas out of the control rod drive mechanisms by depressurizing the system, and we used the noise monitors as a method of determining both when we got bubbles as a result of lowering the pressure, and when we were able to get rid of the bubbles by having the hydrogen dissolve into the coolant.

It appears to us that an expanded noise monitoring system might prove valuable, even during normal operation.

DR. CARBON: Mr. Keaton, is your hesitation on the reactor vessel level in the middle there due to a question of need? Or practicality?

MR. KEATON: It's certainly due to the question of practicality. We are very concerned as to just how reliable such a signal would be. With respect to need, it's the type of thing that, if the circumstance were to arrise again, or a bubble formed in the top of the reactor vessel, if there were a really reliable level signal that would give an unambiguous indication to the operator, then, yes, that would be something that the operator would find very useful. We're just concerned with getting an instrument that won't cause a lot of difficulty due to its unreliability.

MR. RAY: Mr. Keaton, excuse me. Have you lost an operational instrumentation originating where the sensors or transducers and so on were within containment due to the hostile nature of that environment?

MR. KEATON: Yes, sir, we have lost a considerable number of sensors, and I think on my next slide I'm going to address that point.

DR. LAWROSKI: I'd like to pursue a little further the question raised by Dr. Carbon.

I appreciate your hesitancy about putting in level indicators for the reasons you cited, but then you did have something that did prove to be quite ambiguous. Maybe it was worse than what anything that you might add could be. Perhaps only by experience will you find something that you can rely on to better ascertain the level in the reactor vessel.

MR. KEATON: Yes, sir. And I do not mean to imply by my hesitancy that we have taken a position against level instrumentation. It's just that we feel at the moment that the real types of indications that would be obtained from practically available systems are not sufficiently well understood that we're prepared to take a position on it.

DR. MOELLER: I wonder if there was any implication in the order of listing here?

MR. KEATON: No, sir, there is not.

DR. MOELLER: Thank you.

DR. CARBON: Walt?

DR. LIPINSKI: In the Three Mile Island 2 Final Safety Analysis Report, Section 5.5.2.25, Exit Monitoring Instrumentation, refers to Table 7.5-1, readouts available to the operator from monitoring conditions in the unit.

The last item in that table, 72, is a failed fuel monitor. It's depicted to use gamma and liquid log scale indicator with the recorder, three readouts, five decades displayed in the control room. Is that functional? I haven't heard any references to it. In terms of any references to that instrument?

MR. ARNOLD: I believe the instrument being referred to is what we call a "letdown monitor."

MR. KEATON: Perhaps one of the operating staff could answer this question better than I could.

(Pause.)

MR. ARNOLD: That instrument did respond. I'm not sure, at this point, although we may be able to find out, what information we have here, as to what time it failed here.

DR. LIPINSKI: Does that show in the sequence of events as to when the first indication was obtained?

PROF. KERR: It seems to me that I remember reference to an indication of high readings on the letdown monitor.

MR. MILLER: My name is Gary Miller, Three Mile Island Manager.

There is a monitor in the sequence on the intermediate cooling system that was in alert early in the incident. That monitor, due to the background area it sits in, would go into alert before fuel failure. That is not the monitor you're referring to.

The one in the FSAR is the letdown monitor, which I think monitors the reactor coolant.

DR. LIPINSKI: Did it function?

MR. MILLER: Yes, it functioned. It was pegged high, like everything else, somewhere between 7:00 and 8:00 in the morning.

DR. LIPINSKI: If it didn't function, then I wondered why it was not on the list. But it did function, as expected.

DR. CARBON: Go ahead, Mr. Keaton.

(Slide.)

MR. KEATON: Turning to the next item on the list, this possible additional diagnostic equipment. There are a variety of items that you will see here. The first two are sort of generic in nature and applied across the board to the instrumentation.

One is the fact that it appears desirable to have expanded ranges on many of the signal monitors. I mentioned the in-core thermocouple situation already. Another example was the primary hot leg temperature readouts, which are RTDs, which are set up in a bridge network, such as they pegged high during the incident.

There are a variety of other sensors that we think should be reexamined from the standpoint of post-accident monitoring, to look at obtaining a wider range.

The item that was mentioned in a previous question: Yes, we do see the need to protect instrumentation against the type of post-accident environment. The thing that we ran into on Three Mile Island was that some of the instrumentation had not been identified as safety-grade instrumentation, and therefore was not, for example, LOCA qualified.

It was in fact the instrumentation that we were relying on very heavily to control the systems after the accident. Examples of this are the pressurizer level, the pressurizer heaters, and steam generator levels.

e-1

b-2

So we do think that a good look at whether some of the instrumentation that's not normally classified as "safety grade instrumentation," which is very useful in this kind of thing ought not to have that type of qualification.

MR. RAY: Have you lost any of the power supply circuits to the series within containment, such as the heaters in the pressurizer?

MR. KEATON: I don't think it's been a power supply problem.

MR. RAY: It's instrumentation?

MR. KEATON: It's been instrumentation, I think primarily associated with the rising water level in the reactor containment building.

Certainly the question of area radiation monitors is something in which we feel improvement is warranted. Gary Miller mentioned just a few minutes ago our experience with the radiation monitors, that at the time we started getting radiation signals they basically all pegged off scale, high. So we didn't have clear readings; we just knew that we had high radiation.

In addition, in retrospect we would like to have expanded coverage in the sense of more monitors and more hearings.

A closely related item is the question of being able to distinguish and discriminate some of the types of radiation. This was, I think, raised by Mr. Bender in the subcommittee meeting. Yes, we would very much like to have the capability for distinguishing the different types of radiation, the airborne activity versus the plateout activity versus the shine from the reactor or the activity from the liquid level, both for the air spaces and for the sumps.

Implicit in this -- although it's not stated explicitly -- is also the capability to direct the measure of the liquid level in those sumps.

Yes, sir?

DR. LAWROSKI: Would you include, under sampling capability, continuous measurement of radioactivity content? Such instrumentation is available and is used in separations plants. You can arrange to have a circulated sample to make sure that it's representative, and then with the columnated beams the sensor discriminates directly.

MR. KEATON: That is certainly one of the kinds of instruments we had in mind. I'm not sure that our thinking and planning has gone to the stage that I would know whether or not we'd recommend using that continuously, or only on demand.

DR. LAWROSKI: You mentioned in connection with boron?

MR. KEATON: Yes, sir.

537 018

MR. BENDER: A thought occurs to me, that a need to have that kind of measuring equipment in place is determined to some degree by the question of whether you could put it in place if an occasion developed when you needed to have it.

Now it seems to me that a certain amount of the effort ought to be addressed to the accessibility of such instrumentation, if the need arose, rather than assuming that because you'd like to be able to measure things, that necessarily you have to have it in place all the time.

I hope that some thought is being given to that aspect of the question.

MR. KEATON: Yes, sir, it is. And in fact, that is why we labeled this item as "improved sampling capability." We simply need to be able to do it, whether it's with installed instrumentation, or some other technique.

MR. BENDER: Thank you.

MR. KEATON: The next item on the list is "remote TV monitors." Certainly right now, and for sometime preceding this moment, it would have been very useful for us to be able to have a view inside the containment building. So the location of some of the monitors could be used in needed times, so that it would be useful.

Finally, an item which I will address in a little bit more detail on the next slide, is the question of the computer monitoring and recording of the significant plant parameters. The computer system that we had at Three Mile

Island Unit 2 was not a very extensive computer system by modern technology. It neither recorded all of the signals in which we were interested, nor did it do a particularly good job of outputing of the data. And we are certainly recommending some very significant improvements in that area.

(Slide.)

Those improvements are addressed in this next slide. We see both the need for improvements in the capability of the hardware, and also in its reliability. The reliability we believe can be relatively straightforward and can be achieved by simply using redundant systems.

The capability of the hardware is equally available by today's technology. In fact, prior to this accident we already had underway at Three Mile Island a computer upgrading program. That program had proceeded further with Unit 1, which right now today has a very much better capability than Unit 2 had.

We had the plans already laid for Unit 2, but unfortunately at the time of this occurrence the hardware plans had not been implemented.

Also, an item of faster printers. As I'm sure you're all aware, the alarm printer was backlogged for a long period of time. That can be overcome with today's technology. I would like to point out to the committee that the problem with the backlogging of the alarm data was not simply a printer problem; it was a combination of the printer and the computer's memory speed combined. It takes improvements in both of those to really solve the backlogging problem.

We see a very great benefit in the expanded use of cathode ray tube displays. In particular, we believe the color displays, the color coding of certain items is appropriate. We see that the CRTs could be used, developing the appropriate software, to give some alarm prioritization to the operator, to help him with the problem of when a reactor trip or turbine trip occurs, that there is a tremendous number of alarms that are immediately presented all demending attention, and with really no immediate indication to the operator of which ones he should worry about first.

Other things that are fairly common in today's computer technology, such as parameter trending and graphic displays, are also things that we see could be of great benefit.

MR. RAY: How about the possibility of indicating monitoring position of critical facilities? Valve positions, and so on?

MR. KEATON: Yes, sir, very definitely.

MR. RAY: Could this have been added, with memory expansion, to the computer you had?

MR. KEATON: No, sir. The computer that we had at Three Mile Island Unit No. 2 is an older computer. It's at its limit in terms of its capability, and it requires a complete refurbishment of the system.

The final item on my list harkens back to the point on the previous slide. Which is, that we do see a great desirability of having a very wide range of signals fed into the computer and the capability of the computer not only to monitor these signals, but to keep records on magnetic tape of the status of these signals, so that in the post-analysis of any of the transients which occur, all the necessary information is available.

It turns out that, in order to really accomplish what we would like to, this means that almost everything has to be fed to and monitored and recorded by the computer, because it's very difficult to predict in advance, as we've learned, just exactly which signals you want.

So far in the transients that we have looked at we have inevitably found that there were some things that, after the fact, we wished had been monitored.

So our position now is really: Everything that is practical ought to be monitored in accordance with the computer system.

(Slide.)

DR. MATHIS: Pardon me, Mr. Keaton. Was there anything in the way of improved communications that may not be exactly instrumentation?

MR. KEATON: You mean communications between the control room and the outside world? Or --

DR. MATHIS: Well, the control room and outside world, as well as internally. Like separate phone systems, isolated monitors, this sort of thing.

MR. KEATON: Yes, sir, there are several items, and I believe those are addressed. If not, let me just say that we are in the process of upgrading the communications with the outside world substantially in what we are doing on TMI Unit 1 right now. You'll see that that needs to be a generic improvement.

Certainly the communications between the control room and the outside world were very, very difficult on the morning of March the 28th, because of the shortage of telephone lines, a shortage of two-way radio communications, or anything else of that type.

We look for a large improvement in that area.

On the subject of possible improvements to equipment design, I want to reiterate my opening caveat -- in that we have not done, at this point in time, the analysis necessary to really understand the impact of some of the things which are on this list. And so these are simply items that we think should be evaluated.

It appears to us, on the basis of what we've seen, however, that certainly a larger pressurizer might be of great use in some of the types of transients that occur on these units. And we're strongly recommending that the industry as a whole take a look at the benefits, as well as the costs of that.

We feel quite strongly that both a more extensive containment isolation system -- and by that, I mean containment isolation on more than just the high pressure signals we had on Unit 1 -- and also a more selective containment isolation system appears warranted.

The situation as it existed at Three Mile Island Unit 2, the containment isolation on building hi[illegible] pressure when it occurred interfered with the capability of the operation of the coolant pumps, and so it forced the operators into a situation where their first action in response to containment isolation signal was, in order to maintain the safety of the plant, to override that signal.

And we see this as a very undesirable situation. We think that it can be av[illegible]ided by designing the containment isolation signal which isolates only the appropriate portions of the containment on appropriate signals.

So the operators action does not need to be taken counter to the action of the safety system. The human engineering of the control room such as that as Three Mile

Island Unit 2, is in a state that I think could best be described as "primitive" by the modern technology of human engineering. Those of you -- I think probably most of the members of this committee, have toured the control rooms. You're aware of the fact that, by space age technology, there is a great deal that could be done in the design of control rooms.

This is an area that we're recommending this, coupled with some of the earlier recommendations on the computer systems, could arrive at a man/machine interface which would make it much easier for the operator to have a total grasp of what was happening to the system, and to ease his control of that.

MR. BENDER: Most of us, I think, are sympathetic to that idea of using space age technology, but what are the practicalities of really making a change from what is now pretty much a hodgepodge of instrumentation to something that is more akin to being akin to what human beings need in order to avoid confusion? Have you really given any thought to the practicalities of the matter?

MR. KEATON: It's my personal opinion that that question divides itself into two parts: That which can be done to existing plants; and that which can be done to new plants.

537 025

In the case of new plants, I think it would be quite practical to go a very long way in the direction that I'm describing.

In the case of existing plants, it's going to be more difficult and, no, we have not at this point in time done any careful studies as to what really is practical.

MR. BENDER: Is there any move afoot in the nuclear industry to try to look at what can be done to existing plants? If you don't know, just say "I don't know." Don't try to speculate for me.

MR. KEATON: Okay, I really don't know.

MR. BENDER: Okay.

MR. ARNOLD: I might comment on that, though, that the Electric Power Research Institute does have a task force -- for about two years. It is working on that issue.

MR. BENDER: Of existing plants?

MR. ARNOLD: I don't know that, but it's only future design and backfit.

MR. BENDER: I know EPRI doesn't work on new plants. I think most of us need to think in terms of what to do with the existing installations. We're not going to have very many new plants for a long time. And personally, I don't feel like there's much to be gained by paying too much attention to future installations right now.

MR. KEATON: Along that line, without being able to give a complete answer to your question, I can say that we do see that it's practical to go a long way in using upgraded computer systems as a method of improving the man/machine operations, and that we think is practical for existing plants. In fact, we're in the process of doing it on our own.

MR. ETHERINGTON: Are these improvements which you show on the slide limited to those which you consider practical for Three Mile Island 2? Or is it a general list?

MR. KEATON: No, sir. These are intended to be generic and are not specific to Three Mile Island.

MR. ETHERINGTON: I'm su ised there aren't more. Is that a complete list of improvements that you see?

MR. KEATON: As I mentioned this morning, this is just our starting point on the list. We agree with you that it's not complete, but at this point in time we have not yet constructed a more complete list.

MR. ETHERINGTON: Well, for example, are you satisfied with the goose neck to the pressurizer? Or haven't you decided that?

MR. KEATON: We are right now in the midst of doing some analysis that, among other things, addresses that point. The analysis is not to the point we're ready to take a position on it, yet.

537 027

MR. ETHERINGTON: Thank you.

MR. KEATON: The last item that I have on my list here is the question of the set point of the steam generator secondary liquid level following trip. That's presently set at 30 inches. This is very close to the low-level alarm set point of 23 inches. And with the low level in the steam generator, it is easy for the operator to allow the units to boil dry. That in itself of course is no a catastrophic event. Even so, we think it's worthwhile to reexamine the question of whether a higher set point for that liquid level is practical, and we intend to explore this with the nuclear community.

MR. MICHELSON: On that particular point, at TMI it took in the neighborhood of 20 to 30 minutes to begin to show any level rise. Does this indicate that maybe you need more auxiliary feedwater? Or just what? Since changing your set point wouldn't have made any difference -- you weren't up to the set point for 30 minutes or more.

MR. KEATON: I'm not real sure where in thes sequence of events you're referring to. Are you talking about the early portion of the transient?

MR. MICHELSON: The first 30 minutes, yes. If you look at the steam generator level, it was in the neighborhood of 10 inches, more or less, for 30 minutes, 20 to 30 minutes.

537 028

MR. KEATON: Yes, sir. That is the level signal. However, if you look at the heat removal characteristics of the system, I think you'll see that after 8 minutes there was a heat sink available, even though the level was down below the detectable level on that instrument.

MR. MICHELSON: Yes, but the point is, you're saying "raise the set point," and I'm saying "it doesn't make any difference." You weren't getting enough water in to ever get to 30 inches, apparently, for at least a period of time.

MR. KEATON: Yes, sir, I understand your question. We really have not yet looked at the question of whether we'd recommend additional feedwater.

Mr. Chairman, if there are no other questions, that concludes my prepared remarks on this topic.

DR. CARBON: Okay, fine.

MR. ARNOLD: Mr. Chairman, we'll move right into agenda item number three on "unit operations," and since there are no overhead projector aids on this one,

e-2 Mr. Herbein will address that item from the table.

b-3 MR. HERBEIN: This is agenda item three, "unit operation." My name is Jack Herbein, Vice President of Generation for Metropolitan Edison.

537 029

With regard to 3(a), shift checklists and log keeping, our log sheets for recording the systems and component parameters are maintained throughout the plant for a variety of support systems and equipment by our auxiliary operators.

These logs and the trend recorders they provide are used to monitor equipment performance as well as plant status for indications and warnings of off-normal conditions, possible equipment malfunctions, and changes in plant status.

We do believe that nonsafeguard equipment should be on checklists. Some of the plant equipment parameters logged by the auxiliary operators are required to be read and documented by technical specifications. A number of these required readings are initially recorded on auxiliary operator log sheets and then transferred to the form required by surveillance procedure 2301, which is entitled "shift and daily checks."

This procedure which has been reviewed by the plant on-site review committee and approved by the station superintendent covers the shift and daily checks required by the technical specifications. It specifies the instrument number and readout location for each parameter required to be monitored on a routine basis by the tech specs. The shift and daily check procedure requires the recording of surveillance items such as borated water storage tank temperature, steam generator level, reactor building pressure, pressurizer level, core flood tank level, safeguards electrical bus voltage, and the physical positions of a few key valves in the decay heat system.

In addition, rod position indication, reactor protection system, key parameters, and radiation monitoring readings are recorded.

Finally, the procedure addresses the ventilated surveillance requirements. In these instances, specific parameters are required to be monitored and read at a frequency dependent upon reactor coolant system mode, and given parameter deviation.

For example, one outside air temperature is less than 40 degrees, it's required of each shift to ensure the borated water storage tank temperature is greater than 40 degrees.

Additional requirements include recording rod position every four hours when the asymmetric rod monitor is inoperative, and calculating axial power imbalance every hour when the imbalance monitor is inoperative.

A similar requirement exists for quad power tilt monitor. With regard to shift relief and log entries, this requirement is covered by a separate administrative procedure, number 1012, entitled "shift relief and log entries."

537 031

The procedure delineates the shift foreman and control room operator record keeping responsibilities relative to the hourly log, and the control room log, and the shift foreman's log. Information that is required in the logs and the method of making log entries is described.

Additionally, this procedure provides guidance for individuals leaving the watch. They are required to become familiar with operations in progress, any special instructions that have been left to log duty personnel and plant status. Operators are required to acknowledge and have an understanding and awareness of changes in plant status as their own last entry by signing the control room log prior to assuming the shift duty.

Both the shift foreman and the control room operator assigned to Units 1 and 2 keep turnover notes relative to specific actions which have occurred or will occur on their shift.

We've found through experience that looking at explanations relative to what's happened and what will occur in the form of written notes passed from shift to shift enables the operators to focus at watch relief on the other-than-normal conditions.

Copies of these relief notes are passed daily to the station manager for his review. In the future, we will formalize, to a greater degree, to turnover process between the control room operators and the shift foremen, as well as shift supervisors.

In this regard, we're considering the following: A critical valve and components checklist added to the s..ft and daily check procedure which will require the positive position and readiness status verification by both the oncoming and offgoing control room operators for key safeguards components and valves.

In addition to the above valve and components critical checklist, we're considering a formal control room operator turnover checklist and/or status board which will precisely delineate the status of such items as the major equipment out of service, primary and secondary system parameter abnormalities, system tests currently in progress, instrumentation out of service, electrical and mechanical maintenance in progress, off-normal indication for positions in key monitoring and control systems such as the ICS and the reactor protection system, and the location of caution tags, as well as the status of key core reactivity and heat transfer parameters, along with the status of significant alarms will be addressed in the formalized turnover process that we are currently developing.

Finally, to increase our capabilities, we will be assigning a degreed engineer on shift during plant operations.

537 033

That concludes my formal remarks on unit operation, part 3(-). I'd be glad to answer any questions.

MR. BENDER: Mr. Herbein, could you comment on what kind of capability you expect of this degreed engineer on shift?

MR. HERBEIN: We do expect that he would have some prior experience, and we haven't as of yet specifically defined that amount of experience or its length, but we're considering on the order of two years out of school with an engineering degree, or a related scientific --

MR. BENDER: We listened yesterday to some thoughts by the regulatory staff along the lines of having someone whose prime responsibility is safety, with responsibility for the plant's productivity being a secondary kind of consideration.

What's your view about having that kind of interest by someone like the degreed engineer? Do you understand the thrust of my question?

MR. HERBEIN: Yes, I do. My personal opinion is that, while certainly safety should be the foremost consideration, I don't know that we need to completely and separately divorce safety and productivity. It seems to me that they are interrelated, and as such could both be supervised, or at least addressed, by a single individual.

MR. BENDER: One other aspect of the matter: A regulatory organization is seriously considering the presence of an individual assigned by the regulatory staff as the federal employee representing the NRC's Regulatory responsibilities. Could you comment on how he might relate to the operating organization that you envision?

MR. HERBEIN: Well, I'd envision that he would probak . relate to our organization much as our principal inspector does now. Our principal inspector, I think, is typically on-site, perhaps three to four days, somet'mes in as often as a week out of each month.

Now rather than a quarter of the time, he in essence would be there full-time. The relationship is professional, and extremely ethical. There's mutual respect I think on behalf of both parties.

I see that that woul< be a continuing kind of thing, now, on a full-time basis rather than on a part-time.

MR. BENDER: I think that makes fairly good sense for the normal, routine kind of circumstance where things are being done in a quite orderly fashion.

If the need for this additional capability derives from the importance of having people that can respond in emergencies, what would you envision might happen in an emergency where you've got a supervisor and somebody who's responsible for safety, and a government-designated individual who has the authority to shut down and to authorize certain kinds of action?

MR. HERBEIN: Again, personal opinion, it would depend upon the type of emergency. And certainly if it were a very serious matter similar to the circumstance we had at

Three Mile Island, I think that team effort would evolve with communications from each party back to their headquarters, or on command structure.

MR. BENDER: Thank you.

MR. ARNOLD: I wonder if I could add a couple of comments to that? I'd like to say, first of all, that I think our experience with NRC staff people on-site during the emergency was reassuring from the standpoint of being able to work with representatives of the government who also had a clearly defined responsibility.

We did not encounter problems of differences in priorities, I don't believe, or differences in judgment. I think that if we start looking, though, at the situation where we have a representative of the Federal Government in the control room, as I understand is what's being suggested by your remarks, on a full-time basis, there would seem to me to have to be a broad scope of the accountability that that federal employee has for his actions, and not a very narrowly defined one.

537 036

Clearly the safest thing, if one were to look only at maintaining the core in a safe condition, is not to start it up. It seems to me that there is a potential for some real problems developing if a federal employee is not held accountable for his actions the same as the utility employee is held accountable.

MR. BENDER: I see a difference between authorizations to start something and authorizations to stop something, or to continue something. I really believe we need to have from those people that are experienced more views about how to make quick decisions when it's not clear who has the authority to make the decisions. I think that's what some of us are worried about when you think about the federal representative in the control room.

MR. ARNOLD: Yes, I certainly agree. I think perhaps I wasn't saying it as clearly as I should have, but I think it has to be understood who is in charge of the control room, and who has the responsibility for safety.

MR. RAY: May I comment? As I hear your remarks, Mr. Arnold, if I can put a personal interpretation on it, GPU management is not about to abdicate its responsibilities as the operator of the plant?

MR. ARNOLD: That's absolutely correct. Our present license gives us that accountability and responsibility, and I don't believe that at any time have we ever backed away from that or abrogated it, and we would not expect it's in the interest of anyone for us to ever do that.

537 037

DR. CARBON: Mr. Herbein, what responsibility and role would you anticipate this degreed engineer to play, that you speak of?

MR. HERBEIN: He would be on shift and would report to the shift supervisor. At least that's the way we envision it now, and would provide technical backup with regard to system parameters and possible deviation in off-normal conditions. He'd act as a liaison with an analysis group that we're looking at establishing on-site who in turn would review systems conditions on a repetitive basis.

And in another regard, he could probably relieve the shift supervisor of many of the administrative duties which he presently has.

One example would be the coordination of maintenance and operational activities with the health physics group.

DR. CARBON: I guess he'd be basically, then, a technical advisor to the shift supervisor, when called upon?

MR. HERBEIN: Yes, sir, that's the way we see it right now.

DR. CARBON: Thank you.

Are there other questions?

DR. LAWROSKI: Would he be a licensed operator?

MR. HERBEIN: We're looking at that, sir, but as of yet haven't made a decision on that. 537 038

MR. HERBEIN: If there are no further questions, then I would like to address item (b) under "unit operation."

The use of licensee event reports:

Presently, monthly computer summaries of all nuclear plant LERs are received by the training department. The training department then reviews the LER summary for LERs which could be applicable to either unit.

The reviews encompass such items as possible generic concerns, common equipment failures, and procedural and administrative related violations.

Items identified by the training department are then included in lectures that are part of the operators requalification program.

With regard to the future input of licensee event reports to operator training, the summary provided by the Nuclear Regulatory Commission will be reviewed by the licensing group, and the LERs, as appropriate, will be sent to engineering that are related to design and equipment performance. Those LERs that indicate procedural, administrative, or problems related to operator error will be further reviewed by the licensing group.

Then they, as required, will communicate engineering kinds of related concerns on procedural and operator error LERs to the engineering group.

537 039

Following a review of the LERs, both the engineering and the licensing groups will forward recommendations to the training manager for incorporation into the operator training program.

On the initial review, licensing will additionally forward high priority item LERs to the plant operations review committee and the unit superintendent for their information and action as they feel appropriate.

Licensing will manage the task tracking system and will keep a record of the actions taken by the engineering licensing and training groups.

Our experience with the LER summary indicates that we will have to have complete LERs to adequately assess the significance to us. LERs from EEI companies are presently available to Met Ed and GPU. A requirement will be placed on the safety and control analysis group for them to review their analysis work product and provide to the training manager information which should be reflected in his operator training programs.

That concludes my remarks.

DR. MATHIS: Jack, you mentioned lectures as part of your training program. What type of personnel provide that lecture capability? Is it engineering? Or is it more procedural?

537 040

MR. HERBEIN: We have a variety of lecturers, depending on the subject. In some instances it's the shift supervisor, and in other instances it's engineers. It depends on the nature of the training and the technical subject involved. The training administrators, for the most part, have come out of the operations group, and the majority of them have either control room operator licenses or senior reactor operator licenses.

DR. MATHIS: Thank you.

DR. CARBON: Dade?

DR. MOELLER: You indicated what you had done in the past and what you are going to do in the future. In the past, I gather that you did screen all LERs and look at those, or select those that would be of interest for your senior training program.

In hindsight, or even at the time you did screen them, or you at that time screening LERs, and did you select out those that might have given you warnings of the types of problems that you had in the accident?

MR. HERBEIN: We did screen the LERs for problems that we felt could occur at the station. However, the specific problems that we encountered on March 28th were not directly addressed as the result of our LER screening program.

DR. MOELLER: In hindsight, if you had had a better screening program, do you believe you might have had some hints of the problems that did develop?

MR. HERBEIN: I don't really know the answer to that, sir.

DR. CARBON: Harold?

MR. ETHERINGTON: Has B&W ever called to your attention particular LERs?

MR. HERBEIN: Not "LERs," per se; but the occurrence that may have led to an LER has been addressed by B&W in a general sense.

MR. ETHERINGTON: On many occasions? Or just a few?

MR. HERBEIN: I couldn't speak to the quantity. We do have an on-site B&W engineering representative who communicates information to us from the front office in Lynchburg.

DR. CARBON: Mr. Herbein, I left Harrisburg confused as to whether the LERs from Davis-Besse on feedwater losses, PORV valves sticking open, as to whether those LERs were received and factored into your system?

It was my impression that you said initially that those LERs were not typically received, but that later you corrected this. But I'm uncertain. Would you clarify this?

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MR. HERBEIN: The correction really was relative to my initial remarks here, that we do receive the LER summaries, and they are in turn reviewed for input to our training program.

DR. CARBON: What do you mean, the summaries? The LER itself?

MR. HERBEIN: No. Within the training department at Three Mile Island there is a designated instructor who reviews the summary for that of the LERs that have occurred over a monthly period.

This is a very brief summary of the event which --

DR. CARBON: These are the titles, simply?

MR. HERBEIN: Yes. My sense of the summary is that it is just a statement of the titles. It is a commercially available document which we receive on a monthly basis.

Specifically with regard to your question on the Davis Besse incident, that LER was not received by the training department or reviewed.

DR. CARBON: Then you did not ordinarily receive the LERs from Davis Besse or Oconee or Arkansas Nuclear?

MR. HERBEIN: No, we did not receive the LERs a routine basis. We do receive the monthly LER computer summary.

DR. CARBON: I presume B&W did not forward these LERs on some of the plants to you?

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MR. HERBEIN: That is true, sir.

DR. CARBON: Are there other questions?

MR. MICHELSON: Yes, I have one follow-up one.

What document are you using as your source? You say you get a monthly document. Are you using the Atomic Energy Clearinghouse?

MR. HERBEIN: We get that and that is also reviewed by our training department, that Atomic Energy Clearinghouse document --

MR. MICHELSON: That is your source of the LER?

MR. HERBEIN: That is a separate document independent of the commercially available computer LER summaries.

MR. MICHELSON: You are buying these summaries from a company, or is this coming from NRC or --

MR. HERBEIN: We are buying them. It is a commercially available product.

MR. MICHELSON: Do you know the exact source?

MR. HERBEIN: We can find out and get back to you.

DR. CARBON: I guess no more questions.

Go ahead to the next item.

MR. HERBEIN: The next item under Unit Operations has to do with training and procedures, some of the changes and improvements which we are considering and hope to incorporate into our future planning.

With regards to emergency administrative surveillance and operating procedures, we are considering under these categories the following kinds of changes.

First of all, for emergency procedures.

In order to indicate an overall direction to the operator, an objectives section will be added, a follow-up action section of these proceedings. Emergency procedures will also be made to reflect the NRC Bulletin items that occurred since the accident on March 28th.

Additionally, we are going to use a multiple plant parameter philosophy in our emergency procedures to judge the reactor coolant system conditions.

Also, a separate natural circulation procedure will be provided.

To identify times when alternative indications of plant parameters should be considered, a star will be placed in each procedure's immediate manual action section behind certain key parameters. The operator then in an emergency will be directed to recheck these key parameters using alternate indications as the first step to follow-up action.

If, for example, he initially read pressurizer level on Transmitter 1, he will be required in the follow-up action steps to refer to Transmitters 2 and 3 to verify the parameter value.

With regard to administrative procedures, shift turnover checklists which reflect safety features, component

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depressurization accidents, small break loss of coolant accidents, and Unit 1 system change modifications.

Specifically, the training program will consist of three parts. First, the operators will receive 32 hours of instruction at a B&W simulator. Here they will participate in 16 hours of classroom instruction and 16 hours of hand-on simulator training that will cover areas such as the small break loss of coolant analysis, depressurization accidents, and recovery techniques, as well as reactor coolant pump limitations and pump run combinations.

Each group will also receive and be evaluated on unannounced simulator transients.

Additionally, all Unit 1 licensed personnel have received or are scheduled to receive a 4-hour program at the simulator covering the Unit 2 incident, in addition to the training workshop I just described.

Secondly, the operators will participate in a proctored and evaluated classroom training program at Three Mile Island which will consist of 108 hours of instruction. Special lectures on such topics as heat transfer and fluid dynamics, reactor coolant system elevations and manometer effects, the TMI-2 transient, TMI emergency plan and procedures, simulated instrument failure drills in the Unit 1 control room, and NRC licensed category review, and TMI Unit 1 system change modifications will be addressed.

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status will be used to formalize shift relief procedures.

Additionally, the recall of standby personnel procedure will be reviewed to ensure consistency with the emergency planning document provisions.

Also, a new procedure will be developed to describe the proper use of the new direct Nuclear Regulatory Commission phone lines to Bethesda and King of Prussia.

In the surveillance and corrective maintenance procedure area, these procedures will be reviewed to ensure no more than one safety train is defeated during maintenance or testing. Changes will be made requiring checks of major valve and switch position on alternate trains of emergency equipment prior to performing maintenance or testing.

And finally, procedures will contain sign, switch, and valve alignment sheets to restore emergency assistance to their normal line-up following maintenance.

Completion of the above changes we hope to have implemented prior to returning our first unit to power operation.

With regard to the training program for our licensed personnel, a comprehensive accelerated training program has been established for Unit 1 licensed personnel prior to the restart of Unit 1.

This training program is designed to provide the licensed operators with additional guidance and specific instruction in major areas such as heat transfer and fluid flow,

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Third and finally, each licensed operator will receive a company oral and written examination, and we have asked for an examination of all of our operators, both oral and written, from the Nuclear Regulatory Commission.

The simulator training program for all operators is scheduled to take place from July 9th through the 20th.

After we complete 2/3 of the crew at the simulator, they will then undergo accelorated classroom instruction, and finally take the Met Ed and NRC written and oral exams. This group will then be ready for start-up while the remaining crews complete training and examination.

That concludes my remarks on training and procedures. I would be glad to try and answer any questions.

Bill.

DR. CARBON: Bill.

MR. MATHIS: On procedures and checklists, how do you assure yourself they are actually being followed? It is pretty each to put out a checklist. A guy can put on an initial, but how do you know he is really sensitive to what he has done?

MR. HERBEIN: That was one of the, I guess, additional categories of questions. I had some prepared remarks but they are rather lengthy, so I will try and summarize them.

We do in our Administrative Procedure 101, which governs the preparation of procedures, their review and approval,

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we do in that procedure specify that the level of responsibility that the operators have in the procedures -- for example, it is up to the auxiliary operator to proper operate a valve locally in accordance with a given procedure step.

In emergencies, operations personnel are authorized to depart from approved procedures when it is necessary to prevent injuries to people or damage to equipment or facilities. It is a legal requirement that these changes be documented and incorporated as soon as possible into the next provision of the procedures.

As a minimum, this documentation consists of describing the procedure deviation in the control room operator's or shift foreman's logbook.

Specific guidance is also provided in the use and implementation of procedures in the area of operating procedures for major plant evolution such as heat-up, reactor start and shut down.

The control room operator typically signs each step and then the shift foreman signs the procedure and dates it after it has been completed.

In the area of the auxiliary plant and its related operating procedures, these procedures need not be signed off or even available, particularly for routine procedural actions that are frequently repeated, and examples of this are the routine operation of the water treatment plants and the

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auxiliary boiler.

In the area of emergency and abnormal procedures, here the operators are required to carry out immediate actions by memory without referring to the procedures. And unless it is specifically stated, these emergency and abnormal procedures do not require sign-offs.

In this regard, the guidance offered in our administrative procedure specifies that one man should carry out manual actions while the shift foreman gets the procedure and reads the manual action out loud to check the man on the console.

The man with the procedure than also reads the follow-up section out loud and again verifies that the man on the console at the controls properly executed the follow-up actions.

Additionally, the person backing up the console operator is encouraged to assist him by calling out significant alarms while he obtains and maintains an overview of the emergency situation.

In the area of response to alarm procedures, the guidance offered indicates that the alarm responses are to be followed to the degree appropriate, acknowledging that there are a wide variety of responses and a varying degree of detail in the governing procedures.

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It is pointed out also that the need to even consult

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the procedure depends on the nature of the alarm. In that regard, where there is a single alarm, typically the operator would probably refer to the procedure in the event it was one that did not occur routinely.

On an incident similar to the one we had on March 28, there were a wide variety of alarms. A sufficient number came in. They were appropriately written down and analyzed by the foreman and shift supervisor.

In turn, that leads them, then, into the combination of emergency procedures which they need to follow.

In the surveillance procedure area, the guidance offered indicates that the documentation specified must be filled in completely, and it indicates that an individual performing the procedure is responsible for recognizing any problems and reporting them to the supervisor or foreman.

In addition, the person who is responsible for performing the procedure is also required to ensure that the data is completely and accurately filled out and there where required, corrective action is taken.

The supervisor or foreman is responsible to ensure that the individual who performs the surveillance has carried out his responsibility by redoing the results and approving the surveillance status sheets upon completion of the procedure execution.

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MR. MATHIS: Do you feel, then, that this 1-on-1

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kind of procedure, which is what I interpret this to say, would if followed through completely, would have avoided you a valve closure on your auxiliary feed pumps?

MR. HERBEIN: I am not sure I can say that. We are certainly looking at improving our techniques, methods, and in fact the governing procedures which requires us to ensure our people follow the procedures.

Bob, perhaps you want to --

MR. ARNOLD: I would like to make a couple of comments I think relative to the question.

First of all, on the latter one, on the valves, the fact that the procedure required a specific sign-off for the placement of those valves, I think makes us have to give some credence to the operators who were involved in that procedure, who have testified that they are certain that those valves were open at the completion of the surveillance procedure on the Monday of the 26th.

I think that we are unable to provide at this time an alternate explanation for those valves being closed other than a failure to complete that procedure.

But certainly, the three individuals involved in them were quite confident from their testimony that they had opened them.

537 052

I think that in another aspect of a more general nature, as to the question of compliance with procedures, is

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that there is a heavy emphasis in the training program on the need to comply with procedures, the following up of them in a literal sense, and that is also the subject of periodic checking by the quality assurance program, where they actually observe the use of the procedures and whether or not the individual is following them.

MR. MATHIS: Thank you.

DR. CARBON: Steve.

DR. LAWROSKI: I don't have one, but Mike does.

MR. BENDER: Getting back to the point that Charlie Mathis was raising a minute ago --

What ways could the operator know whether that valve was closed or not? Under the circumstances, there is the possibility that he identified the temperature as indicated, and the steam was flowing through the valve. But what are the other ways in which he could know that that was the case?

MR. HERBEIN: I will mention a few, and then let Gary Miller back me up.

First of all, there are the strap-on thermocouples on the discharge of the electromatic relief, the temperature pressure indication in the drain tank in which the electromatic valve discharges. Also, there is a level indication in that tank.

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At the time the rupture disc blew, there was a change in pressure in the tank.

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These indications really, although listed as being available to the operator, escape him, primarily because of some leakage we typically experienced on code safety valves and the electromatic relief valve, both on Unit 2 and Unit 1. Hence, the suspicion that the high discharge temperature really was related to some prior leakage and even perhaps the actuation and subsequent closure of the valve a few minutes into the transient.

Additionally, they did go back and look at the back panel, and at the time saw no pressure or appreciable level change in the tank.

They assumed that if there had been a discharge from the tank, that it in fact had terminated.

MR. BENDER: It was temperature on the valve, and then possibly the behavior of the quench tank that were the main indicators of that valve's behavior?

MR. HERBEIN: That, and also the command order light on the console which went on, indicates that the electromatic relief has an order to open. However, it went off. The operator assumed that not only was the command not telling the valve to open, but in fact the valve was shut. That's the assumption made.

MR. BENDER: Given the points which Mr. Mathis made a minute ago about how operators would relate these, is there some kind of a thought process that would enable one operator to cue the

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other as to what to think about when those symptoms showed up, or does one individual have to think it, perform the action simultaneously?

MR. HERBEIN: We will let Bill Zewe respond to that. Bill.

MR. ZEWE: Bill Zewe, shift supervisor for Met Ed.

In response to your last question, really, we confer as a group and talk out loud to each other. Really, is isn't one person that leads and the other person that lags, so to speak. We just have a total group effort.

In any situation that we have, we try to select the proper course of action. It was also true in this case.

We knew that we had a problem with the high level and the low pressure. We were all collectively trying to analyze it and trying to come up with the right approach.

MR. BENDER: I sort of looked through your discussion, the interview which had been held with the people at the accident. I couldn't find in that discussion anything that suggested that any of you had really addressed that question, whether that valve was stuck or not.

Did it not cross anybody's mind that that thing might be stuck open?

MR. ZEWE: Well, from the indication and from the transient that we had, we knew that it should have lifted and that it did lift to begin with. And from that point on, we

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had felt that it in fact had reclosed because of the indication that we had.

So we really didn't harbor the point further that the valve was stuck open.

We did refer periodically to the discharge of temperatures and also considered this, but we considered that it had receded.

MR. BENDER: What was the indication it had been closed? I had trouble trying to discern how you came to that conclusion. I tried to figure out what I might assume, and I had some trouble, and I wonder how it developed in your mind that the valve was closed.

end #4

MR. ZEWE: I guess, really, from the indications that we had that we didn't have the open command signal and so forth are right, the discharge temperatures, I felt, would be a very good indication of the actual status of the valve. And it did not indicate, the pressure in the drain tank did not indicate, and we just did not feel at that point in time that it was still open.

MR. BENDER: Okay. Well, so you assumed the normal action of the valve that had occurred, and there weren't enough symptoms to tell you that that was not the case.

MR. ZEWE: That is correct.

MR. BENDER: Thank you.

DR. PLESSET: Did you follow system pressure and find any anomaly there?

MR. ZEWE: Yes. The system pressure was low.

DR. PLESSET: You didn't relate that to the possibility of a stuck-open valve? How did you explain it to yourselves?

MR. ZEWE: We really didn't know why the pressure was low. We had several possibilities that we considered, because we had initiated a large amount of emergency feedwater which would tend to cool down the primary system and reduce pressure. Also, the pressurizer heaters are powered from the same area as the main steam safety valves, and we have had problems in the past with the high termperatures and high moisture content in that area affecting our heater capacity.

pv2

DR. PLESSET: The pressurizer level was not low at that point, or some part of this; is that right?

MR. ZEWE: That is true. The pressurizer level was normal at the onset, and then it did come down as soon as we tripped. But then shortly thereafter, within a few minutes, the pressurizer level began to increase at an abnormal rate, and it continued to increase.

DR. CARBON: Chet, is your question on this subject?

DR. SIESS: I think so -- if I know what the subject is. It's been changing around.

At what point in time did you realize that, say, this isn't just a transient, this is a real, honest-to-goodness LOCA that we've been reading about? How did your thinking about things change when you made that transition, if you did?

MR. ZEWE: I really didn't realize for quite some time that we really had a LOCA condition, so to speak, that the valve was open. We didn't determine that until 6:20, whenever we shut the block valve, that we actually had for the previous 2-1/2 hours, that we had an opening in the primary system going into containment. Up to that point, I had no idea that we'd actually had a LOCA condition and that we were actually losing coolant water over a continuous span of time.

DR. SIESS: When you began to think of LOCA, rather than transient, did it change your approach or your thinking, or which emergency procedures you looked at; or was there any significant change that you can recall at that point?

MR. ZEWE: No real significant change, because at this point we had already had on full high-pressure injection flow for approximately 40 minutes prior to finding valves shut. So, we actually had all the flow that we had available into the reactor coolant system at the point at which we closed the block valve. And we continued to keep the high-pressure injection flow going for sometime after we closed the block valve. And then approximately around 7:00, then, we throttled back again on high-pressure injection flow because of the high pressure and high level conditions that we had at around 7:00.

DR. CARBON: Harold?

MR. ETHERINGTON: Has the low tail pressure with the opening of that valves now been rationalized?

MR. ZEWE: To my knowledge, in retrospect, depending on the varying conditions that you have and at what point your system is initially, you can have a varying tail pipe temperature. But as far as some concern, we should have still had much higher temperatures indicated than any of those I was aware, to the neighborhood of 228 to 232 degrees.

MR. ETHERINGTON: You think it should have been higher than that?

MR. ZEWE: Yes, sir, I do. 537 059

MR. ETHERINGTON: I would have thought if someone had looked at the temperature, you'd expect to start with a two-phase mixture or sub-cooled saturated water. I think it's about what you'd expect on it. Mr. Keaten says that the temperature we'd expect in stream is 285.

DR. CARBON: And what was the actual temperature there? You said that the temperature you were aware of. It's my impression that you weren't aware of the true temperature; is that correct?

MR. ZEWE: That is true. Later -- and I have now the computer printout that has the discharge temperature at approximately 4:25 that indicated in the neighborhood of 285 degrees, and later, approximately an hour later, at about 5:30 or so, there was a further printout that showed that it was about 283 degrees. Both of which I had no knowledge of at the time.

DR. CARBON: And why was that? I have not understood why you weren't aware of that temperature or why thought it was about 230.

MR. ZEWE: I have requested that the discharge temperatures be checked on the computer, and the numbers that I got back from the computer -- all right -- were 228, 232, none higher than that. And these numbers, as far as I know, were called up on digital display, which is not printed out on the computer.

I have not yet determined to this time who actually requested the particular printout that we now have for those temperatures at those two particular times. 537 060

DR. CARBON: When you say you requested this from the

pv5

computer, did you ask one of your operators to get the information for you from the computer? Is that what you're saying: He reported back to you, but it was 230?

MR. ZEWE: Originally, I had asked the Unit 1 shift supervisor to come to Unit 2 right after the trip. It was this shift supervisor that I had asked to look over the computer alarms and to check the discharge tail pipe temperature. And I can't remember specifically if it was him that told me directly or if it was relayed to me through one of the other personnel in the control room at that time.

DR. CARBON: And so, believing that it was on the order of 230, you felt that that did not indicate a stuck-open valve?

MR. ZEWE: Yes, sir. The few days prior to the accident, the discharge temperatures on both of the code safetys and the electromagnetic relief valve were in the neighborhood of 190 degrees, and I knew that the relief valve hadn't lifted, and I felt the 230 degrees, that the tail pipe temperature was still cooling down from being initially lifted. And I really didn't have a feel for how long you would be at an elevated temperature. But I had thought at the time that an hour would not be unusual, to where we would come down within the 200-degree alarm.

DR. LIPINSKI: You have a procedure labeled "abnormal pressurizer behavior," and you qoute the symptoms that appear at the top of that procedure.

MR. ZEWE: I can quote several of them, I believe. You are probably referring to the symptom of "greater than 130 dgrees in the tail pipe temperatures."

DR. LIPINSKI: That's one of them. What are the others?

MR. ZEWE: The other ones are: boron concentration, higher in the pressurizer than in the reactor coolant system, drain tank temperature high and pressure high.

DR. LIPINSKI: And the immediate action.

MR. ZEWE: And the immediate action is to evaluate and then shut the block off.

DR. LIPINSKI: What part did this procedure play in your analysis in action?

MR. ZEWE: It really didn't play any part, in my mind, in the accident at all, because I really didn't reference the procedure, as such, for those symptoms, because I knew that we had been 60 degrees or greater than 130 degrees under these symptoms, and I knew -- and it had been evaluated before by management -- that we were to continue to operate with one of the three relief valves leaking by because we were still within the confines of our technical specifications and the leakage was not a new thing to us because we had experienced the same sort of leakage on the Unit 1 reactor plant during its first fuel cycle stages. For practically the whole cycle, we had some

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leakage also.

So that we were accustomed -- at least it wasn't a brand-new thing to us to have some leakage passed on to the relief valve, so it was rather accepted. And everyone knew about it, and we accepted it as fact.

DR. LIPINSKI: But what about the anomalous boron behavior; wasn't there some question in the sequence of events as to why the boron concentration was behaving like it was?

MR. ZEWE: Well, I am afraid here that we are talking about two different things. Prior to the event, we had had the spray valve and the manual depressurizer heaters in hand in order to equalize the boron concentration, which is higher than the pressurizer, and bring it out into the reactor coolant system to have an equalized boron concentration.

The other readings that you are referring to all right were the low boron readings that I received later on, sometime into the accident, which were of a low boron nature. The presence of leaking relief valves causes an increased boron concentration in the pressurizer.

DR. CARBON: Bill.

PROF. KERR: Help my memory. I seem to have read somewhere that earlier in the startup process on TMI-2, it did have another stuck-open relief valve incident. Is my memory playing tricks on me?

MR. ZEWE: That is true, sir. I believe the date was

March 29, 1978. We did have the electromatic relief valve fail open.

PROF. KERR: Were the conditions of temperature and other things at that time well known? Was that something --

MR. ZEWE: That was the day after initial criticality. All right? So our temperature was in the neighborhood of 532 degrees at that time.

The failure at this time was caused by a power failure which activated a high-pressure contact to give the control signal to the valve, saying that we actually had a high-pressure condition which caused the valve then to see high pressure, and we opened it in the normal manner to a false high-pressure signal. The power loss was not to the supply of the valve itself, but only in effect to the relay contact that resulted in a false high-pressure signal as seen by the valve control circuit. So that valve then did open, and it was subsequently shut.

And we had a modification to the circuitry to preclude that happening again. That is when we installed the command red light in the control room, saying that if we had a command light on to open, that we had a command signal ordering the valve to open up.

PROF. KERR: Was there enough familiarity with the system, that you are aware, of what the thermocouple reading was following that incident, for example, so that you had some basis for comparing the readings at that point with the readings you were getting at this point? Or was the situation so different that comparison didn't make sense?

MR. ZEWE: Well, I did not beforehand remember what the temperatures were as a result of that stuck-open valve. I really did not have an absolute number -- all right? -- to say that the temperature should be here, with some firm validity. We had done extensive testing in Unit 1 to a very similar arrangement of the discharge pipes, and I was involved in some of that data-taking. And in those we had the temperatures in the neighborhood of 360 degrees, which I did remember those, and I sort of expected that ballpark. But knowing that the exact type arrangement is a little different, I really didn't have, you know, a real good, firm value for them. But I expected considerably higher than 230 degrees.

We had seen Unit 1 as high as 210 or so, or 215 degrees, due to just normal valve leakage also, and this spread, I figured, was really the result of the opening enclosure still going off at this point.

PROF. KERR: Thank you.

DR. MOELLER: In answer to an earlier question, you said that at about 6:20 was when you first really began to realize -- I don't want to misquote you -- but to realize that you really had a problem.

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MR. ZEWE: No, sir. That is when I realized that the ensuing time we had an open part of the RCS. I knew early on that we had a problem, and we were trying to deal with that problem.

DR. MOELLER: Excuse me. I believe this 6:20 is after -- and perhaps even a half or more after -- you had shut down the primary coolant pumps; is this correct?

MR. ZEWE: Yes, sir. At the same time that we secured the last two reactor coolant pumps, which were the A side pumps, we initiated full high-pressure injection at the same time, which was approximately 5:40, if I remember right.

DR. MOELLER: What did you interpret then as the cause of the vibration in the primary coolant pumps?

MR. ZEWE: From our curves, from the reactor coolant pump, net positive suction curve, we were just below the net positive suction head for the pump. Being a large pump, as it is, I expected to see vibration, change in flow, and also the change in amps, because we were below the net positive suction head for that pump.

I really didn't realize that we had voids in the system at this point. I just attributed that to being below that curve for the net positive suction head. At that time I really didn't have a very definite feel of going below the net positive suction head for a large pump of that construction, exactly what I would see other than I should see vibration, flow oscillation, and a variation in amperage.

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DR. MOELLER: Thank you.

DR. CARBON: Carl.

MR. MICHELSON: I am still a little at a loss as to the operator's interpretation and response to the fact of the sump pump in containment started at 7-1/2 minutes, another one started at about 10 minutes, a high level of iron in the sample received, and these pumps continued to run.

What were you thinking when you watched all this sump pump action?

MR. ZEWE: The first knowledge that we had -- "we" being myself, the shift foreman, and the control room operators -- were aware that the pumps were even on when the auxiliary operator called us from his desk at the rad waste panel in the auxiliary building. There he had a direct indication of the sump level. Also, he has an indication of both sump pumps and control of those sump pumps available.

He called us up and informed us that, in fact, the sumps showed a six-foot level, which is the maximum reading for that sump, and also that both sump pumps were running. This was approximately 4:35 or so. When he called the control room, the one control room operator informed me. Then we asked the control room -- or the auxiliary operator, pardon me, to secure both of these sump pumps and to check his line, which he further related back that he had secured the pumps. He did not alter any valves, but he did check to see the position of these valves for that line.

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At this point, all right, it was just about the time when we observed the level, pressure and temperature in the RC drain tank. We knew something was wrong with the drain tank and that we could have transferred water from the drain tank to the sump. But we had no idea that it was a continuing effect of putting water to the sump. Once we indicated six feet, which is the maximum reading, we had no further indication that we were putting water continually into the sump.

DR. CARBON: Mike?

MR. BENDER: A couple related questions. One, somewhere along the way you suspected that maybe one of the steam generators had developed a leak. I don't know that you tried to analyze the size of them.

Where did that occur in the accident analysis sequence, and what was it that led you to that conclusion?

MR. ZEWE: Okay. The thought that the B steam generator had a secondary side leak into containment -- well, our pressure indicator for the B steam generator was about 300 pounds less than the A steam generator. Also, we had the higher temperatures in the reactor building and an increased pressure in the reactor building.

We did not suspect that we had a primary leak. So I felt at the time that -- we considered that possibly we had a steam generator leak in the containment from the secondary side. So we then isolated, and I'm not sure of the exact time, but probably in the neighborhood of shortly after 5:00 o'clock we isolated the generator. And then we observed a leveling off and a decrease of the reactor building pressure.

MR. BENDER: Did the radioactivity that the auxiliary room operator had reported contribute to that conclusion?

MR. ZEWE: I'm sorry, sir?

MR. BENDER: I thought that the discovery that there was some radioactivity in the auxiliary building was one of the things that your auxiliary operator reported to you. Did that contribute to that conclusion or was that an independent kind of thing.

MR. ZEWE: The radiation I learned of later, not at that time. But I believe that you're referring to the monitor that was right near the rad wastes tower. There's an RM-14 that we monitor to go between Unit 1 and 2. The operator had reported, the control room operator, that he had seen an increase in that monitor.

I was not aware at that point. But that would certainly not lead me to think that we had a secondary side generator leak phase, that I had an indication near the fuel-handling building that we had an increased radiation, no, sir.

MR. BENDER: Had there been any indication of leaking steam generator tubes prior to the accident?

MR. ZEWE: No, there hadn't, to my knowledge.

MR. BENDER: I understand you confirmed, now, that there is a leak from one steam generator; is that true? And if so, what was the confirmation?

MR. ARNOLD: We do have that activity in the B steam generator. It appears that there was a contamination of the secondary side early on the morning of the 28th, and since that time there's been no indication of further transfer from primary to secondary side. So the supposition at this point is that a leak in one of the tubes. I guess there's also the possibility that at some point or other there was transfer from the containment building atmosphere into the secondary side through vent valves or back from the drain tank past the seats of those valves.

MR. BENDER: Let me get back to one last quick question, I hope. The observation that the NPSH was low on the primary coolant pump line -- what things do you conclude when that occurs? What things would contribute to that effect?

MR. ZEWE: The pressure and temperature relationship.

MR. BENDER: Well, that might happen. But if it happens, what things can cause it?

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MR. ZEWE: Depressurization.

MR. BENDER: If the pressure is equalized on both sides of the system, do you still get cavitation? Or are you thinking because the water is hot enough?

MR. ZEWE: I see what you're saying. But I consider just the normal cavitation effect that you have your lowest pressure point and you have bubble formation, and then the subsequent collapse in the loop would result in the vibration indication, cavitation of the pump.

MR. BENDER: So it just has to do with the water flashing?

MR. ZEWE: Yes, it is.

MR. BENDER: Thank you.

DR. PLESSET: Could I just follow up on that same question? How far off the pump design point was it when you looked, just before you shut the pumps off; do you have any idea?

MR. ZEWE: I recall looking at it. We were below it. And I really didn't -- or I can't remember at this point exact points. But we were below it. Not a great deal below it, but we were below it.

DR. PLESSET: That's what I wondered, how far down you were. You may not have been a great deal down, but just somewhat.

MR. ZEWE: Right.

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DR. CARBON: Steve?

DR. LAWROSKI: Somewhere, I guess in the transcripts

I read where you came to the conclusion early that you were not getting a water solid behavior like you expected from what the pressurizer level was doing. Can you explain?

MR. ZEWE: That is true, because at first, with the high pressurizer level, we should have had, in our estimation, close to a solid system, and if we would have had a solid system, we would have had a corresponding change in pressure if it went solid all right. So that we believed at this point at times that we did not have true level indication. So then we did make an extensive effort to try to check out our pressurizer level.

So we selected the other transmitters, of which there are three, and then we selected the computer points for the pressurizer level, which does its own compensation, and it also has uncompensated level. And I also sent an auxiliary operator into the auxiliary building to observe uncompensated levels locally in the auxiliary building. And we really couldn't conclude anything other than all three instruments read the same.

It could have been some common mode of failure.

DR. LAWROSKI: I see.

MR. ZEWE: We just didn't know at this point. But we believed that it was a high water level.

DR. LAWROSKI: You didn't think of any other things that were accounting for the fact that water solid behavior was not occurring in the primary system except as was to be expected from the performance of the pressurizer?

MR. ZEWE: Yes. I could not determine why we did not have the indication.

DR. LAWROSKI: Did you try to surmise what might have been the reasons?

MR. ZEWE: I did try, sir, yes. I really could not determine, all right, exactly why we had that indication.

DR. LAWROSKI: Has anything been included in the training, possible reasons for that?

MR. ZEWE: Not that I was aware of at the time or that I could recall to you, or I would certainly have used it, yes, sir.

DR. CARBON: Does that questions? We're getting behind.

Let's take a ten-minute break.

(Brief recess.)

DR. CARBON: Let's resume the meeting.

Are we ready for Item No. 4, Mr. Arnold?

MR. ARNOLD: We have just a couple minutes on Item 3-D, if you'd like to pick that up.

DR. CARBON: All right, fine.

MR. HERBEIN: Mr. Herbein again.

Conti... ng under unit operations, specifically with 3-D, the role of the B&W site representative. Our B&W site manager has been at Three Mile Island since the construction phase of Unit 1. In this position, he has acted as the liaison between Met Ed and the B&W home office in Lynchburg. The site manager has supported Met Ed in the following areas: operating procedure preparation, procedure review, initial startup and test coordination, physics testing, refueling outage preparation, scheduling and activity coordination.

In addition, they have answered questions from the Met Ed corporate engineering and Three Mile Island operational groups.

The B&W site manager serves as the liaison between his home office and the unit superintendent on site. In this role, he also provides Lynchburg with operating plant data experience and communicates to Met Ed items of possible generic concern related to other B&W plants, based on specific input from the integration group in Lynchburg.

On March 28th, 1979, the B&W site manager was requested by the station manager to participate in the command team in the Unit 2 control room. As part of this effort, he was directed to establish communications with B&W Lynchburg. Throughout the day on March 28th, he participated in technical discussions and concurred with the command team decisions.

That concludes my formal remarks on 3-D. I'll be glad to answer any questions.

DR. CARBON: Are there questions from the Committee?

(No response.)

DR. CARBON: Is that gentleman here today?

MR. HERBEIN: No, sir, he is not.

DR. CARBON: Let's move ahead, then, to Item 4.

Mr. Arnold, we're starting to run considerably behind time. I think if you can reasonably shorten the future topics, it would be helpful.

MR. ARNOLD: Yes, sir, Mr. Chairman, we'll certainly try to do that.

Let me take perhaps about five minutes, hopefully, on Item No. 4, which has to do with the processes by which we were making decisions during the days following the accident. I think it's important to note that the character of the situation was different after the first two or three days from perhaps what the emergency plan envisioned, in as much as we were now into a situation where we had a reactor plant whose conditions were not completely defined for us, where the continual availability of equipment and instrumentation was questionable, and where the methods by which we could bring the core to a cold stable condition needed to be reviewed and, in effect, researched rather extensively.

The resources to be applied to this situation were built up rather rapidly in the Thursday, Friday, Saturday, Sunday time frame following the accident on Wednesday, and we were into what I think was a very difficult management situation, in as much as we had had to bring together a wide diversity of people representing different backgrounds, different organizations, and apply them to what I'm sure is a unique problem.

By Sunday, we had begun to develop the outlines of what later became designated as our base case plan, that is, the processes by which we would take the plant through a series of steps to bring it to a cold shutdown condition, the objective being to eventually have it in a condition where we were below 200 degrees, the core decay heat was being removed by natural circulation, and the maintenance of reactor coolant system pressure and volume inventory did not rely upon any more active components than necessary, and further, that those conditions did not rely upon the use of instrumentation inside containment.

(Slide.)

The organization that was established to direct and manage this activity is shown on this slide, a copy of which I believe was placed at the seat of each of the members of the Committee. And I think the important groups to point out or the elements are shown in the blocks, the elements of the organization.

I have under my direction four functional groups. There was what's labeled a GPU technical support group. That was heavily augmented by other organizations. The Met Ed plant operations, which were the people normally assigned to Three Mile Island, again, heavily augmented by other organizations; a waste management group, which was responsible for the control, containment and treatment of radioactive waste materials; and a plant modifications group, which were doing the major modifications which were determined that could be done in sort of a package basis, as opposed to more minor ones, which were being carried out either through the operation of in some cases waste management and in some cases under the direction of technical support groups.

We had a group that has been variously termed, most commonly, I guess, a think tank, the industrial advisory group, which was a collection of highly skilled scientists and engineers that were collected near the site, and which provided an independent backup to the technical efforts that were going on in the other four groups. Their charter was to initiate those investigations, analyses and scenarios which they deemed to be appropriate for the conditions that existed and, upon request from the functional groups, to provide backup analyses to ones that were being done within those functional groups.

A senior member of each of these functional groups, plus the task management group that was set up to provide staff support to me, were each members of the technical working group. The technical working group included also the senior B&W representative at the site, the senior Burns & Rowe representative, who also during the first few weeks headed up the plant modifications group; and it included the senior NRR representative on the site. Initially this was Mr. Victor Stello. More recently it's been Richard Vollmer.

This technical working group met twice a day for several weeks. Eventually we stepped down to once a day and subsequently stepped down to twice a week.

It's within this group that the strategy for dealing with the situation that we were faced with, the basic plans for how we were going to continue to take the plant through the base plant steps, identification of necessary analyses, identification of necessary procedures and review of the results of those analyses and various procedural steps was accomplished.

I might just mention about half a dozen of what I consider to be representative key decisions that were made by this group, utilizing the management process that I indicated.

There was, first of all, an early decision to proceed with degasification of the primary coolant system. This was necessary so that we would be able to subsequently depressurize even to the point of hopefully having sufficient gas removal that we could go down to atmospheric pressure without the remaining gas being of sufficient volume to form a blockage in the top of the TH legs that would prevent natural circulation.

It was decided very early not to utilize the decay heat system in the plant unless that was absolutely necessary for decay heat removal, since there appeared to be alternative ways for both the short-term and long-term, reliable methods that would remove decay heat without bringing reactor coolant system water outside containment.

There was the decision to, in effect, take the plant down in temperature in a very deliberate way, so that there was an initial decision to remain at 285 degrees TH, T hot leg, 1,000 pounds pressure while we accomplished the degasification, and to bring the temperature down from that point in a relatively slow manner. We thought that there was not a rush to get the temperature down below 285.

There was also the concurrent -- or as part of that decision, the decision to stay at 1,000 pounds until we were down to the temperature that we eventually wanted to depressurize.

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The decision to take the plant solid was felt to be, if controlled by us, would not be accomplished until we were down in temperature to around 170 degrees and down in pressure on the order of 500 pounds, but that there was a contingency plan for going solid in the event that we were in danger of losing our last installed pressurizer level instrument.

That in fact occurred, so that on April 27th, when we had indications that the last installed pressure level instrument was nearing failure, the plant was placed on natural circulation.

I am sure confused that with a misstatement. Let me go back and repeat that.

We had decided that we did not want to go on natural circulation until we were both down in pressure and down in temperature.

If we continued to have reliable pressurizer level instruments, reliability being defined as one instrument of the plant instrumentation.

On April 27th, we had indications that we were going to lose the final pressurizer level instrument, so the decision was made to go on natural circulation at that time. We did not want to have to take the plant solid; subsequently, we did not want to take the plant solid.

While we did not have pressurizer level instruments, or -- let me start over again.

The concern with going on natural circulation in the solid mode was that of the difficulty of controlling pressure with the small temperature changes while solid, so that we recognized that if we did not have reliable pressurizer level indication, we would have to take the plant solid.

So, prior to getting into that position, we wanted to be on natural circulation. Therefore, on April 27th, when we were in danger of losing reliable pressurizer level instruments, we did go into natural circulation. We remained with a pressurizer level indication sufficiently reliable until late in May, when we eventually took the plant solid, and it stayed solid since then.

There was a decision to modify the B steam generator, to permit solid water to solid water circulation for decay heat removal. This modification has been completed, is going through final checkout, but in the meantime we have continued to remove decay heat by steaming the A steam generator to the condensor with about five pounds absolute pressure in the A steam generator.

We have the capability now of steaming the A steam generator as it is, steaming the B steam generator to the condensor, and also circulating the B steam generator with a solid water system.

I think those are representative of the decisions that were considered and which this team processed in the immediate weeks after the accident.

If there are any questions, Mr. Chairman --

DR. CARBON: Mike.

MR. BENDER: Just one point, Mr. Arnold, what have we wound up with is some kind of jerry-rigged arrangement to deal with this action. I think it's best that we come to a -- and I'm not critical of it, don't misunderstand me, but can you comment on what should have been there in order not to have to through this kind of jerry-rigged arrangement?

MR. ARNOLD: I think we're going to do some thinking about the desirability of having decay heat system, heat exchanging inside containment. Obviously, we're now using the B steam generator in that mode. It may be desirable to have the normal decay heat system inside the containment, in a sense, but I'm not really confident of it in my own mind.

There's also, I think, the feasibility of looking at piping up a steam generator normally for the type of arrangement that we've made on the ad hoc basis.

The major difficulty with that, with the B&W steam generator, I think, is that the very high flow rate that is required to the secondary side of the steam generator, to ensure that you can continue natural circulation, we have to be sure that the cooling takes place high up in the steam generator. That requires very high flow rates on the secondary side, so we have a very large installation from the standpoint of piping and pump size.

So I think it's an important question. It's something that we have not really started to look at in detail, but it is something we have been discussing.

MR. BENDER: Are you giving any thought to some rearrangement of the shutdown heat removal system. You suggested it might go inside containment, but other than that.

MR. ARNOLD: We have not yet; in the sense of a backfit item on Unit 1, we are making modifications to the Unit 1 decay heat systems, similar to those that we accomplished on the Unit 2 decay heat system. Those modifications are to improve the ability, to monitor remotely the operation of the pumps, and to improve leak tightness of the system.

MR. ETHERINGTON: With RHR inside containment, are you considering the high pressure system?

MR. ARNOLD: I'm sorry, sir; I don't think we really have gone through it to the point of deciding on whether the high pressure system inside containment would be feasible.

DR. CARBON: Other questions for Mr. Arnold on this topic?

(No response.)

DR. CARBON: I believe not.

MR. ARNOLD: I think we are ready now to move on to the specific questions. I think Bob Keaten probably is doing the .irst one; is that right?

Okay. Bill Zewe will have the first one.

MR. ZEWE: The initiating event on the morning of the 28th was the closure of the condensate polisher valves on the condensate feedwater system, and starving the suction to the condensate booster pumps and also to the feedwater pumps, which resulted in their automatic tripping and ensuing automatic trip of the turbine generator, and then the high pressure trip of the reactor itself.

The cause of the valves to close, as best as we could determine, were the presence of water in the air system going to control, the position of the condensate polisher valves themselves, and water rather in the air control system, the result in this valve closure.

We feel at this point this is what happened and what started the sequence of events.

DR. CARBON: Questions from anyone?

DR. LIPINSKI: Could you be more specific as to how you got the water in the air system?

MR. ZEWE: Yes, sir.

During the morning of the 28th and also the last shift on the 27th, starting at approximately 4 p.m. on the 27th, until the trip at 4 a.m. on the 28th, we were trying to dis.odge a resin clog in the transfer line from the number 7 vessel to the receiving tank for normal regeneration mode of that resin.

This cloggage was trying -- was in the process of trying to unclog for this whole period. And in this process we actually transferred the resin over in a water-tight slurry into the receiving tank. And we turned what is termed "fluffing air," which comes from the service air system that we intermittently admit to the vessel itself to keep the resin in a slurry mixture, and mixing in the tank so that we can transfer it over to the receiving tank.

And at a point in the procedure, you could introduce high-pressure sluice water, approximately 150 to 160 pounds, at the same time that you intermittently introduce the fluffing air, and we believe that the water being at a higher pressure, of about 50 pounds higher than the air pressure, forced water back through the instrument air system, past a check valve that is in the air line that would preclude water from going back into the air system.

We have found, subsequently, that this check valve was in fact -- failed in an open position once we inspected it. We ran a test a few weeks ago, checking to see how much leakage we could induce past this check valve, and we found that it leaked in excess of five gallons a minute.

So we inspected the subject check valve, and it was found to be failed in open position. And it subsequently has been replaced and retested. The water then continued from the service air system and into the combined service air instrument air system.

Then it came back through the instrument air system that feeds the control signal to operate the polisher valves. And a volume of water in the line going through the fission controllers would result in the blockage of the air signal going to the positioner that actually determines which portion of the valve receives air for either a closure or an opening operation.

And the positioners are set up originally that they will close on failure of signal air, and the blockage of this air, which we believe occurred in the fissure air regulator, would result in a zero air signal or cause the valve to fail shut.

After the transient, we went down and indeed found that all of the polisher outlet valves had isolated themselves without any operator action. We also began to bleed out the pressure regulators to see if there was water in the lines.

We drained water from all the pressure regulators in that area and also from the lines off the service air and instrument air system.

For sometime afterwards, in the neighborhood of 45 minutes to an hour, we still had water coming out of the lines.

DR. LIPINSKI: Did this contribute to the water hammer that followed this transient?

MR. ZEWE: I don't believe it did. I believe that the water hammer, in my opinion, was just the result of the closure of the valves themselves, not actually the water and air in the service air system, but actually just the closure of the condensate polisher valves, causing the condensate booster pumps and feedwater pumps to automatically trip.

And their ensuing trip caused the hammer that you're referring to. The auxiliary operator at the time, at the polisher panel, observed considerable movement in the neighborhood, in his recollection, of about two and a half feet of the suction line going to the 2-A condensate booster pump, which is the line which is directly across from the condensate polisher panel, where he was at that point.

DR. LIPINSKI: And this ripped the air lines loose to certain valves that were involved in controlling hot well level?

MR. ZEWE: I would have to assume that that is true. There are two valves that are involved in rejecting the high hot well level to the condensate storage tank. I had received words that one of these air lines going to one of these valves had come loose, presumably from the movement of the line.

And in fact later I spoke with the instrument man that repaired the line, and he showed me at which point it had parted, and it was on COB 57.

DR. LIPINSKI: Then the filling the hot well resulted in your having to go to an atmospheric dump in the course of the transient?

MR. ZEWE: Not at this point in time, no. We did go later to the atmospheric dump, somewhat later in the event.

DR. LIPINSKI: My interpretation of the transient was that the hot well had filled. As a result, you then had to dump to the atmosphere; you could no longer condense and put water in the hot well.

MR. ZEWE: We did that at some point later. But we did not do it in the very early stages of the transient. I'm referring to some time after 5:00 o'clock we did do that.

DR. LIPINSKI: But was it as a result of the hot well being full as to why you had to dump to the atmosphere?

MR. ZEWE: No, it wasn't. As a matter of fact, it was much later than 5:00 o'clock really that we lost vacuum in the main condensor as a result of losing auxiliary steam capability from the Unit 1 auxiliary boilers.

Then, once we lost vacuum, then we had to shift the control to the atmospheric release. That was only done on the A side, since the B steam generator at that time was isolated.

DR. CARBON: Carl.

MR. MICHELSON: Apparently you're using the air system both for service and for control. I didn't notice any suggestion in design improvements that you eliminate the surface usage of control air.

Do you know have any thoughts on this, or are you going to change the system design at least so it's single-failure proof, or what?

MR. KEATEN: We haven't fully evaluated that. But at the moment we are not necessarily suggesting that, and the check valve functioned as it should have. This would not have occurred -- and perhaps attention should be directed toward making sure that the check valves are not quite so vulnerable.

MR. MICHELSON: Well, alternatively, maybe the attention be directed to the safety significance of using the control air system for safety devices and also air for service usage. And apparently this may be not reviewed in that regard.

MR. ARNOLD: We'll go back and take another look at our activities in that area, sir.

DR. CARBON: Let's move on to B then.

MR. ARNOLD: Mr. Chairman, we have perhaps more detail on that if you like. We handed out the drawing. There has been some discussion.

Would it be easier to handle just questions at this point?

DR. CARBON: I think probably so.

Does anyone have any questions on item B?

(No response.)

DR. CARBON: If not, let's go on to C then.

MR. ARNOLD: I'd like to ask Mr. Dick Dubiel, Supervisor of Radiation Production and Chemistry at Three Mile, to address item 5-C.

MR. DUBIEL: Item 5-C deals with the control room ventilation system.

First of all, as the design basis for the control room ventilation systems of Unit 2, the system is designed to go into an emergency lineup following an ES or an RMS radiation monitoring system signal.

Part of that lineup includes the introduction of makeup air, outside makeup air, to allow for positive pressure in the control room.

I'd like to point out at this point that in the design of Unit 1 that is not the case. The normal emergency lineup is only a recirculation lineup. Any introduction of outside air is a manual event.

In the Unit 2 system, the design does not provide for any automated controls. In other words, once the system is placed in the energency lineup, there is no instrumentation detecting the pressure in the control room, nor any subsequent feedback to the outside air makeup dampers or fans.

On the morning of March 28th, the system was very early on place in an emergency lineup, which should have provided for outside makeup air. 537 090

I don't think at this time that we can positively state the actual flow rate of makeup air, but I think it was pretty obvious to us in the control room that the control room was not at a positive pressure continually through the day, relative to the surround ng buildings.

As a result, on many occasions there was an introduction of airborne radioactivity into the control room. This occurred both in Unit 1 and in Unit 2. The primary reason for the introduction of the airborne radioativity can be tied back to the stagnant meteorological conditions that existed and the fact that the surrounding buildings, such as the turbine building, in both units were drawing airbornce activity into those particular buildings.

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The result in the control rooms were that on several occasions in each control room the requirement for respirators existed. Personnel in the control rooms were required to don respiratory protection devices, and, as a result, I think you probably have been aware that there was much difficulty in communications: personnel in the control room communicationg with each other and, probably more dramatically, difficulties in communicating over phone lines.

The problems that existed, then, I think, can be separated. First of all, the problems of the positive pressure in the control room. I think the positive pressure in the control room would definitely have been an advantage on the morning of March 28, both in Unit 1 and Unit 2 control rooms. But secondly, the communications aspect in respirators was addressed separately in another question at the subcommittee hearings. And I think that particular question should be addressed not only from the emergency standpoint that we faced, but also from the normal usage of respiratory protection equipment throughout the units.

I think in both of those cases there is the need for improvement in both the design and also the equipment used in both control room ventilation systems and respiratory protection devices.

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I would like to just point out, though, that although the communications aspects were difficult, I don't believe in

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any case that they were what you would refer to as "impossible," nor were communications such that messages were not understood, not clearly understood or not clearly communicated.

I think that's all the prepared remarks I have. If there are any questions --

DR. CARBON: Dade.

DR. MOELLER: A quick question on the respirators. Are they of a type that primarily protected you against particulates, or did they have an absorption unit in them for taking care of noble gases?

MR. DUBIEL: On March 28 they were strictly the particulate respirators.

DR. MOELLER: Thank you.

DR. CARBON: Dave.

DR. OKRENT: What activity levels did you get to in the control room?

MR. DUBIEL: The activity levels that we were monitoring were at levels of approximately five times 10-8, to maybe eight times 10-8 particulate activity levels.

DR. OKRENT: I can't convert that into anything very meaningful.

MR. DUBIEL: Fine. In terms relative to maximum permissible concentration for some of the particulate isotopes, it would be about 10 times to 100 times MPC. 537 093

PROF. KERR: The units in which you're giving this are

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microcuries?

MR. DUBIEL: Microcuries per cc. That's correct.

DR. OKRENT: Where do you take your outside air from as you're using it?

MR. DUBIEL: Outside air is taken from an air-intake tunnel. For Unit 2 it exists on the east side of the unit, approximately 150 feet from the outside of the auxiliary building. In Unit 1 it would be on the west side of the building, slightly further, approximately 300 to 400 feet from the buildings.

DR. OKRENT: How large a release from the containment under either stagnant conditions or moving slowly toward these intakes might have made one or the other of the control rooms noninhabitable?

MR. DUBIEL: Is that question assuming respiratory protection?

DR. OKRENT: Yes.

MR. DUBIEL: I don't believe that it would have reached the proportions of not being inhabitable. I think with respiratory protection we still had a significant safety factor. And also I think it may have limited the stay time of personnel but not -- in other words, we might have had to rotate personnel a little more rapidly, but not made the control room uninhabitable.

DR. OKRENT: Well, let me say, suppose all of the gaseous activity that got into the containment were leaking in that direction. Would that have made the control room uninhabitable?

MR. DUBIEL: If all of the activity in the containment, which we have measured to exist in the containment, were to get into the control room, yes, sir.

DR. OKRENT: I didn't say it got into the control room. I said it escapes from the containment and was available to get into the control room.

DR. SIESS: Standard leak rate?

DR. OKRENT: No, not standard leak rate.

DR. SIESS: It all escaped from containment?

DR. OKRENT: I am just trying to see whether, with a much larger release than you had, you could have been driven from the control room.

MR. DUBIEL: I think I can only give you a personal opinion there, and I would have to say "No." I do not believe that. If we had lost all of the activity from the containment, I would only have to assume that a fairly small portion of that total activity could get into the air intake structure, just due to normal dispersion even under relatively stagnant conditions. I would have to assume that the levels would be sufficiently low.

DR. OKRENT: Have you ever analyzed this?

MR. DUBIEL: Personally, I am not aware of a detailed analysis, other than the analyses that have been done for the FSAR for both units to show the fact that the systems do meet the design criteria. I am not totally aware of the assumptions made there, I think, is the answer.

PROF. KERR: I bet the assumption was a tenth of a percent leak rate per day, for example.

DR. CARBON: Chet.

DR. SIESS: If respiratory protection had not been used at any time during the incident, do you have any idea what doses would have been received by people in the control room?

MR. DUBIEL: I don't have a specific number, but I think I can give relative numbers. I think on that particular day we would have had individuals receiving greater than the 40-hour MPC limitation. Personally, I don't think that that would be a serious exposure, total exposure. It would definitely warrant significant follow-up evaluations. And I think my feeling would be more towards possibly receiving in the first couple of days as much as a quarterly limit of MPC.

DR. CARBON: Carl.

MR. MICHELSON: On Unit 1, I understood, I believe, that you go into recirculation without additional makeup air. Is this still keeping a positive pressure in the control room?

MR. DUBIEL: On strict recirculation it would not guarantee positive pressure.

MR. MICHELSON: But you could keep positive pressure by bringing in makeup air?

MR. DUBIEL: That would be a manual event, and that

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could establish positive pressure.

MR. MICHELSON: Now, the makeup air in that event, is it filtered?

MR. DUBIEL: Yes, it is. The makeup air is first filtered through the emergency filters prior to introduction into the control room.

MR. MICHELSON: Is this charcoal?

MR. DUBIEL: It is a combination of high-efficiency particulate absorbers and charcoal.

MR. MICHELSON: Did you use the makeup to keep a positive pressure on Unit 1?

MR. DUBIEL: I am not aware that that was, in fact, done. I do not know.

MR. MICHELSON: Now, on Unit 2, you also brought in makeup air automatically, as I understand it. What happened to the positive pressure, and how did the activity then get in?

MR. DUBIEL: I am not absolutely sure of the details surrounding the introduction of the air. I know for a fact that the air did come in from the surrounding buildings, specifically from the turbine building, on several occasions. The turbine building ventilation draws air in through roof fans -- excuse me -- it exhausts air through the roof fans, therefore drawing air in through openings in the building.

537 097

On many occasions, the air flow from the turbine building to the control room was in that direction: turbine building to control room. And I do know that on many occasions when the door was open we could actually see the increase in activity; peop!e actually came in through the doors and opened them. Activity levels would increase.

The reason for the control room not being positive with respect to the urrounding buildings, I think, can only be tied to the fact that there is no absolute controller on that system. In other words, it is established initially and balanced and is shov ~ be able to provide positive pressure, but during an event such as March 28 there is no i dication in the control room of what that pressure is nor any automatic feedback to the makeup dampers. So, the position of those dampers could have been different than they were when the system was balanced.

MR. MICHELSON: It would appear, then, to me, that this is an area that needs very close scrutiny. There must be something wrong with the regulatory requirements or something on these systems. You've certainly got to account for the door being opened and closed occasionally, or double doors being put in.

MR. DUBIEL: Yes, sir. I agree with you.

DR. CARBON: If there are no further questions, let's move on to Item D.

537 098

MR. KEATEN: Mr. Chairman, we have passed out a three-, four-, or five-page handout on that, and I will be glad to answer any questions there are. Of, if you prefer, I will present the material. But I think it's fairly self-explanatory.

I might make this comment, that most of our analysis of natural circulation has shown that it is really quite difficult to interrupt it by anything other than physically creating some sort of a blockage in the line that prevents it. And the analyses, not only by GPU, but by a wide variety of organizations, have indicated that within a very wide range of conditions that it will be maintained.

DR. CARBON: Does anyone have questions to raise at this time on natural circulation?

Carl, do you have any?

(No response.)

DR. CARBON: Let's go on then.

MR. BENDER: Mr. Chairman, I wanted to ask one question.

Have you looked carefully at the natural circulation condition that exists when the pressure power-operated relief valve is open? The pressure gradients that exist in the system should perhaps be considered when you're saying that -- and you're certainly not losing natural circulation; you may, in fact, be getting heat removal. But the circuit that involves removing the heat around a steam generator -- if that's what you're referring to -- I am not sure you can establish it. So I want to be sure I understand the definition.

MR. KEATEN: We have not really done that analysis.

You are correct. The answer that I gave was really directed toward natural circulation in the mode that the plant is in now. We have not done a detailed analysis of what it would be with the pressurizer relief valve open.

MR. BENDER: I just want to be sure there was no confusion. Other than that, I don't have any questions.

DR. CARBON: Dave.

DR. OKRENT: Not for the situation the plant is in now. For the plant not having had an accident, if you lose your off-site power so that you want to go into natural circulation, do you need the pressurizer, or do you need some kind of pressurizer control, or not?

MR. KEATEN: I am not sure that we have done a detailed analysis of exactly that situation. But, I believe, Dr. Okrent, that the analysis that we have done would indicate that it could be done either with a local depressurizer or with off-site, but I am not completely sure of that information.

DR. OKRENT: One other question: When you're in natural circulation, do you get some degree of spray in the depressurizer?

MR. KEATEN: No, sir. Very little.

DR. OKRENT: Is there an alternate spray system?

MR. KEATEN: Yes, sir, there is an alternate in the decay heat system. But you have to have a decay heat -- we have not done that examination.

DR. OKRENT: You have used the term "decay heat pump." Is that a specific pump?

MR. ARNOLD: Yes. The low-pressure injection pump for emergency core cooling considerations for the decay heat system, as we call it, which is also used to remove decay heat on the shutdown depressurizer plant.

DR. OKRENT: That's a low-pressure system, so until you got down to that pressure you would not have pressurizer spray; is that correct?

MR. ARNOLD: That's correct. It is a 375-pound relief valve, setting up a relief valve on the decay heat system.

DR. OKRENT: Let me ask Mr. Michelson: Where do we stand on this question of natural circulation capability under the circumstances I was talking about, a loss of off-site power and a SCRAM? There was an interest in having pressurizer heaters available, but you don't have pressurizer spray. Are you in any difficulty?

MR. MICHELSON: You don't need pressurizer spray. It's primarily to bring pressure back down again. You need either heaters -- it is a possibility, under less desirable conditions, of going solid and attempting to control over-pressure with the high-pressure makeup pump. This is a little trickier business, and it's probably not the preferred way to do it.

537 101

DR. OKRENT: When you say you don't need pressurizer spray, you're assuming what?

MR. MICHELSON: I am assuming that I don't mind going higher in pressure, but I do mind going lower because I want to stay well sub-cooled. If I go up in pressure, I don't mind waiting a while to bring it back down. I do that by shutting off heat input to the heaters. You could pop a valve, of course, but I think you would just simply, if the pressure starts rising, you just back off on the heaters and wait for it to settle down. But to spray is to bring you down quickly for normal control.

DR. OKRENT: I hear you. I am just thinking. Thank you.

DR. CARBON: Let's go ahead, then, to Item E.

MR. KEATEN: The next item has to do with the operations of the pressurizer relief valve in two different time periods. The first is from four to five hours into the event. We have been investigating this, and I will report to you the results of our investigation, but it does not give an unequivocal answer to the question.

An inspection of the data, particularly data of the reactor containment building temperature during that period of time in which the temperature went up and then remained up in this period of time would lead us to infer that the block valve was open during that period of time. 537 102

In discussion with the operating staff, however, it is not their recollection that they left the valve open. It is, rather, their belief that the valve was closed during the majority of that time. This is the period of time when we don't have the computer data to directly indicate what was going on. So all we can do is to try to infer it.

The operators do remember that they wanted to confirm whether they could use that valve to control the pressure in the primary cooling system. And so they do recall opening it and closing it once during this period of time, to determine what the effect of that cycle had on the reactor coolant system. And past that, we really are not in a position to say any more at this point in time. We are continuing to investigate this, but we just don't really know.

With respect to the second portion of the question, which was the operation at 10 hours after the trip, it is my understanding that at that period of time the operators were deliberately intending to open that valve as a method of depressurizing the primary coolant system as part of what was at that time their intent of lowering the system pressure in order to be able to put the decay heat removal system into operation.

And it is further my understanding that the shift supervisor, Bill Zewe, gave the instructions to the operator to open that valve at a particular point in time while he was watching the building pressure indicator, and that when the operator opened the block valve it was at that moment in time that we obtained the pressure spike in the reactor containment building, which was subsequently analyzed as a 28 psi spike.

end#8

DR. CARBON: Carl?

MR. MICHELSON: I think I understand what you're saying. I think that you can draw some equally good conclusions, though, from the reactor system pressure curves such as your Figure 4 in your annotated chronology. It seems to fit very nicely throughout the entire period of 16 hours, the original assumptions on relief valve operation.

Now it was my understanding later, though, that even though the numbers looked real good in your chronology, that you really just looked at the chart and took the numbers down from the chart; whereas, I thought I was looking at some kind of computer data, or something equivalent.

If you first thought these were relief valve operations and you now think they're something else, then what is your new explanation for the very fine wiggles on the reactor coolant system pressure which seem to match the idea that these were relief valve operations?

I mean, after all, we're talking about wiggles of several hundred pounds pressure durations like an hour, which seem to track very nicely the likely operations of the relief valve.

It just seems like it's just as good a logical argument, and I couldn't actually give you much on a reactor containment temperature and pressure. I'd try to track those. They just don't track.

MR. KEATON: You are correct in your first assumption, in that the original version of the sequence of events, t' operations of that block valve, were simply inferred from the reactor coolant system pressure. They are not based on any direct data.

The people subsequently reviewing this have come to believe that the behavior that they initially postulated is inconsistent with some of the other data charts. At least one of the wiggles in the reactor coolant system pressure that you're describing we now believe to have been due to a high pressure injection that occurred at that point in time in cooling the system down.

But I think the point that you are raising is a valid one that is simply indicative of the fact that we've got several different pieces of data we're trying to infer something we have no real direct indication of, and we're continuing to work on it. It could be, as time progresses, that we may revert back to the original scenario, or to still some third scenario.

It's just sort of a detective story that we don't have the ending of right at the moment.

DR. CARBON: Let's move on, then, to item (f). Considering the time, I think it would be most appropriate if the committee members addressed Mr. Arnold with any questions you might have, rather than for them to lead into a discussion.

Excuse me, Milt?

DR. PLESSET: I have one.

DR. CARBON: Go right ahead.

DR. PLESSET: We raised the question at the meeting in Harrisburg about the hydrogen bubble calculation. Can you tell me more than what you gave us in the handout?

MR. KEATON: The information that we gave you in the handout today addressed some of the questions that were raised. The other two questions that I remember that you raised verbally were, number one: Was there any correction done for the presence of steam in the bubble?

The answer is "no."

DR. PLESSET: What kind of temperatures were you encountering when you were first making these measurements? Do you recall?

MR. KEATON: About 280 degrees Fahrenheit.

DR. PLESSET: That was, say, March 30th? I thought it was a higher temperature than that.

MR. KEATON: I believe that was the general system temperature at that point in time. The core thermocouples were still reading higher. The system temperature was about 280. It was about 1000 psi.

537 106

DR. PLESSET: In view of the temperature, did you take PV and divide it by RT? That was the other part of my question. That would be kind of a check on whether you're in the right ballpark or not. That's a pretty good relationship, Boyle's Law, but this is another relationship.

MR. KEATON: I'm not sure that we did not, no, sir.

DR. PLESSET: You did do that?

MR. KEATON: No, r, I'm not sure that we did.

DR. PLESSET: I wonder why not? Because you had such a big spread in your numbers that it would be a way to really get another bit of information. You knew the temperature.

MR. ARNOLD: I think Mr. Wall was involved in some of the calculation.

MR. KEATON: As far as the spread, as we tended to indicate in the handout, the spread is relatively explainable by just the inaccuracies in the instrumentation.

DR. PLESSET: I'm curious as to what PV divided by RT would be. Was it 1? Or 10? Or .1?

MR. KEATON: I'll go home and calculate it.

DR. PLESSET: That's what I asked at Harrisburg, if you recall.

537 107

DR. LAWROSKI: What's the volume in the pressurizer? Everything you give is in percent.

MR. KEATON: It's about 1500 cubic feet.

DR. CARBON: Are there other questions to raise?

(No response.)

DR. CARBON: If not, I believe that winds up this session.

We thank you, Mr. Arnold, you and your colleagues.

MR. ARNOLD: Thank you, Mr. Chairman. We appreciate the opportunity to appear before the committee.

(Pause.)

DR. CARBON: Mr. Taylor, as soon as you're prepared, we're ready.

MR. TAYLOR: On behalf of Babcock & Wilcox, I want to say that we're happy to be back. We spoke to the subcommittee, to the Generic Implications Subcommittee, on the 31st of May and the 1st of June, for a rather long session.

We're not planning to be here that long this time. We have tried -- you have an agenda -- the committee has an agenda in front of it which was prepared by the committee staff, and I would just like to make a couple of comments about how our agenda compares.

You have a copy of our agenda.

(Slide.)

PROF. KERR: Mr. Chairman, where in front of me do I have that agenda?

MR. TAYLOR: Richard Major is passing that out right now, and it's also on the overhead, Professor Kerr.

PROF. KERR: I'm with you.

MR. TAYLOR: Comparing the agenda that you have, that I believe you received earlier from the ACRS staff, I would like to call your attention to two items which are different, really -- one which is definitely different, and one which may appear to be different but which is not.

Item number three on the ACRS agenda is simulator capability (operator training). We are not planning to address that item. We did not interpret from the comments that were made after the subcommittee meeting that that was going to be an item on the agenda, and so we did not include that.

The other reason we did not include it is because of the visit by some of the ACRS members to the simulator in Lynchburg. We did have one question which the subcommittee asked us, and that was to provide them some documentation regarding simulator capability and the equations used in the simulator, and we are doing that.

We expect that work to be completed next week. And so there were a couple of reasons why we felt, with the time the way it was, that we would not cover that particular item.

As far as item four is concerned, "response to NRC bulletins," we have not a formal presentation, but many of the items in the agenda will address items in the NRC bulletins. And we can answer further questions later on at the end of our presentation, if the committee wishes.

As we understand the purpose of the meeting today, it's for the ACRS to gather and evaluate information which will be used by the committee to further develop their recommendations regarding the future implications of TMI 2.

We interpreted the subcommittee's requests for the presentations that we're going to make today and structured our presentations accordingly. The presentations that we have made fall into two broad categories, with the exception of the one that I am going to make in a minute about the chronology of events. But the rest of the presentations are directly related to two broad categories.

Category one is the reduction in frequency or severity of transients that are actually happening in the plants.

And category two is related to improving the management, or the handling of these transients when they do occur. This second category -- that is, the improved management or handling of transients when they do occur -- involves some of the things that you see on the agenda: additional analysis, additional procedure guidelines, improved diagnostic equipment for the operator, some hardware changes, and so on.

So that's the context in which our presentation will be made. It will fall into either of these two broad categories. That is, reducing the severity or the frequency of the transients that are actually happening in the plants; and number two, improving the ability to handle those transients which remain.

Now on the agenda, following the presentation which I will give dealing with the chronology of events and the B&W support, Dr. Womack will talk specifically about actions taken to reduce the probability of a TMI 2 initiating sequence.

Then Mr. Dunn will talk about small-break phenomenology, which leads then into the operating guidelines that were prepared for the small break and which have led to the procedures which are not in effect in the B&W operating plant.

A very specific item that we're going to talk about, Dr. Womack will talk about the transient experience review. One of the things that we have been trying to focus our attention on in recent days and weeks is something that can be shown on this diagram.

(Slide.)

And that involves closing the loop between some of the key participants who can affect the transients that are occurring in the plants, and the handling of those transients. So those key participants are: the designers, the analysts, the operators, the trainers, and the guideline and procedure writers.

And so we feel that in these two broad categories of activities -- that is, reducing the severity or frequency of transients that are actually happening in the plants; and being able to handle them better if they do occur -- this is the emphasis that is really important. It's important to try to close the loop between these people and achieve improved communication on anything that perturbs the system.

DR. SHEWMON: Jim, now or before you get done with your presentation would you also comment on where LERs might come into this, and what services you provide or plan to provide for B&W's specific plant LERs, and that kind of feedback?

MR. TAYLOR: Yes. One of the things that Dr. Womack is going to talk about, I don't want to have us constrained to the terminology "LERs," but it's the feedback and field experience, and it's the mechanism that you go through to do this, and LERs or any other way of getting information back from the field, from its actual occurrences into the hands of people, must ask questions: Did the system behave the way it's supposed to? Are there changes? Are there safety significant things happening?

We're going to talk about this later on.

(Slide.)

In terms of the agenda where that will appear, we're going to go first of all -- we're going to go through some specific actions that were taken very quickly after TMI 2; then we're going to talk about small break phenomenology which is the different ways in which a small break can appear to the operator; and then from that, the guidelines which were prepared from that consideration by not a formally structured interdisciplinary team, but by a group of people which has not been common to involvement in operating procedures until now.

And then, shifting over toward the end of what Dr. Womack will talk about here, he will try to give some concept of where our current thinking is with regard to what we have learned about the preparation of these operating guidelines and the feedback, the closing of the loop, that can lead to better procedures, better information about where changes might be appropriate.

So it will be at the end of this presentation. I think we've moved a little bit further from where we were on the subcommittee with this one, and there's some very interesting information coming out of that transient experience review that we want to share with the committee today.

So, yes, we will do it, but it won't necessarily be in the context of LERs, per se, but perhaps in a broader context. And I might mention also, in the activity that Dr. Womack is going to talk about here, we will be trying to show you where we are now in terms of looking at transient root causes. That is, what are the things that are really initiating these transients?

We've got a great deal of work to do in that area, but we feel it is important to get back to the very root cause of what's initiating these things, even though characteristically it has not been the practice to look at some of these things as being safety related. So we are doing some work in that area.

Okay, so that's the background on the meeting. If there are no questions, I'll move on into the chronlogy discussion.

DR. MOELLER: Excuse me. Could you repeat where the root cause is? Which speaker is going to cover that?

MR. TAYLOR: Dr. Womack is going to cover that, Dr. Moeller.

DR. MOELLER: The next-to-the-last item? Thank you.

MR. TAYLOR: And really, what we're doing there was initiated as a result of our investigation which comes under the title of "integrated control system failure mode and effects analysis."

(Slide.)

There's a slight change from this slide that the subcommittee saw. It was a result of a subcommittee comment. In the previous presentation, I spoke about 7:45 in the morning as being the time when Babcock & Wilcox was notified of the TMI 2 incident. One of the members said, "Well, you had a site representative, and he works for B&W, and he was notified at 6:00 o'clock. Why is not that the correct time?"

That is the correct time, in that sense. So at 6:00 o'clock in the morning -- and I'm really restricting, based on the kind of guidance we got from the subcommittee in their previous agenda, my comments to March 28th. What was B&W doing on March 28th?

Then I am going to get into, a little bit later on, what we did just shortly thereafter.

At 6:00 o'clock in the morning, Mr. Rogers got a phone call. It was a conference call with Mr. Miller and Mr. Herbein, I believe, and one other gentleman, who were involved in that telephone call. That telephone call lasted for about 20 to 30 minutes.

It was at that time that they decided that they should each go to the plant as quickly as possible, and our man arrived on the site -- Mr. Rogers arrived on the site about 7:00 o'clock in the morning.

He tried to call Lynchburg at 7:30. The switchboard was not open at that time. We had a situation where the guard at the building answers the phone during the night, and until the switchboard opens just shortly before 7:45, the guard receives all the calls.

He was of the opinion that very few people were in the building, and when the first call came in at 7:30, so the call did not go through to Mr. Rogers' supervisor until 7:45 on Mr. Rogers' second attempt.

At that time, he passed on some very basic information. He did speak about a site emergency having been declared. He gave him some basic information, such as the reactor coolant pumps were not running. He gave him some very preliminary information about reactor coolant system pressure and temperature, and that sort of information.

That telephone call led to a meeting which was called by a number of people in Babcock & Wilcox's Lynchburg offices, such that by 9:00 o'clock a task force had been formed to try to develop recommendations and to try to be in a position to assist the site with what appeared to be a significant event.

At 9:00 o'clock, or shortly after 9:00 o'clock, three people from our Plant Analysis Section were deployed by charter plane to the site, and the motivation behind that action was to obtain additional information to help evaluate what had happened and learn what kind of condition the plant was in so that it could be put in a safer condition. Those people were not able to get on the site because the emergency had been declared.

Mr. Rogers, who was the man involved in this telephone conversation with Mr. Irvine and Mr. Miller, was the only B&W man on site until the second day.

DR. SIESS: Excuse me, did you find out who it was that stopped you?

MR. TAYLOR: Yes, it was the guard.

DR. SIESS: It was plant guards, not local officials. Thank you.

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MR. TAYLOR: At 10:30 we had further indirect communication. When I say we had further communication, it was of an indirect nature, and it came about as a result of a telephone call from another B&W man who had been working at the site, who had received a telephone call from the control room sometime in this time frame here.

Now, actually, it was after this period of time.

He was asked to relay information back to Lynchburg with some further information regarding plant conditions.

As a result of the question that was asked by the subcommittee why did Mr. Rogers not call Lynchburg offices directly, I have been able to learn two things:

First of all, they attempted a couple of times to get a long distance line to Lynchburg. On the morning of the 28th, from the control room or the area right adjacent to the control room instrumentation shop, was not able to get that line.

He decided at that time that he would be able to be of more assistance to Mr. Miller if he were able to pass on messages indirectly, where he could get a local line to our offsite representative.

So the difficulty in getting communication lines and the desire to be helpful to Mr. Miller, as he requested, were the two reasons why he did not call directly.

It was a judgment matter by him that he could serve

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his function onsite better in that way.

So, Professor Carbon, that is about all I can really say about that matter.

We did recieve some further indirect information through one of the Met Ed supervisors who was in training on the simulator at that time. He had been able to communicate through a telephone number that he was aware of to the shift supervisor of Unit 1. So he obtained some additional information and passed it on directly to us in the Lynchburg offices through that channel.

Then we received further indirect information from our offsite representative, and I believe this particular item might be a little bit off in time as far as the request for radiochemistry support, but within an hour of that particular time Metropolitan Edison had requested radiochemistry support and two people were dispatched from B&W Lynchburg.

About noon, a task force that had been formed began its special procedure work in the interest of trying to decide what precautions should be taken before starting the reactor coolant pump.

The things that were of primary concern to the people who were developing that procedure or identifying those precautions were:

Whether or not the services to the reactor coolant pumps had been maintained during this early part of the

RMG 3

transient, the services regarding sealed water, cooling water to the motors, and so on.

But the first special procedure work was begun at about noon. Then we had further communication with our offsite representative as a result of another telephone call that he had received from our onsite man at 1:30 in the afternoon.

Between 2:00 o'clock and 4:00 o'clock B&W requested GPU and Met Ed to set up communications between the site. We were having no luck in getting long distance lines directly into the site, so this was attempted through the GPU/Met Ed organization.

Also through that telephone conversation or one of those telephone conversations, the message was passed to make sure or to try to obtain at least gpm high pressure injection flow. This was passed both through this channel and also through Mr. Floyd, who was in training at the time, to get the message to the Met Ed shift supervisor in Unit 1 and have him communicate.

Then at 6:35 in the evening we had our first direct telephone conversation with the control room, with our site representative, and that conversation, the emphasis in that communication was primarily on obtaining information that would allow us to help them decide what was the best way and what were the best conditions under which to start reactor coolant pumps.

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That information was communicated to them. It involved a momentary jogging of the pump, watching pump characteristics. And shortly thereafter the first reactor coolant pump was started.

That was essentially the chronology of B&W's support, or the chronology of events that involved B&W support the first day.

During the second day, we were able to establish with Met Ed help between 1 and 3 direct communication lines involving telecopy services and videotransmission through additional telephone wires.

Now, what I would like to do in the next couple of minutes is just shift over to the kinds of things, the kind of organization that we had set up and the level of effort that was involved in that organization.

(Slide.)

This is nothing more than a direct copy of an organization that existed on the second of April. There were similar organizations that varied from day to day. Sometimes the organization on a more than once-a-day basis.

But the numbers -- this is just a reduced version of the charts that were actually passed around -- but this chart shows the organization that was set up temporarily to provide support to Met Ed and to our site representative.

The organization here shows many different

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disciplines, and the initial organization was set up on the basis of 2 12-hour shifts. This one happened to be on the second of April, refined to three shifts, because we could see that it was going to go on for a number of days.

The kinds of things that the people were involved in and the level of network was involved and the total number of people, the slide I just showed you, was pretty much the supervisory people.

(Slide.)

But the number of people that were involved by B&W on the 29th of March was at 62 people with 12 of them being at the site and 50 in Lynchburg.

These are average numbers from here on:

By the 5th, it had jumped up to a total of 243, and then started to decline thereafter.

Today, we have about 35 people at the site in a support role to Met Ed.

(Slide.)

So the main point of that slide is to show there was a very substantial effort going on in Lynchburg.

The kinds of things that were done, they involved analyses -- these are just typical B&W outputs --

Analyses -- there was a significant amount of equipment shifting to the site;

There were arrangements for decay heat coolers

RMG 6

and pumps for another project to go to back up the equipment that was there;

There were procedures, there were as of this time about 140 procedures that had been prepared, supplementary procedures or modified procedures in the form of contingencies, test procedures, and so on;

There were also supplementary procedures aimed at assuring the safety of the operating plant, handling the projectable system voids, and so on.

There were training services going on, so that by the 9th of April a special training program had been set up and people were coming in from Lynchburg, all the operators -- as of today about 180 people -- essentially all of them.

All the operators of the B&W plants have been through a simulation exercise on the B&W simulator showing exactly what happened to the best of the simulator's ability to do that, at TMI.

So this was a training program set up very quickly.

There were special tests run of many varieties. There was a great deal of information transmitted, both verbally and by telecopy, involving special equipment, information that would help make decisions at the site.

There were consultation and design activities, and we had 24-hour communications going on.

So there was a fairly sizable effort going on

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involving up to 250 people in the period of time immediately following the incident, and I felt that it was important for the full committee to see this, just as you further develop your recommendations with regard to the roles that various people can and do play in recoving from an accident such as the TMI-2 event.

Now, I have no further comments to make with regard to chronology, unless there are some questions.

We will go on into Dr. Womack's.

DR. CARBON: Walt.

DR. LIPINSKI: On the auxilary feedwater system, do you provide support to Met Ed in writing the procedures for the operation of those systems?

MR. TAYLOR: I don't believe so, Mr. Lipinski.

DR. LIPINSKI: That falls under the balance of plant aux feedwater?

MR. TAYLOR: Yes. We have, I think, different arrangements -- correct me, perhaps, Ed, if you can -- we have different arrangements in terms of service support that we would provide on a contract basis. And I suspect that some of our people have been involved in that. But generally speaking, no.

Now, on the auxiliary feedwater system, we would provide criteria regarding start time on the pumps and flow requirements and so on. But in procedure support, until now

I think it has been a pretty modest effort.

DR. LIPINSKI: How about the test procedure?

MR. TAYLOR: Yes, we do provide -- are you talking specifically about aux feedwater?

DR. LIPINSKI: Aux feedwater test procedure.

MR. ROY: Don Roy of Babcock & Wilcox.

We do not provide a direct input into the preparation of test procedures. I believe on some occasions we have reviewed test procedures for the auxiliary pump system testing during start-up.

DR. LIPINSKI: Will you provide any guidelines?

MR. TAYLOR: In terms of acceptance criteria, these would be -- yes, I believe the acceptance criteria would be spelled out in terms of demonstrating the flow requirements had been met, the start time had been achieved, and so on.

DR. LIPINSKI: Let me point out why I am asking the question, because the original procedure for TMI-2 on those aux feedwater pumps did not call for all the redundant systems to be blocked out in order to perform the test.

They had the set of procedures, and then later on time they revised these procedures, and the revision then resulted in the blocking out of the redundant aux feedwater trains.

And I was just wondering if you had any initial role in the first procedures or in the revised procedures.

MR. TAYLOR: I don't know that, Mr. Lipinski, I'll try to find out for you.

DR. CARBON: How long will Dr. Womack's presentation take? I want to schedule a break here somewhere.

MR. TAYLOR: We say 15 minutes on our agenda slide. It depends on how many questions there are.

DR. CARBON: Let's take a break now, then, and reconvene at 12:15.

(Brief recess.)

DR. CARBON: Let's go ahead, Dr. Womack.

DR. WOMACK: Thank you, Mr. Chairman.

During this next section of our discussion with you, I will attempt to survey briefly a couple of the important activities that B&W have undertaken in response to the TMI-2 sequence, to attemp to reduce the probability of the initiating events occurring again at any B&W plant, and then to look further at the accident mitigation sequence and attempts to improve that by review of operational procedures for small breaks and some additional small breaks analysis, and a focus on operational experience review which has been undertaken by the method of failure modes and effects analysis for this plant's integrated control systems.

The major actions that I believe should be mentioned here include the initial bulletin regarding high pressure injection system operation, and the conditions for maintenance

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of that operation which was issued to all B&W operating plants, and subsequently to all pressurized water reactor plants by the Nuclear Regulatory Commission shortly after the event of March 28th;

And the actions connected with the second NRC Bulletin, which focused especially on the challenges to the pressurizer pilot operated relief valve which is in B&W plants and in other plants, but was used differently in the B&W control system, which I will explain briefly momentarily.

I would like to reiterate and reinforce Mr. Keaton's remark earlier this morning as applicable to what I am going to say.

That is, that these actions we have taken, we believe to have significantly contributed to the mitigation possibility that such an event will occur again. We are continuing to learn, and we will expect to continue to learn, more about the events that took place at TMI-2.

So that at the second time that I appear before you today I will, as Mr. Taylor promised, offer some thought about some of the things that we have learned for the future, and we will attempt to apply.

If I may, for a moment I would like to focus on the second major action which was taken by B&W and the Commission Staff and the B&W utility owners to reduce the probability that the pilot operated relief valve on a B&W plant might again fail

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and lead to the necessity for either isolation of the event or loss of coolant from the primary system.

(Slide.)

This is a fragment of an event tree which describes the situation in B&W plants, and they were designed and operated prior to the 21st of April, 1979.

So it applies in general to the situation that existed at all B&W plants on March 28, 1979.

What this event tree does is attempt to illustrate the sum of its potential sequences of events which occur following a loss of main feedwater to the once-through steam generators.

The B&W pressurizer is designed with 2 ASME Code safety valves and one pilot operated pressurizer relief valve, which is controlled by electrical circuitry to open at a pressure lower than the code safety valve.

At the time of the March 28th event at TMI-2, the setting on that pilot operated relief valve open command was 2255 pounds per square inch, slightly above the normal operating pressure of the reactor, and lower than the setting of any reactor protection system high pressure trip.

It was thus intended that the pilot operated relief valve provide some relief from the pressurizer at pressures lower than the reactor trip.

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It should also be noted for those unfamiliar with

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the B&W system that the loss of main feedwater event does not have or did not have a direct anticipatory reactor protection system trip at that time.

The reason for this is quite simple, and I will illustrate at a later point in my second talk with you what its result it.

The loss of main feedwater or a partial loss of feedwater event and a turbine trip are fairly frequent occurrences in nuclear power plant experience, and with the responsive and tightly coupled integrated plant control system which is a part of B&W plants, it is possible for the system to be managed to run back in response to such partial losses of feedwater and turbine trip and avoid challenges to the reactor protection system.

We believe that this feature is highly desirable, in that it avoids challenges to the safety system and it promotes plant productivity.

The pressure relief system was designed to aid that, and the pilot operated relief valve is one of the devices which assists in the relief of pressure during the transient which accompanies such a runback.

The other device is, of course, the pressurizer sprays which mitigate the pressure rise.

Therefore, in a B&W plant, following the loss of main feedwater event, the first system action as the steam

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generator heat removal heat capacity decreases as a result of reduced feedwater flow to the generator, is for heat-up to occur in the primary system.

This results in a pressure and temperature rise which is sensed first by the pressure sensors, such that the pilot operated relief valve will open.

In a full loss of feedwater, this valve opening has a very slight effect on a rate and total rise in the transient.

The pressurizer rise normally continues until the set point in the reactor protection system is reached. It causes the rod to trip in, the pressure rise is then terminated because of the sudden reduction in heat generation in the core. The pressure falls. The pilot operated relief valve control system closes the pilot operated relief valve, and the sequence continues with the arrival of heat water to the generators.

end #10

This is the normal control sequence as designed. I have also illustrated on here a couple of other paths, just for information.

(Slide.)

Before I walk through those with you, let me show you a nominal calculation of expected system behavior with all systems working more or less nominally. Before the set point adjustments were made on the 21st of April, the initial pressure rise due to heatup before reactor trip is shown. The pressure trace in the solid line is shown here. A pressure peak of something less than 2400 pounds will be reached. A reactor trip occurs just before that peak pressure is reached. The pressure then falls and as auxiliary feedwater is delivered into the steam generator, the system comes into equilibrium and the pressure falls to something slightly above 1800 pounds and then recovers back under primary system pressure control to its pressure set point value.

DR. MOELLER: This includes an opening of the relief valve on the pressurizer?

DR. WOMACK: Yes, sir, the relief valve will open here and reclose approximately here.

DR. LIPINSKI: Before you take that off, at what level are the heaters exposed?

DR. WOMACK: The heaters are exposed about 40 inches.

MR. KANE: This is Ed Kane. It varies from plant to plant. Either 40 or 80 inches.

DR. LIPINSKI: And for TMI-2?

MR. KANE: 80 inches. Excuse me. That's where the cutoff is.

DR. WOMACK: There's an automatic cutoff.

MR. BENDER: How long does the valve stay open during that transient?

DR. WOMACK: Well, this is one minute, which you probably cannot see here. So I would say the valve probably stays open 10 seconds, 5 to 10 seconds.

MR. BENDER: What temperature drop in the pressurizer is associated with that?

DR. WOMACK: I don't have that data, Mr. Bender. I can't give you that.

MR. BENDER: I think it's relevant to questions about the behavior of the pressurizer heater.

DR. WOMACK: I don't believe it's significant, but we can get that from others.

MR. BENDER: It would certainly be important if the valve stayed open a long time accidentally, in any case.

DR. WOMACK: Yes, sir. Well, if the valve stays open a long time, which is the path shown on the event tree here, which was in fact our best judgment of the path that occurred at TMI-2 on March 28th, then we know very clearly what happens to the pressure.

(Slide.)

The pressure looks like this.

DR. PLESSET: Is the pressurizer relief valve something that B&W supplies?

DR. WOMACK: We normally supply that valve, yes, sir. We supply two kinds.

DR. PLESSET: Have you ever tested those under mixed flow?

DR. WOMACK: To my understanding, they have not been tested under the conditions of mixed fluid flow, two-phased fluid flow.

(Slide.)

The final path that I will trace for you on this little event tree which I think is of interest to the Committee, might be of interest to the Committee, is the path that is normally analyzed --

PROF. KERR: Excuse me, Mr. Womack. Let me just add one follow-on. Do you have plans to test it with mixed flow?

DR. WOMACK: We don't have definite plans at this point in time. But that's certainly on our list of considerations. We feel that such testing as a follow-on item from TMI-2 is important, not only for this valve, but for pressurizer safety valves.

DR. LAWROSKI: Doesn't Wylie have facilities to do

mte 4

this?

PROF. KERR: Wylie has facilities to test safety valves. I don't know whether they have facilities to test them on mixed flow.

DR. ROY: Professor Kerr, we have just prepared a stress specification test of both the pilot-operated relief valve and the code safety valves, and are in discussions with EPRI on a test program. We're also looking beyond that at a failure modes and effect analysis for not only valves, but the power supplies for it, as a system; the primary pressure relief system, looking at its failure modes.

PROF. KERR: Thank you.

MR. RAY: Do you make these valves?

DR. WOMACK: Mr. Ray asked me if we make these valves, and we do not.

DR. SHEWMON: Let me go back to ask the members of the Committee: If this thing functions properly, we don't care about two-phased flow, and if it's hung open then it's hung open. So I don't see why we're concerned about two-phased flow there. We're interested in whether it goes off into the next --

PROF. KERR: Well, unless the probability of two-phased flow is so low as to be negligible, I would think it would be worth knowing how it functions in two-phased flow.

DR. SHEWMON: But it's already hung open by that

mte 5

time.

DR. WOMACK: The situation -- there are two reasons I can see.

PROF. KERR: It is not obvious to me that every time it goes off and has two-phased flow, it's hung open. For example, if you want to have a solid system through some mechanism and open it, wouldn't it have two-phased flow?

DR. WOMACK: Yes.

DR. SHEWMON: It might even have one-phase flow.

PROF. KERR: I assume they'd start clashing.

DR. WOMACK: In analysis which might involve such modes of operation, we do in fact have a strong interest in having the experimental confirmation as to what the valve behavior might be.

DR. SHEWMON: Thank you.

DR. WOMACK: To complete the examination of this little event tree, I have drawn one more path on here, just to illustrate what is analyzed in the final safety analysis report relative to this system. And in the FSAR what is done is to assume the failure of this valve in a closed position, since that contributes to the concern, the primary concern of loss of main feedwater events which was in the safety analysis here overpressurization.

The safety analysis assumes this valve has failed and assumes other bounding conditions. It fails closed or

mte 6

does not open. It assumes other bounding conditions and actually forces pressurization up, which opens the code safety valves.

In actual practice, it has certainly been the case, at least in a few plants, that block valves or this control valve has been closed. And in most cases, if that's the case, that the block valve is closed, the pressure still does not reach the pressurizer code safeties.

Now, we undertook to find ways, as a prompt action right after TMI-2, to reduce the probability that that valve would fail to close, and the immediate action was to reduce challenges to that valve. The steps we took were to sacrifice the control relief capacity of that valve and readjust the reactor high pressure trip downward to 2300 pounds and readjust the opening set point of that valve up to 2400 pounds, so that the expected sequence of actions in the same fragment of operations now looks somewhat like this.

(Slide.)

An additional change was made to provide control grade anticipatory trip on loss of all feedwater in B&W plants, and the event tree now looks like this. The expected action following a loss of main feedwater event is detection of the loss of feedwater by the control-grade equipment and transmittal of a signal to the reactor protection system, which trips the plant.

mte 7

That trip then completely avoids challenges either to this 2300 psig reactor protection system protective function or any of the pressurizer relief valves. And the normally expected sequence is to proceed directly to auxiliary feedwater to the generators.

Should that control-grade trip not work, we have also analyzed the possibility that this anticipatory trip does not work. 2300 psig reactor trip is also expected to lead to peak pressures which do not challenge that valve. By taking these changes in set point, we feel we have significantly reduced the probability --

(Slide.)

-- of opening the pilot-operated relief valve such that that probability is now quite small.

Realistic calculations of the two cases I just described to you lead to peak pressures below 2400 psi, assuming that the anticipatory trip does not work and that the reactor protection system high-pressure trip produces the shutdown of the reactor system.

If the anticipatory trip works, the pressure never rises at all. In fact, the Oconee 1 unit had such a loss of main feedwater event during the last weekend and the anticipatory trip on loss of main feedwater did in fact shut down the reactor, and the pressure trace was similar to this.

(Slide.) 537 138

mte 8

Having taken that step, we then looked further at the possible effects on the system of delays in auxiliary feedwater. This is a more complete event tree, which examines some of the possibilities that might occur if auxiliary feedwater is delayed beyond its specified injection time. The expected path of operation on this event tree, assuming that the reactor protection system trip at high pressure terminates the critical operation in the core, terminates core heat generation, is that the auxiliary feedwater will cut on at approximately 40 seconds, OTSG level control will establish a level in the steam generator and the transient will be terminated stably.

We have examined the system behavior in the cases that auxiliary feedwater is delayed. We find that there are three major points of system response which are worthy of mention.

If auxiliary feedwater is delayed following reactor trip by approximately two to three minutes, the system will again heat up and repressurize to a pressure which will open the pilot-operated relief valve at its new set point of 2450 pounds per square inch.

If auxiliary feedwater continues to be delayed, the thermal expansion of the primary system through it will fill the pressurizer, so that liquid will begin to reach the top of the pressurizer in approximately eight minutes.

If continued auxiliary feedwater delay occurs, we have calculated, especially for pumps-off cases, but we have calculated a potential to remain with sufficient inventory in the reactor system to cover the core for approximately 20 minutes. And on delivering auxiliary feedwater at the end of approximately 20 minutes, the system can still be cooled without damage to the core, according to our calculations.

Failures of these sequences in which the pilot-operated relief valve fails open do in fact result in small loss of coolant a:cidents in the reactor system. And as a result of that examination we took, that examination and follow-up to the TMI-2 event, we took steps to do calculations of additional small break analyses and to prepare small break operating guidelines for the use of our operators.

The next two speakers, Mr. Dunn and Mr. Kane, will describe the phenomenology developed as a result of those calculations and used in the preparation of the small break guidelines.

If there are no more questions, Mr. Catton.

DR. CARBON: Paul?

DR. SHEWMON: I'd like to talk about what happens when you've got your PORV open and your HPSI on, if there's no aux feedwater for longer than 20 minutes. If I have that scenario right, you've got this LOCA, you've got your high-pressure injection, in which you don't have your steam generator or you don't have pumps moving through that. Can you indefinitely keep your core covered in that mode? If not, what keeps it from being uncovered?

DR. WOMACK: This is a calculation that we have done to determine the capability to cool the plant with just the high-pressure injection system. And this calculation does indicate that continued operation of the high-pressure injection system with relief out the relief valves, the pilot-operated relief valves plus the safety valves, should provide cooling sufficient to keep the core in a safe condition.

Do you agree with that, Bert?

DR. SHEWMON: Is that the question you asked in your recent letter, one of the questions you asked?

DR. WOMACK: I think his question was: Is sufficient cooling provided by operation of the high-pressure injection system alone, given that there is relief out the pressurizer relief system, to keep the core cool? Our calculations indicate that there is.

DR. SHEWMON: You brought out a concern about having to go to natural convection.

MR. BENDER: I think that's a partial answer to mine. I think I was thinking of a broader situation that didn't have that kind of injection. We ought to be able to find some way within a period of time to put enough water in the coolant, in the core, to take care of the heat removal process. But you might have to go to boiling and it would take a long time to do it. I don't know whether you're going to get to the point of discussing the capability of the core to survive boiling mode for a short time.

Are you going to include some kind of coolant injection?

DR. WOMACK: Yes, sir. Our calculations of delayed auxiliary feedwater injection with pumps off do in fact assume that the core goes into a boiling mode. Mr. Dunn will discuss this in the context of small break phenomenology.

MR. BENDER: I think that'll show the point that you wanted covered.

DR. PLESSET: Could I ask another question along another line? Is there a possibility that the power-operated relief valve will hang partially open and not completely close? Have you considered that situation? You have a smaller break than what you've been talking about.

DR. WOMACK: Mr. Dunn will talk in his small break phenomenology discussion about the spectrum of break sizes to some extent. And we have, especially since the March 28th event, focused on breaks really from zero size up to the size of what we have treated in our final acceptance criteria analysis as the worst case break, which is a break that's five or six times larger than the PORV.

So we believe that smaller breaks are indeed covered and understood by the phenomenological description that Bert will talk with you about. As far as the mechanistic possibility of sticking that valve open, it might be worthwhile to show that slide on the pilot-operated relief valve if you have it handy.

If not, this valve has a disc in it which is mounted on a spring and supported.

Do you have it?

(Slide.)

The valve is shown in its normally closed position.

Normally, with this pilot exhaust port closed and a low pressure in the discharge, the disc of the valve is held firmly in place by the system pressure on the upstream side.

DR. PLESSET: That's an undamaged valve?

DR. WOMACK: Yes, sir, this is a normal valve.

When the pilot exhaust port is open, pressure in the chamber behind the disc is reduced and the differential pressure acting on the upper face of the valve drives the disc open against the restoring force of that spring. The valve then remains open until the pilot exhaust port is again closed.

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The pressure then is approximately balanced, but

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the restoring spring moves the disc back up.

I do not have any extensive data to quote to you regarding the empirical possibility of partial operation of these valves. But the valve is certainly designed to be either fully open or fully closed, and at least in this concept it would appear that it would certainly prefer those positions.

e-11

DR. PLESSET: I thought the valves seemed to leak on occasions for long periods of time. So how do you fit this in with this idealized description?

DR. WOMACK: This kind of leakage might result from wear or damage to these faces. That's a possibility.

DR. PLESSET: It was a fairly new valve, wasn't it, at TMI-2?

DR. WOMACK: I am not sure what the history of that valve at TMI-2 was.

MR. BENDER: Sometimes it doesn't take but one opening to erode a seal.

DR. PLESSET: Anyway, it leaked, I gather, for quite a long period of time. So it wasn't operating.

DR. SHEWMON: It had only been operating for a month or two; hadn't it?

DR. CARBON: Three months.

MR. TAYLOR: I think, Prof. Plesset, a safety valve can be in its totally normal position and have a hairline mark on the seal, and leakage will be sufficient to show an elevated temperature in the discharge. It would not need to be mispositioned to have leakage.

DR. CATTON: I would like to ask you a question about the event tree. Which of the branch points depend on operator action?

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DR. WOMACK: In this event tree there are only a few shown. This event tree is not complete, and it is intended only to illustrate the main actions.

Let's trace the normal path. The normal path, there is no operator action assumed there.

DR. CATTON: Actually, what I am interested in is whether the actions might be different if the operator thought that the pressurizer was full or if it was empty. Everything seems to be pretty idealized on your event tree. It doesn't seem to allow for heading in the wrong direction.

DR. WOMACK: You are asking me what if the operator -- what action would you be thinking the operator --

DR. CATTON: It says pressurizer full. Does the operator do anything to carry it down that branch?

DR. WOMACK: This branch?

DR. CATTON: That's correct.

DR. WOMACK: No.

DR. CATTON: That's all automatic?

DR. WOMACK: If the auxiliary feedwater delays and the operator does nothing to restore auxiliary feedwater, this well will fill the pressurizer.

DR. CATTON: So, if the pressurizer is empty and he thinks it's full, that will not lead to problems?

DR. WOMACK: If the pressurizer were empty here and he thinks it's full?

537 146

DR. CATTON: And he thinks it's full.

DR. WOMACK: If the pressurizer were empty and he thought it was full. We haven't yet called for any operator mitigating actic- .ere at this point in time. Getting the auxiliary feedwater on or manually initiating high-pressure injection is certainly needed within some minutes to approximate that by 20 here. But at this point in time we haven't called for any operator action or we haven't assumed any operator action.

Any action that the operator might take, assuming that the pressurizer was empty, to turn on a high-pressure injection system would mitigate that.

DR. CATTON: No. The other way around. I am referring to the Oconee event, where the indicator was stuck showing that the pressurizer was full.

DR. WOMACK: Yes.

DR. CATTON: Yet it was empty.

DR. WOMACK: Yes, sir.

DR. CATTON: Is that going to lead the operator anywhere where he could get in trouble?

DR. WOMACK: Certainly, I think, if the operator felt that the pressurizer was full and utilized only that indication to take an action such as reduction of charging inventory into the primary system, that would be an action that would have a negative effect on this system. 537 147

One of the first actions that we took following this event was to try to stress that pressurizer level alone should not be relied upor 'or such action.

DR. CARBON: Go ahead.

DR. WOMACK: Okay. The next speaker is Mr. Bert Dunn, who is the manager of our emergency core cooling systems unit. He will describe to you the work we have done in the recent two months on small-break phenomenology.

MR. DUNN: What I wanted to do, leading up to the discussion of the guidelines, was to review the system evolution during small breaks and what the important factors are surrounding this accident and how the design systems, emergency systems compensate or mitigate the accident.

(Slide.)

There are a couple of key points about small breaks. The first point is that they are basically the evolution of a series of quasi-steady state conditions. Basically, in a pumps-off case of small break we will have hydrostatics controlling the movement of fluid within the reactor system. In the pumps-on case, we will have the pumps rolling fluid around through the system.

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A second key thing in considering the small-break evolution is that it is a catch-up game. The initial capacities of the high-pressure injections systems -- okay -- are not sufficient with the consideration of single failure to totally absorb core decay heat levels. Therefore, the initial inventory of the RCS is used for a period of time to buy enough time for the decay heat to drop to the point where the high-pressure injection system can remove decay heat energy and supply sufficient makeup.

There are key external influences in the analysis, and I have listed these here as the break location, which changes the evoluation of the transient, whether the pumps are running or not running, and the steam generator feedwater availability is important to some classes of small breaks.

DR. PLESSET: You say you are considering it as a kind of quasi-static event.

MR. DUNN: Yes.

DR. PLESSET: That sounds very reasonable. Now, in describing that, does that take a very compliated code?

MR. DUNN: There are a variety of opinions on the thing.

DR. PLESSET: Well, I am asking for yours.

MR. DUNN: Our code includes the full dynamic equations, et cetera. I personally believe it would not have to.

DR. PLESSET: So it doesn't take an involved code to treat the problem; is that right?

MR. DUNN: That would be my opinion.

DR. PLESSET: I wonder why the staff is going through the exercise of adopting TRAC to small-break LOCA. I wish somebody would explain that to me. It's an interesting

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question.

MR. BAER: We are doing calculations and getting reasonably close to it.

DR. PLESSET: Other people are doing that, too, without using a computer.

I would like the staff to explain why they feel it necessary to adopt an advanced code like TRAC to small-break calculations.

PROF. KERR: I think you have hit upon the reason, Prof. Plesset. The prestige of the results is much greater if they have been achieved by an advanced, sophisticated code than if they had been done by hand calculation.

DR. PLESSET: Prestige, yes. But accuracy, maybe no.

PROF. KERR: Well, one has to consider all facets of the situation.

DR. PLESSET: I yield.

MR. BAER: I don't know if we can get a response today.

DR. PLESSET: Tuesday or Wednesday.

DR. CARBON: Go ahead, Mr. Dunn.

(Slide.)

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MR. DUNN: There are phenomena involved in the small break which do have to be followed by the computer simulation, or by the engineer's hand calculation, if you will. And I would say these are the important ones which need to be tracked accurately. They include steam water distribution. Steam water distribution is important for prediction of steam generator performance.

The effluent that is occurring from the RCS, is it steam, is it water, is it some mixture. I don't know where the steam water is; I can't very well predict that.

And the efficiency of the high-pressure injection, is it injecting under water under a two-phase mixture, in a steam mixture.

Steam generator performance is important for very small breaks. At the heat removal tank it's important; to some extent, for the larger breaks as a heat source.

Counter-current flow is a necessary modeling need in order to drain the system, the upper reaches of the system, allow them to drain into the reactor vessel while the reactor vessel is producing steam which is trying to go up.

Vent valve actions, for our plan, are important. Pump modeling. And, of course, core heat transfer.

(Slide.)

I would like to discuss, then, with what I have said is important, two types of small breaks: The pumps-on small break, what happens in that case. And I will then -- in the reactor coolant pumps-off small break with the RC pumps on, I was going to show a thermodynamic system, but I think that's obvious. Heat is being generated or energy is being generated from the HPI as an injection, a certain amount of energy. And the core decay heat energy is being removed by either the steam generator or the brake -- rather, the brake, and perhaps the steam generator. Steam generator connected in both directions.

Tracking that through for small breaks, the approximate sequence of events would be a reactor trip, stored energy will be removed from the core, that initial operating temperature within the fuel which is at a rather high level will be removed during the early phase of the transient. It will very quickly go to the decay heat power levels within the system. The steam generator will be affected either as a source or a sink continuously during the transient. The system will stabilize at or below the steam generator because of its effectiveness in removing energy.

The system will maintain an approximate homogeneous state, and it can be viewed as a rolling body of steam.

DR. CATTON: Excuse me. Are the slides out of order, or are you going to skip phenomena?

MR. DUNN: It's far easier if I move the slide up because I wanted to dwell more on the pumps-off case in explaining some of the phenomena that occur. And I wanted to advance that I apologize.

MR. MICHELSON: Before you go on, would you at the appropriate point in time point out how model in the HPI pump characteristic?

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MR. DUNN: At the appropriate point in time.

MR. MICHELSON: Now is a fine time to tell me. How do you take account of the variable flow from HPI as pressure varies?

MR. DUNN: The design of the system is both tested and calculated, and we use a margin versus the calculated or designed performance basis. The numbers that are placed in my hand are the HPI flow as a function of reactor coolant system pressure at the location of injection. And I model it as an infinite source of water that can flow against that pressure at a certain rate.

MR. MICHELSON: So you insert the known pump characteristic into your calculation?

MR. DUNN: The known pump characteristic plus the known line loss.

System flow will degrade associated with two-phase effects in the pumps, but the RCS pumps will continue to circulate a fluid. The core will be cooled by flow, cooling and the following equilibrium conditions will evolve. A very minor temperature excursion is possible with this mode of cooling, perhaps 20 to 30 degrees Fahrenheit from the saturated value.

(Slide.)

Pumps-off small breaks. Far more interesting from the standpoint of the evolution of the transient. There are three phases of a pumps-off small break. During the first phase -- we would call that the "pump coastdown or natural circulation phase."

I will be showing slides later on associated with each of these phases in terms of their distribution or what have you.

This may last for the first 100, 120 seconds of the accident. The pump will be coasting down. The cooling that will occur during that time frame will remove the initial energy of the core to a large extent. HPI will be initiated, and the required auxiliary feedwater will be initiated.

An important thing that happens here is that the initial stored energy of the fuel has been removed.

(Slide.)

I am going to switch ides on you a little bit.

This is flow phase, which is still the p mp coastdown.

Yes, sir?

DR. CATTON: The last presentation you made, there were some questions about natural circulation. In particular, when you went into situations where there were some voids. Are you going to devote a few sentences to this, or would you like to start straight-away?

MR. DUNN: I would prefer you wait about three slides.

DR. CATTON: Fine.

MR. DUNN: This would be the flow phase. The system is blowing down. The pumps are coasting down. Cooling is still by a flow process. Steam is being generated in this phase from decay and fission heat, flashing and primary metal.

The one thing that I haven't stressed before that is important is to keep account of your steam generation sources, the location. I will give you another slide on that in a minute.

Dropping into the second phase, which we will call "loop draining" -- and I am going to illustrate each one of these phases with a slide of the reactor coolant system later on -- we have a steam discharge starting to the break. If the break is in the hot leg or if the break is in the horizontal section of the cold leg, if the break is on pump suction it still may be water discharged. The loop is trying to drain from high in the system down to the nozzle belt area. And we will get into that.

The steam generator will start into a condensation mode.

(Slide.)

The system is still blowing down. The pumps have become ineffective. They have coasted down and stopped. They are probably free-wheeling. Core cooling is now by a cool boiling process, and steam is being produced in decay heat, flashing and primary metal.

(Slide.)

A final stage, or the boiling pod mode, in this mode, this is a stabilized mode, the loops have drained completely to where water levels within the primary system are at or about the nozzle belt range.

For the reactor vessel, the HPI water is the: carried directly into the reactor vessel to make up for the steam that's boiled. The upper regions of the system are voided. Steam may be passing to the steam generators for condensation. This is where we now have to achieve equalization.

(Slide.)

At that point, very early in the boiling pod mode, we must achieve a long-term favorable situation for core cooling.

DR. CATTON: What happens to the hydrogen coming off during this period?

MR. DUNN: We have not uncovered the core during this time. We should not have any.

DR. CATTON: I thought you were condensing.

MR. DUNN: Condensing in the steam generator.

DR. CATTON: There's no hydrogen in the water?

MR. DUNN: There may be a little bit, but it would be the initial inventory plus what's added from the BWST.

DR. CATTON: That won't affect the fermentation process?

MR. DUNN: Not significantly, by our calculations. It may control a few degrees in delta T.

DR. CATTON: Not having made the calculation, I will have to take your word for it.

(Laughter.)

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MR. DUNN: There are two sources: There is a noncondensible source in the RCS and other variables as well.

DR. PLESSET: In connection with Dr. Catton's question, what's the temperature difference between the hot liquid, the boiling liquid, and the condensing liquid? How much is it in the calculations?

MR. DUNN: The hot liquid, the boiling liquid, and the condensa'ion will depend on the breakthrough to remove energy.

DR. PLESSET: What's the maximum delta T there, roughly?

MR. DUNN: I guess I can't give you an exact number. I would expect it to be five to 10 degrees.

DR. PLESSET: That wouldn't be very much at all, I would guess, for that small delta T.

DR. CATTON: As I understand this, as you approach saturation the dissolved hydrogen begins -- it seems to me that it's going to begin to collect, and it seems to me it's going to collect where you begin condensing.

MR. DUNN: It seems to me it's going to collect high in the system.

DR. CATTON: How sensitive are your results to the actual energy exchange? If you exchange 50 percent plus or minus --

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MR. DUNN: That would not seriously impact me.

DR. CATTON: If you can stand 50 percent one way or

ad#12 another, then I think you've answered my question.

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MR. BENDER: Before you take that off, I'd like to just be clear. Suppose you didn't do any condensing at all, will the system cool itself just by blowing down?

MR. DUNN If we did not do any condensing whatsoever, yes, the system would cool itself by blowing down, but it would be a different scenario. We would be up at high pressures okay, and it depends on the break size.

For example, let's take a normalized flow that's equivalent to what I would calculate at .2 square foot break. That system will stabilize at around 1500 psi without any steam generator performance.

Now if the break becomes smaller and smaller, then I will go and make another break. If I don't have any condensing mechanism --

MR. BENDER: Refresh my memory. What's the size of the PRC?

MR. DUNN: 007, approximately.

MR. TAYLOR: Mr. Bender, I think Mr. Dunn meant to say ".02" instead of ".2" square foot break.

MR. BENDER: I was just trying to get some relationship, but the relief valve if it blew down without the benefit of the cooling from the steam generator, would it take away the afterheat from the core?

MR. DUNN: The relief valve, the PORV? Eventually, yes.

DR. SHEWMON: It was "07" and "02"?

MR. DUNN: "007." It would take a period of time for it to depressurize, but we have performed calculation on what we call the "burp and slurp" mode, which says that 1 HPI with the relief through the core, or the code safeties, will provide extended core coolant. Eventually, if that valve were left open, as opposed to being controlled to its set point, that would come down to a low pressure.

MR. MICHELSON: I think we want to be real careful to be sure to always talk about two things at the same time. One is the ability to remove the heat from the core through the hole; the second is what the final minimum water might go to as a result of using that mode of operation.

So whenever you talk about "yes, it can remove the heat," talk about the ultimate outcome of the repressurization and having to take the heat out at very high pressure.

MR. DUNN: The situation has been evaluated. No core uncovery has been examined or been shown, and that's a realistic calculation. For conservative evaluations, a small degree of core uncovery would be necessary.

MR. BENDER: With, or without, the steam generator?

MR. DUNN: Excuse me?

MR. BENDER: If I just took out the steam generator as a heat sink, that's the only heat sink I've got, what goes out of the opening in the primary system, what's the scenario that goes with that? That's sort of what happened at Three Mile Island. It may not have happened so abruptly, but that's basically what happened.

MR. DUNN: At Three Mile Island, the steam generators were in operation following eight minutes into the transient.

Let me try and answer the question directly.

MR. BENDER: There were eight minutes when it was working?

MR. DUNN: And during that eight minutes, you start to incur pressurization. Okay? You've actuated your high pressure injection, and you're filling the pressurizer.

Now there is a similar question on the board, and I do have some slides later on bearing on this, what would happen is you are going to go up in pressure to approximately 2500 psi, maybe 2550, perhaps 2600 psi. You'll open the electromatic relief valve, and both code safeties. You'll be injecting with on high pressure injection pumps. You will exchange the system -- for a period of time, use the initial inventory, or pump the initial inventory out, depending on what period of time you're talking about, through those valves, but you will provide successful core cooling against realistic decay heat levels, without uncovering the core.

Now if I'm forced to use the escape calcula ions, there might be a temperature rise in the core.

MR. BENDER: All I want you to do is prevent you from using the steam generator as a heat sink.

MR. DUNN: I did not use the steam generator in what I just told you.

MR. BENDER: What you're saying is the core will just drive off whatever water you put in, and that will keep the core cool?

MR. DUNN: Yes.

The pool boiling mechanism is maintained.

MR. BENDER: That's all I wanted to know.

MR. DUNN: So here we are down at the end. In general, blowdown is completed. I've stabilized it somehow in my energy removal path. Okay? I may be at the steam generator stage, removing a certain amount of energy from the steam generator, a certain amount of energy via the break, or I may be below it and take it all out of the break, cooling it by a cooldown process. And at this time, primary metal is gradually decaying faster than decay heat.

(Slide.)

Let me show you a couple of things. I'll be using this slide in a few minutes quite extensively to illustrate where fluids and steam are in the primary system during the transient. But if you notice, within the reactor vessel we have a nice trap situation. We have a couple of capabilities for opening and losing fluid. One thing that occurred during a break is that, as far as the vessel is concerned, once the fluid levels fall below this location, I can't lose anything any longer. I will not lose fluid except by the boiling process. Okay?

Now that is an important thing to remember, because there's also a situation that says I can't put anything more in; that I am making steam in this location; steam takes a certain amount of time to separate from water, and there's only a certain degree of filling of the system that can occur before I spill it out into the nozzles, either the hot leg or the cold leg nozzles, and it goes to the break or over into someplace else in the system that may be available.

(Slide.)

The relative elevations, to give you a handle on this, this is the lowest region at which I can lose fluid from the reactor vessel, and it is approximately five feet above the top of the active region of the core.

You will see in graphs that we predict on core mixture height, for example, you will see certain stabilization planes that appear very common and almost arbitrary. Generally, they will be the bottom of the vent valve, because once they fill the system up to the vent valve, for example, if I can refill then I just spill water over and I start a circulation mode. I really have a hard time filling the head up above this location unless I've got some super pump that can really overpressurize, and you may see stabilization at the bottom of the hot leg, the lowest level at which I lose cooling.

DR. SIESS: What's the significance of the horizontal scale on that slide?

MR. DUNN: I should probably apologize. I have used this slide with various break sizes to illustrate where they go, and I forgot to take that off.

(Slide.)

Now just walking through some transients, this would be illustrative of steam and water; its approximate location for a pump discharge break during either solid water circulation, the very first day; pump coast down, or the two phased bubbling in recirculation; injecting water, have water pour back over from the steam generators; the water will be going out the break, coming into the core; becoming two-phased, trapped in the mixture, attempting to separate, the steam is attempting to go faster than the water, but it can't do it very well; passing over, condensing in the steam generator at some location, and coming back as water.

Up in here (indicating), I will gradually be able to build up a level of steam. And at first that level of steam will build up on this side. You will see that in the next slide.

DR. CATTON: I think this is probably as good a point as any: You are basing this on the homogeneous flow of the Wilson Bubble Model, as I understand, and your nodalization, you only have one node that's up there near the top. Yet the distance between the centerlines of those two, the upflow and downflow, must be 10 feet.

The flow velocities in natural circulation are probably on the order of a foot per second. The flow is going through a bend, which in itself means that as you move up through to the top, you are going to be getting separation through the whole period that that slug of fluid is in the turning zone.

I can't imagine that you're going to be able to take the bubbles around the corner and down the other side.

MR. DUNN: Well, no. They would tend to separate here.

DR. CATTON: You show them being drawn down into the stop of the steam generator.

MR. DUNN: I perhaps should go to the next slide which would show them more like that.

(Slide.)

DR. CATTON: Well, now I would believe that. That's all steam in the top; sure.

MR. DUNN: The level has separated down here. There will be an overflow, and a steam region accumulated in there. That would be the first sign, if you could see it --

DR. CATTON: I guess the question is: How important is the timing? How important is it to know when you reach the stage of this red graph below you here where you actually have vapor blockage?

Because if you're carrying any steam over, you're going to delay the time that you reach there.

MR. DUNN: It's just about nonimportant. It depends really on whether we're trying to provide a specific answer to the concern over very, very small breaks.

DR. CATTON: I guess if it's not important, then why don't you make the conservative assumption in the natural circulation of voids, that they all separate at the top of the candy cane? If it's unimportant, it would seem to me that would be the thing to do.

MR. DUNN: I'm just trying to stay in the middle of the road, I suppose. For awhile, the important consideration was how fast could the water from the hot leg reach and get back in? We were concerned that we perhaps were modeling it coming back to the core too fast, okay, such that, you know, if it got suspended up there, then conceivably you could have a large amount of water in that area unavailable for core cooling. So the idea was to get it from the hot leg to the reactor vessel.

DR. CATTON: I guess I'm not really following that, but I understand we'll talk about it on Tuesday. I just want to mention that an earlier report dated -- I can't find the date, but back near the beginning of April -- B&W indicated that there were three criteria for natural circulation, and one of them was that the RCS loops must be water solid without stain, and that's not what your modeling here.

MR. DUNN: That would be natural circulation planned in the plant, I believe.

DR. CATTON: Well, but it says there are three basic criteria which must be met for natural circulation to be established in the RCS.

DR. WOMACK: The context of that report, Dr. Catton, was a discussion which was centered on solid water natural circulation. And if that was not clear, after what you have, you have my apology. I may be reading from the minutes of the meeting which took place in early April in which that was what was being discussed.

DR. CATTON: I understand the sentences. The third criterion was that there must be no interruption of flow by bubble of noncondensible gas; partial pressure of hydrogen must be below the pressure of the RCS.

This is incompatible with what you're doing now.

MR. DUNN: It would be, and it's probably a slip. The only answer I can give you, having not read that report and the context of that report is that's an attempt to provide natural circulation at the solid-water mode, and those are the criteria you would want in place to assure yourself solid water. I am forced out of solid water, and I'm talking about a different mode of natural circulation.

Maybe I should use a different word than "natural circulation," but it seems like it's very natural to me.

DR. CATTON: I would guess it would be all right for a bubble pump that was open at the top, but it's not; and you do have almost 10 feet horizontal that that steam has to travel before it goes back down into the top of the steam generator. That's a long ways in a 3-foot pipe without getting into stratified flow.

Further, your codes are homogeneous. Homogeneous flow does not allow for the stratification to take place. In a realistic way, you don't have enough nodes in the top, either.

MR. DUNN: Stratification -- I'm not really sure I'm following that. Perhaps another time would be best. You're talking about stratified flow in the riser section? The hot leg?

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DR. CATTON: The top. Maybe "separated flow" would be better, but I view "stratified" as water in the bottom and steam on the top as it goes around the top of the candy cane.

MR. DUNN: But if we take a look at the next slide here, one thing that should be remembered is, I've only got a certain escape velocity in this region here (indicating). That means, the density in that region is going to be low. Okay? Whereas, the density in this region (indicating) is going to be high, because it's all water.

Now that will create this head imbalance. Okay? This pipe length is about 30 feet or so. And the question as to whether, what I would envision here -- and let me just add it on -- as the thing that first happens, is that I do separate, and I have a waterfall. Okay?

Now for very, very small breaks, that can be important. For the larger breaks, we go through this phase of loop draining more quickly and it's dominated by that effect. Okay? And that's the reason why we don't have it explicitly in the model.

However, when we looked at the very, very small breaks, we did put a node up here to allow stratification and separation. That was the only way we could predict an interruption of circulation during the early part of loop draining.

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MR. MICHELSON: Just to be sure I understand. At this point in that figure, I assume that there is no longer heat removal out of the steam generator. Is that right?

MR. DUNN: No. There'd be heat removal with cold water down here (indicating). There wouldn't be steam condensation.

MR. MICHELSON: Well, where is the cooling surface now? Are you assuming a spray at the top of the steam generator?

MR. DUNN: Yes.

MR. MICHELSON: This is true, then, only for the 177 plants. The 205s don't spray.

MR. DUNN: The 205s would be removing heat down here (indicating).

MR. MICHELSON: No, not unless there's kind of a forced circulation of some sort. It certainly isn't condensation.

MR. DUNN: Okay, while this level is up here, okay, while the head imbalance between the hot leg riser section and the cold leg downcomer section is evolving to where both could fall at some [illegible] of canted elevation viewed in mixture, I will have w[illegible] and water circulation.

After that period [illegible] then the heat removal would stop and it would probably degrade on the way to that.

DR. CATTON: Doesn't the pressure begin to rise at that point in time?

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DR. CARBON: Will all this be taken up in more detail Tuesday?

Maybe we'd better pass at this time. Let's defer that until Tuesday, then, and go ahead here.

MR. DUNN: Okay. Ignore now that line which I drew for Dr. Catton.

This (indicating) would be an interrupted phase, practically at its end, 177 for a TMI plant. The important thing is, I'm visualizing this exchange here (indicating), the mixture level here has been depressed in the vessel, steam is flowing through the vent valves to the break, that water injected in this cold leg, or that water forced to overflow that particular cold leg, will also be in the vicinity of the break and allowed to exit.

Water will be flowing down through the pipe in one direction. The steam will be forced up and bubbling through the mixture in the other direction. This level will be dropping. That level will be dropping. Okay? At sometime later --

(Slide.)

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-- we may be halfway through loop drain. We'll still have the same general actions going on in the vessel. We now have a lower level drain. We've drained the system down. Here's the canted elevations. Perhaps I exaggerated them a bit too much. Now we are in a condensation mode.

We spray auxiliary feedwater high in the steam generator through these particular plants.

The point made earlier about the 205 would be that this (indicating) wouldn't be here. Steam is coming up the separation. Water flow is in this direction into the core. The steam flow is like this (indicating). Some involvement is occurring at the 90-degree elbow, and mixing the steam, allowing it to pass in the form of bubbles through the hot leg pipe.

(Slide.)

MR. BAER: May I ask a question? This is Bob Baer of the staff. In all these sketches you show the pressurizers are nice and empty. Why wouldn't, once you stopped heat removal in the steam generator, I believe the system pressure starts to rise. Why aren't you forcing liquid back up?

MR. DUNN: After a significant period of time, I would have forced liquid back up into the pressurizer. You're right.

MR. BAER: Is that loss of inventory accounted for in your calculations?

MR. DUNN: Yes, sir. 537 172

MR. BAER: When you responded to Dr. Bender's question about cooling the core with no steam generator heat removal, did you account for the inventory going back to the pressurizer on those calculations?

MR. DUNN: Yes.

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MR. BAER: Thank you.

MR. DUNN: Okay, so finalization would occur generally -- it may occur at slightly higher inventories. It's going to depend on the capability of the HPIs, et cetera, and the particular break size. Usually finalization occurs at a drain-down of the system to a level, okay, where things are relatively trapped in here, HPI is coming in, three injection points are reaching the reactor vessel providing fluid to the downcomer, the steam separated in this region is passing to the break.

This arrow now will indicate a water flow from the HPI line. Steam may pass, depending on where the steam generator level is, condense and flow back in that fashion. That would be the reason we want 95 percent in the operating range there for the long term, so the fluid can flow over and return steam condensate.

MR. MICHELSON: Just as a generalized question, I think it might be pertinent here: Would you tell us your thoughts concerning the injection of 70-degree water into the area where it is apparently filled with steam?

MR. DUNN: My thoughts are that it's around 100 percent efficient in terms of condensing, and that 70-degree water, by the time it hits the other side of the pipe and bounces back, is now at the steam temperature.

MR. MICHELSON: I kind of agree with you. But this is also a rather explosive effect, I think. Have you looked into the mechanical forces being produced by blowing cold water into hot steam pipes?

MR. DUNN: I believe you can get mechanical forces if you blow -- if you have a water pistol and squirt it into a steam loop, or you've got interrupted flow that can cause this kind of a thing happening. This process here I believe to develop very smoothly during the transient, and I don't see that it's susceptible to forces and unstable modes. I do see it susceptible to delta T's causing steam to drag to that location.

MR. MICHELSON: But don't lose account of the fact that it's a trapped section of pipe with water on both sides and a check valve which will now want to close when you start using these forces, although those vent valves are being slammed closed by the possible effects of the pressurization and depressurization.

It's just something to think about.

MR. DUNN: Okay.

DR. PLESSET: I think that you maybe should think about this. This is not such a smooth, stable process, and maybe before Tuesday you might think about it a little bit.

MR. DUNN: I can try. I admit that I had not examined these vent valves. However, the pressures that are involved at this time should maintain them in the open position.

I don't think I'll change my mind, but I will be willing to further examine it.

DR. PLESSET: If you're open-minded --

MR. DUNN: As long as my wife doesn't have a baby between now and then.

(Laughter.)

(Slide.)

MR. DUNN: Now, with that, let me defer a moment just to another slide.

(Slide.)

With all those processes involved, it should be recognized in any kind of operating procedure or in any kind of an evaluation of a small break that almost anything is possible, okay. And the idea is to be sure that once you get to that location where you're starting to have an opportunity to lose fluid from the key region, being the core, that you're supplying enough high pressure to make up for the boiling ratio, which is our philosophy behind our break spectra.

We will see pressures during small breaks ranging from rather large small breaks that go way down all the way to LPI coolant, to very, very small, small breaks that may even hang up in the form of a leak and still maintain 2,000 psi in the system, okay.

We will see the potential of interruption, the re-establishment of condensation, et cetera. I just wanted to make that point, that it's not single-value. Okay.

(Slide.)

There's been some confusion, I think -- and I probably contributed to this the last time I talked to you by showing a slide, which I'm going to repeat later on, that was actually wrong. It had an error on it about pressurizer performance during a break, perhaps on the top of the pressurizer.

In this case we will have steam or water pumped through the pressurizer. This is after the pressurizer has been refilled. The steam and water are coming out, whatever the break may be, code safety or what have you, to a certain extent. And the void fraction between the instrument taps on the pressurizer, which means that the pressurizer, instead of indicating a full flow, should probably indicate a little bit less than full.

(Slide.)

Now, Dr. Etherington asked us last time, in response to him, could the safety valves and the system vent capacity, could we be assured that they would hold at a given pressure. This is a slide of the system vent capacity for the pressurizer done at 2600 psi. This is the maximum, and I stress that word "maximum," vent capability required to maintain 2600 psi.

Now, I have done this slide symptomatically and I have not accounted for certain hydrodynamic effects that I believe to be involved. I have said that the core is at 2600 psi, it is boiling and it is making steam, okay. And if that steam is then pushing water out the -- well, pushing this quality fluid -- excuse me -- out the break, one can see that we do have excess vent capability.

MR. ETHERINGTON: Why is it pushing that quality out of the vent? It's pushing pure water out, to begin with.

MR. DUNN: It begins to push pure steam, and then it pushes saturated water, and then it pushes

MR. ETHERINGTON: Later it becomes high-quality.

MR. DUNN: It pushes sub-cooled water for a little bit, I guess, and then it pushes saturated and steam again.

MR. ETHERINGTON: My question is really directed to the worst condition, pushing pure water out.

MR. DUNN: That would be down at this end here, and we will be okay.

MR. ETHERINGTON: But that shows a 10 percent quality, doesn't it?

MR. DUNN: The quality goes from zero to minus two.

MR. ETHERINGTON: Okay. My eyes are not that good.

MR. DUNN: Now, how we developed this slide is to take the rated steam flow for the valves at 2600 and divide the 2600 steam discharge rate to give us a normalization of performance versus quality. Now, as people mentioned, we haven't tested these things in here, but I think this is the best way I can do it.

That gives me kind of an effective break area or an effective area for these valves, and this is what -- down here I've gone to the better sub-cooled correlations for it. Now, with that and the design capacity probabl having something like a 10 perce margin in there, I don't think there's any problem with the valves.

MR. BENDER: What boiling rate does that correspond to?

MR. DUNN: That was a boiling rate as early as 12 minutes into the transient, the approximate time I felt the system could heat itself back up to 2600 psi saturated water and had expanded to that degree.

MR. BENDER: From some break size?

MR. DUNN: There's no break size involved in this. This would be something like the total loss of feedwater.

MR. BENDER: Okay. So it's just the after-heat curve that we're looking at?

MR. DUNN: Yes. 12 minutes on the after-heat curve is what that boiling rate corresponds to.

MR. ETHERINGTON: Does that use all of your relief capacity in the chart that you showed?

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MR. DUNN: Yes.

MR. MICHELSON: Could we go back?

DR. CARBON: What kind of time? How long do you expect to go on?

MR. DUNN: I have really one slide left, about two slides.

MR. MICHELSON: Could we just clarify one point on the previous slide? Is that one HPI pump higher than two, and how do you interpret that?

MR. DUNN: There's not as much condensation or lack of steam formation with one high-pressure pump. I took credit here for I was either condensing steam on the high-pressure pump or not making as much steam within the core, because sub-cooled water was coming up to the core.

I tried to do it the other way, but obviously, from that slide, I couldn't.

(Slide.)

And I want to just remind one thing that I did last time. We have done a TMI-2 simulation. It's based from time to time on the best estimate of the HPI flow. I understand that the estimate involved in this one may have changed from best estimate to yesterday's best estimate. It's basically a simulation with our evaluation model, corrected to a certain extent for best estimate calculations. Okay.

Obviously, I need to use 100 percent decay heat rate rather than the 20 percent decay heat rate.

I've mentioned the best estimate HPI flow. The one

I mentioned is based on an assumption of 50 gpm continuous during the first hour and 40 minutes of the transient, and that information is under constant evolution and may change from time to time for a specific value there. But this is the average in that input, okay.

This is the not just the average HPI flow. It's the HPI flow minus the post-letdown flow.

The steam generator, in my model, would come on instantaneously, and I stopped it for eight minutes and then turned it back on.

The reactor coolant pumps were -- the first set was tripped at 73 and the second set was tripped at 90 minutes. Now -- I'm sorry, the second set in 101 minutes. And the steam generator started at 90 minutes.

I'd like to add one thing. This was not a fiddled-around-with calculation. This is the second-only calculation of the GPU event. I have performed the first one. The only difference between that and this one is that I guessed that 200 gpm was going on.

(Slide.)

I showed previously a pressurizer level which I think had erroneous information on it. This slide will correct that. The solid line is the data from TMI-2 for pressurizer level during the transient, the best we have. The solid line is the pressurizer level I predict in the pressurizer, and it goes right up to the top and stays there. The dotted line down here is what my code would say the instrument should be reading, okay.

Before we had something that was wrong there.

MR. MICHELSON: Can we get a copy of the corrected curves?

MR. DUNN: It's in the package that you're receiving. If it's not, by all means, you may have a copy.

That's the only new one.

DR. CARBON: We don't have several of the curves that you presented, I believe.

MR. DUNN: The ones I drew up before I came up. I think we can do that.

DR. CARBON: We definitely would like them.

(Slide.)

MR. DUNN: Finally is the void fraction curve for the transient. It evolves to approximately, in our estimate, 67 percent void fraction, steam being pumped into the pressurizer, being pumped out the open valve. And if I can back up just one second and show this up here --

(Slide.)

What's important about the high void fraction is that when the pumps were tripped, the following -- and partially because of the sequence the pumps were tripped in -- the following system evolution occurred: Water, if you imagine this as B loop over here, which was tripped first -- water accumulated in B loop during the remaining flow period, to a point where finalization after final pump filled this loop in our simulation. Okay.

This is our simulation. It makes sense relative to what I have seen of the data. It explains what happens. Water filled in the c[illegible] region and this loop was empty.

Okay. Following that, a hump occurred in the fashion of steam condensation from here and here, which boiled the core off, uncovered the core and produced clad damage. That's what we see today.

DR. SIESS: I lost your chronology there. You said it depended on the order in which the pump, loop pumps were turned off, and I didn't hear any more. Did you start with [illegible] pumps off or with B and A off?

MR. DUNN: I started the transient with all the pumps running and then I tripped the B pumps. And what that caused is a water storage in this location. When you develop a pressure in here, that pressure is fed up here, pushes this leg down a little bit on a higher level within the steam generator over here.

MR. MATHIS: And you have no injection at this time?

MR. DUNN: I modeled injection continuously.

DR. SIESS: [illegible]ou now have the B pumps off, the A pumps running.

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MR. DUNN: Yes, sir.

DR. SIESS: Is that where you stopped?

MR. DUNN: No. I have the rolling system here. This is at 70 minutes, and that rolling system continues to pump fluid out the RCS for a period of time, and then that rolling system is turned off and it collapses. At the time it collapses, the level in B loop is approximately at this location. Okay. In our simulation it's right there.

The mixture in the core -- there is mixture in the core and the core is covered up on pump trip. That's supported by the data, because it takes, I think, about five minutes in the data to start to see superheat conditions. But this loop is almost dry, okay.

The steam generator here attempts to go from the three-foot level control to a 50 percent of the operating level control. All right. The core is being boiled. This is providing even a further depressurization of the system, so the core is also flashing, and that takes fluid out of the core and stores it in the A loop steam generator, because it was dry, there is no way for that fluid to come back to the core.

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DR. SIESS: What would have happened if they had been turned off in the reverse order?

MR. DUNN: You mean relative to the pressurizer? I don't think much difference, but I'm not sure.

DR. SIESS: You started off by saying it made a difference, the sequence of turning it off made a difference.

MR. DUNN: No, just the fact that he turned them off all in one loop and than all in the other loop I think made a big difference.

DR. SIESS: If he turned off all four at once?

MR. DUNN: It depends on when he turned them off.

DR. SIESS: At 73 minutes.

MR. DUNN: Well, it would depend. He would separate, fall down. At that point I think he would have had core coverage and full loops, okay. And it would depend on follow-on high-pressure injection.

MR. BENDER: Did it make any difference at the time of the transient, when you turned the pumps off, whether he turned them off in sequence or turned them all off at once?

MR. DUNN: Yes.

MR. BENDER: Yes meaning what?

MR. DUNN: It made a difference as far as the fluid volumes are concerned.

MR. BENDER: Can you give us some quantitative feeling for what happened when the first two pumps were turned off and how much more change in the inventory arose after the second?

MR. DUNN: I can give you my opinion now.

MR. BENDER: I realize.

MR. DUNN: I do not have a lot of hard data.

MR. BENDER: How about speculating a little bit, for a change?

MR. DUNN: Like I said, these pumps in this loop were feeding pressure into the downcomer, and this whole side of the system is still rolling around. You can see that on the flow plots. The other side is not. You can see that on the flow plots from the plant.

The overpressure condition is created at this nozzle. It's all the way around the downcomer, okay. And that creates a pressure up here which suppresses the height of fluid that has fallen into this look, okay. So the fluid is down here in the cold leg, probably up about here in the primary side of the steam generator for that loop. Okay.

I'm not sure of the exact amount of storage. But that occurs at 70 minutes or 73 minutes, and that just kind of stays there. It doesn't do much.

Another thing one can look at here to verify the stagnant nature of this and why that has to be full, besides the thermocouples, is that during the resultant core excursion, okay, the A loop hot leg RTD increases in temperature faster than the B loop RTD. And that's telling me that I've got a water seal over here, and that superheat evolution to the B loop hot leg is by a diffusion process of some sort, or a slow process, natural convection, whereas A loop superheat conditions is by this steam pump or condensing the steam over here. So the steam wants to go this way as opposed to the other loop.

MR. BENDER: I'm just having trouble with the volume changes. But I see a foot change in the level in the core when that first set of pumps stopped.

MR. DUNN: There's no level in the core. The core is still flowing in a basically homogeneous fashion.

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MR. BENDER: You're taking some of the liquid out of the system somewhere.

MR. DUNN: What I have said happens when the first pump trip occurs is that I can develop a trap of fluid over here -- okay? That fluid then never goes anywhere; it's just stored there, but it's of no use to anybody.

MR. BENDER: It's just inactive?

MR. DUNN: Inactive.

DR. SIESS: But you don't need it either, then? You don't need it at that point, either; do you? You said the core --

MR. DUNN: No, I don't need it at that point.

DR. SIESS: But when you turn off the A pumps, you do need; is that right?

MR. DUNN: Well, I think our response to your question is, really, remember that I said that small breaks were catch-up -- okay? -- that I had to be sure that I used the initial inventory properly on my way to small breaks.

There is another way of saying that, another way of thinking about it. And that way, I have insisted that this be into our calculations, and it's the main reason for the 50-degree sub-cooled criteria we put out. To survive a small break, I not only need the instantaneous high-pressure injection rate, I need the capacity of the high-pressure injection rate for a period of time before that. And what we have here is a situation where that capacity hasn't been used. We evolved to a bad situation. We've tripped the pumps. We've separated it. Then we go to an instantaneous charge rate of high-pressure injection. We just didn't have enough water in the system before we did that.

DR. SIESS: You've entered a new variable now, the HPI, which you weren't mentioning before. You were talking simply about cutting off the circulating pumps. Now you're talking about the HPI wasn't on.

MR. DUNN: Our calculations indicate if we'd had the HPI on it would have gone to no more than an eight-percent void fraction system total, and it would have been okay. That is one HPI pump. It's very important that the HPI pump --

MR. TAYLOR: Could you put your void fraction curve back up on the overhead again? I think in response to one of the comments that Mr. Bender made, one of the differences that Mr. Dunn referred to -- and maybe it didn't come out too clear -- was the difference in void fraction that existed in the loop when the two different sets of pumps were secured, so that when the first set of pumps were secured, the water in that loop was denser. So you trapped more water in the B loop than you did when you later secured the A loop pumps.

MR. DUNN: That makes a lot of sense, that we were at 50 percent void fraction.

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MR. BENDER: What the physical change in the coolant inventory was in the cooling surface when we turn off the first few pumps and then we turn off the second one. I think you could express it as what void fraction, if that's what you know.

MR. DUNN: I didn't follow you completely. You were talking in that direction. I didn't hear you.

MR. BENDER: Let me go back again and try and develop what Jim was trying to tell me.

When you turned off the first two pumps, you trapped some water, took it out of the circuit. Did it have any change -- did it result in any change in the inventory that would be available in the core for cooling?

MR. DUNN: I would not think it would result in very much of a change. I could probably get those out of circulation.

MR. BENDER: When the second loop pump was turned off, what was the impact?

MR. DUNN: The impact was that I changed cooling modes, forced flow to cool boiling. The immediate impact was very little in our simulation because the core was covered. Following that, the core boiled water and flashed to some extent, passed that water over to the A loop steam generator where, because that generator was dry, they could not return to the core, resulting in a core uncovery and clad damage.

MR. BENDER: What I want to know is -- I never could get to that point of asking this question: How fast did the core level get drawn down?

MR. DUNN: I don't know the answer to that one yet. We've seen a couple of phenomena possible, and we are pursuing those calculations. And it should have been drawn down within five to 10 minutes. Now, that's going to depend on exactly how accurate this 67 percent void fraction is.

DR. CARBON: May I ask two or three questions, to pass on.

The small-break analysis does take into account a steam-water mixture; is that correct?

MR. DUNN: Yes, sir.

DR. CARBON: The second thing is: About 30 percent of the fraction of the high-pressure injection that's assumed to bypass the core?

MR. DUNN: Depending on the break location, sir. If the break is at a location between the HPI is injected at this location -- okay? -- if the break is between this region and the reactor vessel, 30 percent of the HPI will be placed into that volume and then will go out with the break flow. If the break were down here, it would not do that. We would not lose it. If the break were up in here, we would not choose to lose that water.

DR. CARBON: So 30 percent is pretty much a maximum.

MR. DUNN: Yes.

DR. CARBON: The third question: Are the pressurizer heaters considered operable or inoperable in the analysis?

pvo

MR. DUNN: Inoperable.

DR. CARBON: Inoperable. Then we have a simple thermodynamic model. It doesn't have heaters or sprays.

If we're through with questions? I guess we are.

MR. MICHELSON: Wait a minute. He just made one little comment there that I think affects something you said earlier.

If you do have sprays -- and I think you do when the pumps are running -- then it does significantly affect where the level goes in the pressurizer because now the pressurizer goes to essentially TX in the core or something like that.

MR. DUNN: That's quite possibly true. We have not included that.

DR. CARBON: Does that wind up your presentation?

MR. DUNN: That comes real close. I have an introductory remark for Ed.

I would like to characterize, just briefly, the use of the computer code in arriving at the operating procedures. The computer code has been utilized to help us evolve the nature of transients and perhaps to discover certain effects of small-break transients. But the operating procedures are based on what that particular plant [illegible]es. It's not based on whether I calculated 15 or 20 minutes for some separation of condensing -- okay? The computer shows us that a separation of condensing or an interruption of condensing is going to occur, and it has something in it that helps us quantify the seriousness of that event a little bit.

But the actual operating procedures that we just talked about next are performed as the system evolves on line with the reactor.

DR. CARBON: Fine. Let's break for lunch and come back at 10 till.

(Whereupon, at 1:50 p.m., the meeting was recessed for lunch, to reconvene at 2:50 p.m., this same day.)

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AFTERNOON SESSION

(2:50 p.m.)

DR. CARBON: Mr. Taylor, let's resume our discussion and go ahead with Mr. Kane's presentation.

MR. TAYLOR: Thank you very much. Mr. Kane is going to talk about the operating guidelines involved during the past few weeks, and he's going to talk about this as we did them on this one particular case, and then as I mentioned earlier this morning, Dr. Womack will spend just a brief time talking about the current concept we have for the way we might appr ach it in the future.

MR. KANE: My name is Ed Kane. I am nager of Operating Plant Licensing for B&W.

(Slide.)

As Mr. Taylor indicated, I am going to be talking about the small break operating guidelines that B&W helped develop for our operating plants. And as he indicated, I am going to discuss the thought process and the methods that B&W, with help from our utility group, used to develop the guidelines.

I am going to show the flow chart and logic we used in developing them; discuss some on the organization that was put together for developing them; who was involved.

We'll then proceed into a little bit on the guidelines themselves and the conclusions that we have reached so far in our pursuit of small-break guidelines.

DR. CARBON: If you could do this in about 15 minutes, it would be welcome.

MR. KANE: With help from the committee.

(Slide.)

What B&W did in developing the guidelines is that the first thing that we did was to form a task force of diverse personnel from engineering or training groups, and from what's called our nuclear service group, who are the people generally involved in the startup and testing of our plants.

We had the analysis people, the people from Bert Dunn's organization, describe the small break phenomena, indicating the various manners and ways that small breaks can proceed.

As Bert indicated on one of his later slides, the small break can vary significantly in response. So his group described for the task force the basic small break phenomena.

From that task force, which included members from our analysis group, Mr. Dunn's organization, we developed a basic flow chart for the small breaks.

This included things such as: with and without feedwater; with and without reactor coolant pumps; and it's the basic flow chart that we developed the small breaks guidelines from, and the flow chart which we sent to our utilities.

Now in the development of this flow chart, we had the benefit of utility operators in Lynchburg in the development of the flow chart, and somewhat the guidelines themselves.

Each of the utilities sent personnel to Lynchburg to help us in this, and these were primarily operators, although it did include some engineering personnel.

We also had the benefit of a meeting with the NRC staff, and a representative from the staff in Lynchburg, for several days while we were working on this general flow chart and the guidelines.

As I said, we basically developed the flow chart first, and then developed the guidelines which we transmit to the staff on May 7th in our Blue Book Report.

We received additional staff input. I might back up a little bit and say that during this time that we were working on this additional analysis was ongoing, small break analysis, and this continued to feed into the guideline development as we proceeded.

As I said, we developed the guidelines, and we since have received additional staff input in which we made some modification to the guidelines. And the utilities themselves then, from the operational guidelines, developed detailed operating procedures, and we have also been receiving feedback from the individual utilities to us on the guidelines and they have continued to receive some suggestions on ways to improve the guidelines.

So this is the general flow chart and way that the guidelines were developed.

(Slide.)

Basically, the organizations that had input to the guidelines, as I said before, formed the B&W task force. This task force consisted of engineering personnel, analysis type individuals who performed the small break analyses, it consisted of training personnel, people from our simulator who are familiar with the procedures that the utilities use and also very familiar with the capabilities of the system and things that may be easier to see or understand from an operator-training standpoint, and also people from our customer service department which, as I said before, is the arm of B&W which is responsible in general for developing or writing procedures for plant startup.

And also, the startup and testing of the plants. Mr. Rogers, whose name you heard before, the B&W site representative, is a member of the customer service organization. As I said before, we also had input from the utility operators in the development of these guidelines.

Each of the utilities sent representatives, at least one, and they were in Lynchburg for several days to help us out in this area.

And as I said before, we also had useful input from the staff, both during the guideline development and in review of the guidelines.

(Slide.)

The operational guidelines really essentially consist of two parts. One is the guidelines themselves, which contain more the step-by-step cookbook procedure for handling small breaks. They contain essentially symptoms, those items which the operator would use to help recognize a small break.

The immediate actions which are those items which an operator is supposed to commit to memory precautions things that the operator should be concerned about. And as an example, we have a precaution that says that the operator should check redundant instrumentation during the transient to make sure it's not a particular instrumentation system that might be malfunctioning. And also, the followup actions which generally are the more detailed, involved actions the operator might need to take place in bringing the plant to a cold shutdown condition.

The supplementary information was a package that was also supplied to the utilities themselves, and this contained a description of a small break phenomenon.

One of the sections in the Blue Book, you may have read it, and it just describes the various ways the system can behave due to different break sizes and different responses to the system.

I would like next to move into the general, or a portion of the guideline itself. I've extracted just a portion of the flow chart to indicate in general what we've told the operators.

(Slide.)

The initial responses for small break are essentially al' the same. You have your symptoms in the plant, your low reactor coolant pressure, reactor trip, as fast actuations.

You then proceed into the operator's immediate actions or recognition systems. The first thing he's supposed to do is confirm the trip indication and verify automatic actions. We've also asked to verify that the HPI flows are balanced.

These are essentially the immediate steps that the operator takes ;pon recognition of a small break or actually verified trip indications or just the normal operations that the operator takes in the event of a reactor trip.

The next step in all the actions that we have for small breaks is that we ask the operator to essentially determine the plant's status. And from this, what we called for is the plant status in terms of whether he has feedwater or not, whether he has his HPI on full or not, or whether the reactor coolant pumps are operating.

We chose these parameters as the items that provide slightly different actions for the operator to follow in the small break. Having reactor coolant pumps on. The plant phenomena will be slightly different with or without reactor coolant pumps. The same can be said for feedwater.

The basic plant response will be different with or without feedwater.

So we call for him to look at these major plant indicators, and from there to proceed to various steps in the guidelines -- or, in his case, detailed procedures from which to take further action steps.

DR. OKRENT: Could he be deceived in the process of determining plant status?

MR. KANE: Could you give an example?

DR. OKRENT: I'd like you to give me an example, is my question.

MR. KANE: Obviously there are potential things that might deceive an operator if he looked at only one instrumentation system.

For example, there might be some reactor coolant pumps, or maybe some indications that the pumps are on from lights on the console, or something like that. There are other instrumentation systems that he could refer to which could confirm or deny that indication, like system flows, that type of thing.

So, yes, the possibility for being deceived is there, but we don't believe so, if he uses redundant instrumentation systems.

DR. OKRENT: We'll see, then, in what you're going to talk about, how he's been alerted to the possibility that he could be deceived?

PROF. KERR: Do you put a caption down at the bottom of the instrument, for example, which ways "in an emergency, do not rely on this instrument alone"?

MR. KANE: We have put in precaution statements in there that he should not rely -- he should check redundant instrumentation, and I think a good example, as Jack Herbein indicated this morning, in their detailed procedures they are putting stars beside parameters which they believe should be checked or verified from alternate sources of information.

DR. SHEWMON: You have said nothing about pressurizer level. What are the instructions on that in plant status? Is he told to ignore it?

MR. KANE: No. We have in there that that is a potential symptom of a loss-of-coolant accident, but it is one of a number that he should refer to. And it is not, by itself, a firm indication of a loss-of-coolant accident.

DR. OKRENT: Well, let's see. If I recall on Three Mile Island, for auxiliary feedwater, would it have been obvious to him right away, recognizing there were lots of alarms and lots of things to do, that he didn't have flow? And would the procedures have alerted him to look hard enough? I don't mean looking three weeks later, but hard enough in 10 or 15 seconds, which is what he has to establish that, do you think?

MR. KANE: Let me answer that by proposing something. The guidelines themselves -- I'm getting a little ahead to some of the conclusions of some of the things that we've decided, or whatever you would like to call them.

The guidelines themselves are actually relatively similar, whether you have feedwater, whether you don't have feedwater, whether you have reactor coolant pumps, whether you don't have reactor coolant pumps.

The major items that he's supposed to -- or the major step that comes next -- that is, to maximize high pressure injection --

DR. OKRENT: But I am interested in another point. I'm a little bit familiar, I think, with your guidelines, but I'm trying to find out if the people who work hard in preparing these guidelines, who presumably know the systems rather well -- and I have no reason to question that -- have themselves tried to see in what ways the operator might either be deceived, or at least have information that's not readily interpretaed in an unambiguous way, and so forth.

MR. KANE: The answer to that question is that we did not, in detail, do that.

DR. OKRENT: Is there any attempt to do that?

MR. KANE: Yes. I think Alan will address that somewhat in his presentation in about 15 or 20 minutes.

This is the way we did it. That's what I'm showing up here. Alan's going to address somewhat what we think we would suggest for further followup.

DR. OKRENT: Suggest to who?

MR. KANE: I see Alan reaching for the phone.

DR. WOMACK: A further remark to this. As Ed has said, I will comment a little bit further on this later on, but the process that was started and is being described here is only the start in these procedures. The guidelines themselves were then taken by the utilities to prepare actual procedures.

While I cannot say exactly to what extent the questions you are now raising were addressed on a specific control room by control room basis, as the utilities prepared their object proceedings, I believe this was something that was attended to in that process, as far as our guidelines were concerned.

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We used the input we had -- as I think Mr. Kane shown you, from the plant operators in the early stages. We also relied on input relative to the operator/machine interface from our manager of training, who was a member of Ed's task force and has pretty good familiarity with the operating unit control rooms, as well as of course operating a single control room himself.

So while I don't believe the process has yet achieved perfection in what Mr. Kane is describing to you, I would like not to leave the impression that it was ignored, either.

DR. OKRENT: I'd like to pursue the point in a somewhat generalized way. I have the impression that the detailed technical knowledge probably resides within three different groups: One is the NSSS vendor; one is the AE; and one is the utility. And they each have a part of the detailed knowledge.

It's not completely clear to me that right now, within the way things are done, that we get enough detailed technical interaction both in things like setting tech specs, for example, as well as in looking at operating procedures.

I'm not convinced that a process where you provide some general guidelines, or even fairly specific guidelines, which then are given to the utility, which they try then to write for their plant, is necessarily going to give as good a job as one would get with this tripartite kind of thing. In fact, I don't know whether it's necessarily going to e-16 be adequate, looking at past experience.

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So, I am asking these rather specific questions with this rather more general concept in mind, if you want to know where I am heading.

(Slide.)

MR. KANE: I think we generally agree with you. Mr. Taylor earlier showed this slide, and indicated that there is a definite need to close the loop between the designers, the analysts, those who write the procedures, those who train them, the operators who use them. And I think -- I know B&W basically agrees with you that there have been gaps in the past in this area. We are trying to move with the utilities in trying to close these.

So, in answer to your question, I believe we can cover it.

DR. OKRENT: With the more general view, but I guess, getting back to the specific question, you have not yourselves tried to look at the ways in which the operator might be, not only for this particular transient, which, by now, is a well-studied transient, but for many of the others that one might want to think about.

MR. KANE: Not in a detailed, well-documented manner.

MR. MATHIS: When you go ahead with your procedures, how would those be indexed in the control room? I am an operator, and I see a particular symptom, and it kind of puzzles me. Where do I look, how do I find what I should do next? I assume that I have it memorized.

MR. KANE: Could you repeat your question? I guess I had a little trouble following exactly what you're aiming toward.

MR. MATHIS: Let's go back to, say, low reactor pressure. I am an operator in the control room, and I start to try and figure out what kind of a situation I have, and I don't know whether it's a small LOCA, I don't know what it is. What is my index? How do I put my finger on it? Is it cataloged under "small LOCA"?

MR. KANE: Okay. There are a number of symptoms, and there are various plant transients that could look similar to the LOCA, a small LOCA in the initial phases. The item that we feel is most critical is to initiate and maximize HPI injection. We had passed on recommendations to our utilities that if the system becomes sub-cooled -- or saturated -- excuse me -- that they should initiate and maintain high-pressure injection until they obtain 50 degrees sub-cooling.

Now, the system can become saturated through, as you indicate, perhaps several possible mechanisms, and the operator in itself may not recognize initially that he has a small break. However, the action of initiating and maximizing high-pressure injection, if the system becomes saturated, will in itself assure the plant safety in the event of a small break.

MR. MICHELSON: Before you leave that point, what is your view concerning the maximizing HPI effect if I experience what appears to be a small break if I am still in a semi-cooled condition? In other words, does the operating procedure differentiate whether I am at full pressure and temperature or just coming up or what?

MR. KANE: I see Bert reaching for the microphone there.

MR. DUNN: There are two possible conditions: One might be what's termed a "leak" -- okay? -- and these are generally not considered LOCAs. There are separating operating procedures to handle those.

Leaks may cause pressure reductions down to 2000 or 1900 psi, something in that range, perhaps causing a trip of the reactor, perhaps not.

Then there are LOCAs which take you down in extensive pressure ranges to the HPI actuation point. With those you may still or may rather quickly, once HPI is initiated, return to a basically sub-cooled reasonable pressure situation, depending on the break size. We don't have anything against leaving the HPI on in those cases.

MR. MICHELSON: You are not worried about NDT in the vessel?

MR. DUNN: Not at that stage.

MR. MICHELSON: See, I am talking about starting out with a relatively cold system, to fully pressurized, which I can easily do. Now, do I want to bring HPI on if it's solid?

MR. DUNN: You're talking about plant startup?

MR. MICHELSON: For instance.

MR. DUNN: For instance. I guess I really don't know the answer to your question. I will see if we can find out.

DR. CARBON: Go ahead, Mr. Kane.

(Slide.)

DR. CATTON: Could I ask a question?

DR. CARBON: Just a quick one.

DR. CATTON: If you had years of experience in the simulators, do you tabulate the kinds of errors that operators make and incorporate [illegible]nto your procedures?

MR. KANE: Have we in the past?

DR. CATTON: Do you have information available? I am wondering if you use it. And you just ran through all 190-some-odd operators for B&W reactors through your simulator.

MR. KANE: I guess I am having a little difficult time understanding exactly what the question is.

DR. CATTON: Do you do simulator training?

MR. KANE: Yes.

DR. CATTON: Do you keep track of the kind of errors that operators make, and do you use them in preparing your procedures?

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MR. KANE: The answer to that is: I don't know.

DR. CARBON: Charge on, Mr. Kane. We're falling behind. It's our fault.

MR. KANE: Okay.

(Slide.)

I guess in answer to that, I don't know whether we keep track of what operator mistakes are made.

Okay, I have just broken out just a little bit of one leg of the guidelines. This is the case with feedwater available and reactor coolant pumps available and what are the basic operator actions.

What we asked them to do is -- the first thing we asked them to do is maintain maximum HPI flow. This is consistent in all the various trains that the operator proceeds down, depending on the plant conditions. We then just ask him to allow the plant to stabilize if the plant is going down naturally to the LPI system. We are trying to give the view to the operator that the plant itself will take care of itself if he's maintaining maximum high-pressure injection during this transient.

Depending on the break size, the plant may go down to the LPI system; it may hang up at higher pressures. If it hangs up, we then ask him to begin cooldown. And most of the utilities themselves are using their normal procedures for these cooldowns. And we can cool down and go to the LPI cooling system, using available equipment.

This is the simplest flow chart, since it's -- you have your feedwater available right away, and you have reactor coolant pumps available so that you have cooling at all times during the break, to reduce system pressure and keep the secondary and primary systems close together in terms of pressures and temperatures.

I would just like to show the general guidelines and what may happen if reactor coolant pumps are not available.

(Slide.)

As Bert indicated in his discussion, there is the potential for repressurization as you lose the steam generator cooling as primary cooling system inventory falls off. In this case we have broken it down into essentially two different categories, one in which pressure stabilizes -- and this will stabilize generally consistent with the secondary system temperature and pressure, saturation pressure; or there is the possibility that you may lose the cooling capability of the steam generators, as Bert discussed in his presentation, and the pressure may increase.

What we have asked to do in the case of the pressure increases is, if necessary, we ask them to open the PORV, the power-operated relief valve, to keep off the safetys. If he can't do this, the safetys will relieve to take care of it. From this point on, the only thing that the operator can do and should do is wait until the steam generator cooling is available, or if a pump can be started by the criteria that we have given him, startup pump.

From this step, he would go over to one of the other steps in the procedure. And you can follow down. If pressure stabilizes, it simply begins tc cool down, and if you should lose the cooling capability of the steam generator because of loss of primary inventory, a pump or startup pump, depending on the criteria which we have passed on to the operators, then the same thing: cool down and go to LPI cooling.

Those are some of the general guidelines. These are actually abstracts of a flow chart that we've given.

(Slide.)

But the basic conclusions that we've drawn are reached from our development of these guidelines in association with the utility operators and the NRC staff itself is that the small-break system responses do indeed vary depending upon the type of break, the location, and the equipment available.

But the operator responses are basically the same. They vary just a little bit depending upon the equipment available, but the major one and the main one that we try to emphasize is when you are in a saturated condition in the primary system, to maintain maximum high-pressure injection flow. We try to emphasize this in the procedures and in our discussions with the operator and in our training programs. If the feedwater is lost and it's needed to cool down, you must obtain feedwater.

And the other major item in the basic flow chart is just the cooling down, using steam generators to the LPI system.

That concludes my presentation.

DR. CARBON: Fine. Thank you.

Let's move on.

MR. MICHELSON: Could I ask just one question?

If, indeed, these operator responses are basically the same, how come tnere are so many different options within the operating procedures that are being written for specific plants? It would be nice if they didn't have to figure out which option. If it's all the same, why aren't they just going to one procedure?

MR. KANE: Well, the basic response, adding high-pressure injection, is in all the steps. Okay? Some of the other steps, like if feedwater is not available, the steps in that particular portion of the guidelines or flow chart is reobtaining that feedwater and then going back over to the one basic flow chart, of cooling down with feedwater available.

MR. MICHELSON: My only reaction is that if I have got to read a 25-page procedure to figure out how to handle a small break, we're fortunate it's a very slowly moving thing. It's going to take a lot of time to read the procedures. It would be awfully nice if there was just one basic thing you did instead of having to go to all these various options. It's extremely complicated to read.

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PROF. KERR: On the other hand, you realize that the more time the operator spends reading, the less time he has to make a mistake.

(Laughter.)

MR. MICHELSON: One more thing in line with the same question I asked on possible breaks during startup, for instance. What happens if you have a small LOCA while you're on shutdown cooling? Do you go to this procedure, or is there another procedure?

MR. KANE: During shutdown cooling?

MR. MICHELSON: If I experience what appears to be a small LOCA, what do I do?

MR. KANE: You're in cold shutdown?

MR. MICHELSON: Basically, you are down to 300 degrees maybe, or whatever, and whatever the pressure limits are, 150, 200 pounds, and I am percolating along there and suddenly this happens. It looks like a small LOCA. Do I now turn around the HPI and run them flat out? If so, what isolates my low-pressure systems and so forth before they get overpressurized?

MR. KANE: We have not addressed that issue.

MR. MICHELSON: It's a distinct possibility.

DR. WOMACK: Mr. Michelson, to your earlier comment, I share your view, the greater simplicity that we can build into the method by which we communicate the basic objectives and basic phenomena behind any operating procedure in the training program to all of the other members of this tripartite or maybe multipartite organization that Dr. Okrent has mentioned earlier, the better off we will be.

We certainly do advocate utilizing every means we can to achieve a communication of basic objectives and principles which are understood to be at the root of operating procedures as a part of the training program. And I would list that as one of our objectives for the future, especially to emphasize that.

I was particularly pleased this morning to hear Mr. Herbein mention a decision -- I think, quite independent of ours -- to include an objectives section in their procedures. I think that is founded on the same kind of thinking.

I believe we will need to go further even than that.

As far as answering your specific question is concerned, I am not expert in the writing of the final procedures in the plants. Those more expert than I assemble these procedures. They do tend to get quite detailed. When I have asked a similar question, one of the things that I have been told is: In order to respond in a fairly precise way to questions such as those Dr. Okrent raised earlier, is it possible for the operator to be deceived. It's frequently necessary to list explicit instrumentation multiply, redundant instrumentation. This tends to expand the number of steps in the final document.

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I think we need, really, to do both parts of this job.

I am now going to talk about a fourth item, in which the committee has expressed some interest, which grew out of

TMI-2, although it's not directly related to the accident, per se. This item has to do with the performance of the integrated control system in the Babcock & Wilcox plants, and, in connection with that, the use of transient experience data which we have gathered in the process of proposing failure modes and effects analysis for our ICS.

The B&W plant contains a high-level ICS which has been described to the ACRS subcommittee, which maintains balanced heat removal during normal operation between the reactor and the reactor core, the primary system through the steam generators and out to the turbine. The once-through steam generator in the B&W plant are a tightly coupled and responsive system which has many advantages in terms of power control and in terms of capability to resist transients.

We were asked early on by the staff if we had ever performed what would today, in today's technology, be called an "FMEA," a failure modes and effects analysis, for the integrated control system. We acknowledge that while informal failure analysis had certainly been a part of its design, an FMEA by modern technology had not been performed, and it was one of the steps we did undertake after the TMI incident.

(Slide.)

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The scope of that analysis is outlined briefly on this slide, and it has been under way now for some weeks.

Our basic objective is to perform a reliability analysis, including an FMEA, to identify sources of transients initiated by the ICS and recommend any design improvements which may be indicated by these analyses to reduce the frequency of those transients.

We chose in this analysis to do two things: not only to conduct a more or less cl'ssic FMEA, but to make a very specific attempt to collect and analyze all the operating plant data we could obtain from our operating plants and learn as much as we could about transient performance in these plants from those data.

We then would, as a part of the effects analysis, simulate the failure modes, examine potential hardware changes, consider normal transient performance as well as off-normal transient performance, and address the results in terms of recommendations for specific design or operational actions which might reduce the probability or severity of the transients in the future.

end#17

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In agreement with the staff, we chose to use IEEE-352 as a guide to the FMEA format and content.

MR. BENDER: Before you take that off, I'd like to ask one question. If you were to decide to do an FMEA on the Three Mile Island incident and you had done it prior to the event, what kind of numbers would you have come up with?

DR. WOMACK: If we had done an FMEA on the Three Mile Island sequence prior to the event, I believe we would have predicted precisely what happened at Three Mile Island, given that series of actions.

As I think Bert told you this morning, as we went through the craft analysis, when we put those actions analytically into our models, we got out, essentially without any substantial adjustment of the model, primarily the system behavior that was observed.

MR. BENDER: What would have been the initiator?

DR. WOMACK: The initiator would have been the loss of main feedwater. It could have been a loss of main feedwater. It could have been anything which would have resulted in a sticking open of the pilot-operated relief valve, coupled with reduced action by the high-pressure injection system.

MR. BENDER: Would the frequency of that action have been an acceptable frequency by the standards which you judge such events by?

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DR. WOMACK: We are not at this time planning to establish in detail quantitative acceptance criteria at the component level as a result of this study. However, I think that we certainly could, by using experience data, arrive at conclusions which would lead us to think that we should exam e certain components, like the PORV, such as power supply reliability -- I'll point this out to you in a minute -- with our utility customers, in order to reduce the frequency of transients.

MR. BENDER: There are an infinite number of these events you could look at and you have to decide on some basis which trees to follow. Now, I'm sure that there has to be some implicit judgment about the probability of the event, and I'm not clear that you've told us very much about how you're going to select the paths to follow.

DR. WOMACK: No, sir, I haven't told you anything so far, really, about how we would select the paths. And I think that that is a matter in which there's going to be considerable judgment.

In the ICS FMEA, which will not be a plant FMEA as a whole, in the ICS FMEA, that system being bounded by having rather distinct boundaries, we'll be examining failures in its inputs.

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(Slide.)

We'll be examining failures of its modules, and we'll be examining failures of the object equipment that it operates.

A larger event tree or failure analysis which would address the entire plant system would be considerably less bounded; to put it another way, would have to be bounded by more judgment than this one would have to be. And our present thinking is that to a large extent those kinds of judgments should be made by looking at what's actually happening in the plants.

For example, we've learned in this study that approximately 50 percent of automatic reactor shutdowns occur due to upsets in the secondary system, loss of main feedwater events primarily. That would seem to me to justify a great deal of focus in following many, many paths from the initiating event, loss of main feedwater.

Much less frequent events -- multiple control rod drops, for example -- might deserve less treatment. Those events which do happen in plants, however, which have a particular severity I think also deserve special examination.

Those are my ideas. And certainly those things are the kinds of things we are discussing within B&W and with our colleagues.

MR. BENDER: I certainly don't disagree in principle with what you're doing. It would be nice if you could develop somewhat more definitive criteria for deciding what you are going to study. Maybe that shouldn't be done right now.

DR. WOMACK: Yes, sir, I agree. I think it's going to be the work of some time to develop those criteria so that they do not exclude the kinds of things that actually happen in the plants, because, to anticipate a conclusion I had intended to make a few slides later, one of the things we learned by looking at this study is that every event is different, and that in itself is a lesson to be learned.

Here's what we've done so far. We have sent teams, engineering teams, to each of the operating plant sites owned by B&W utilities --most recently have just completed the work this week at the Three Mile Island site -- collected data and analyzed this data. And this analysis is continuing.

The FMEA tasks themselves are in progress. These include identification of failure mode inputs and their propagation through the ICS, identification of failure modes within the control system, simulation analysis and so forth.

We are targeting for a completion date of the FMEA at the end of this month.

DR. OKRENT: Let's see now. At the Subcommittee meeting there was a little bit of discussion about how you were doing that FMEA. I think you were doing it in terms of applying a single-failure, if I remember correctly.

DR. WOMACK: That's the primary way. We're trying to examine the effects of individual failures at the inputs, individual failures in the modules. However, I would expect that we will follow those failures through in the simulation if they result in action in the system which might be off-normal elsewhere.

DR. OKRENT: Well, let's see. The question was raised: Are there failure modes of the control system from whatever source which, if they occur, could be very awkward? And are you going to try to identify whether or not such failure modes exist independent of whether it appears to be a single or multiple failure?

DR. WOMACK: Well, yes is the only answer that I would find acceptable to your question. That question, of course, it is difficult. We will try to be systematic about that. There will be some judgment involved.

For example, one of the questions we've asked ourselves is, is there any failure mode of the integrated control system which could result in the loss of both main feedwater and auxiliary feedwater. That kind of failure would be, as you say, awkward.

So far we believe the answer to that question to be no. We will look for other failures like that. I suspect when we complete the FMEA and present it to our customers, that it will be available for others to comment on, and we may wish to go back and look at other cases. We'll attempt, to the best of our ability, to follow that course you just have outlined.

I'm skipping some of the slides that are in your package in the interest of time. I will not go over the detailed PORV actuation data. They are there if you are interested.

(Slide.)

Before I go into the plant trip data, I thought you might like to see some of the positive effects of the integrated control system in terms of reducing challenges to the reactor protection system. As it was configured in the original design, as I told you about this morning, these data are for one plant and represent approximately five and a half years, reactor years of operation, during which period of time this plant experienced 37 automatic reactor trips, and during which time the ICS, by runback action, avoided reactor trip approximately 47 times.

The addition of anticipatory trip on turbine trip and load rejection, anticipatory trip on the trip of any feed pump, for example, alone in that period of time would have added 30 more challenges to the reactor protection system.

We believe that these data are important and it would be our objective to re-establish control system capability to avoid these challenges within the design in the future.

(Slide.)

The data that we have collected on challenges to the overall RPS. This does not include the TMI-2 data, but of the other plants we have. It indicates that we get, on all causes at all times, which includes, of course, a lot of startup data, about seven challenges to the protection system per year, of which loss of feedwater and turbine trip comprise about four. So secondary side upsets represent a very significant part of the total automatic reactor trips.

DR. LAWROSKI: Did you use startup there in the context of the early life of the plant?

DR. WOMACK: Yes, sir, the program of initial startup testing and startup.

DR. LIPINSKI: A question along the same lines. You just showed us challenges to the RPS. But what about challenges to the primary system boundary? Generally the safety arguments go that fuel clad is the first boundary, primary system represents the second boundary, and the containment represents the third boundary.

Consequently, in expressing this philosophy, you're looping at challenges to the RPS. What about challenges to the primary system boundary?

DR. WOMACK: What do you consider a challenge to that primary system boundary, Dr. Lipinski?

DR. LIPINSKI: Opening of PORV.

DR. WOMACK: For that, I would go back to I think it's about the third sheet you have in your package, which gives the PORV actuations f-r anticipated transients. You will see that all of those events which resulted in a high reactor coolant system pressure trip did in fact open the PORV. And in retrospect, I believe that we would prefer to avoid those challenges in the future, and we'll be looking at ways to do that.

DR. LIPINSKI: Because your design philosophy was to reduce the challenge to the RPS at the expense of increasing the challenge to the primary system boundary.

DR. WOMACK: Since those challenges per se didn't challenge the boundary other than that valve, I think that the question of whether those were actual challenges to the pressure boundary is a discussable item, in any case.

DR. LIPINSKI: Well, unfortunately, 10 CFR 50 Appendix A wasn't too clear on how in[illegible] that primary system boundary is, and that's where the interpretation comes in. And you elected to use it as part of a control system.

DR. WOMACK: I think that that, in the sense of the availability of these kinds of valves, is fairly common practice. But we used that valve for pressure relief perhaps more often than [illegible]ntrol systems, based on different principles, that's right.

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(Slide.)

This pie chart shows the breakdown of 246 reactor trips, and we have especially broken down those which relate to the integrated control system. Hardware failure in the integrated control system itself -- that is, the electrical modules which form it -- have contributed a fairly small percentage of the overall trip response we've seen. Failures of inputs -- sensors and transducers, power supply and so forth -- have contributed a larger slice here. And failures related to control response in certain situations have contributed a number of events.

This is an area in which we believe that it is possible to make significant reduction by completing the optimization of gains in the integrated control systems on some of the plants.

The remainder of this chart is divided into failures of control equipment, such as valves and the like, failures of other power system equipment, such as turbine equipment and the like, the turbine generators, and actions which might have been taken by the operator or technician.

Now, to the extent that the Committee is interested, I would like quickly to go through a breakdown of these categories.

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(Slide.)

ICS hardware failures out of this summation really amount to about five events. The two at the top related to failures which caused unbalance in the feedwater flow to the two generators. The two in the middle had to do with flow measurements in main lines and startup lines summer and some failures which took place in that. These failures are probably consistent with performance of a pretty reliable system of equipment at a non-redundant level.

(Slide.)

The next item is that part of the pie that was over here to the ri ht t at I talked about, which had to do with controlled response. In these events -- there are some 19 of them here. They're all headed "Tuning" and in each case these, we feel, represent reactor trips which resulted because final optimization of gains within the system to match the control equipment had not been completed in the plants. And many of these, of course, occurred during the startup program, before the tuning was complete. And we will be addressing a considerable amount of attention to those in the future.

(Slide.)

The next item has an interesting point to make, I believe. This is failures of the inputs to the ICS. In terms of events in this category, power supply failures form a very large proportion. And we feel that, coupled with the data you'll see in the next two slides, that this indicates a direction for improved reliability, which we will be pursuing closely in the coming months.

(Slide.)

Controlled equipment failures exhibit the same sort of behavior, with failures of controls, especially power supplies, being an important consideration.

(Slide.)

Finally, failures of balance of plant equipment again indicate a fairly high allocation for electrical supply failures. These data allow us to form some preliminary conclusions from this study, which is very imcomplete, still incomplete at this time.

I would sum those up this way: Direct integrated control system contributions to reactor protection system challenges have been relatively few. But we believe they can be reduced further by tuning and we will be looking for ways to do that and any other reliability improvement results which appear from this task.

Yes, sir?

MR. BENDER: The term "tuning" has a connotation to it that sort of leans toward just making small changes of detail. Certainly I wouldn't argue with the desirability of doing that. But there's always the question about whether you're going too close to the operating margin.

DR. WOMACK: Yes.

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MR. BENDER: And I don't get much of a feel for whether you're evaluating that aspect of things -- the pressure limits on the system, whether you should be allowed to encroach as closely to them as you have is something that has come up in a number of ways, ATWS being the one of biggest concern prior to Three Mile Island. I don't think we've forgotten ATWS. Just because we're addressing this circumstance doesn't lead me to believe that we should forget it.

What are you doing about looking at whether you really are working as closely to the operating margin as is prudent?

DR. WOMACK: We are continuing a program in support of our utility owners on ATWS and we certainly haven't forgotten that question either. And we'll be doing that in connection with this program.

I can tell you that it's an important engineering consideration on a continuing basis within our design group to look at and to attempt to maximize these margins wherever we can. And without being more specific than that, which I really can't do right at the moment, I would say we haven't forgotten it either.

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MR. TAYLOR: Allen, could you perhaps help clarify the connotation of the word "tuning"? Perhaps that's what's necessary here.

DR. WOMACK: Certainly. I think that Dr. Bender understands what I meant. But the tuning is the process whereby the fine adjustments in feedback response are made in this control system, to match it as closely as possible to the response of the plant and the control equipment.

Did I say that right, Walt? You have an expert on control systems and tuning in your midst.

DR. LIPINSKI: Let me ask a more general question: Other than tuning, are you looking at the overall basic philosophy of your control system? Similarly, in control systems, you can apply redundancy techniques just like we have in plant protection systems. There are theorems and design procedures that allow you to improve your reliability by going to parallel control.

DR. WOMACK: Well, the answer to that question is "Yes." We will do that as a follow-on to this study, and I would expect this study to identify those control paths which would be suitable for that kind of treatment with good reliability gains.

DR. LIPINSKI: Are you aware of the Canadian philosophy that says "thou shalt not have a failure more frequently than once in three years with a control system, and if you do, you shall redesign it until you meet that reliability goal"?

DR. WOMACK: No, I am not aware of that philosophy. It has not been applied explicitly to the design basis of these systems.

DR. CARBON: Paul.

DR. SHEWMON: I guess the things which strike me most frequently are when somebody is doing maintenance on a system and the system gets tripped or something gets shorted out, when I look at this pie figure that you have back there, I find one which has operator technician action, and that's 33 percent. I find others which say failure of power system equipment.

Are there any times when the failure was caused by somebody doing maintenance? Would it come under operator technician action?

DR. WOMACK: Yes, it would come there. If the maintenance procedure itself, the procedure performed by the maintenance resulted in the trip.

DR. SHEWMON: Okay. Thank you.

DR. CARBON: Let's move on then. Does that finish?

DR. WOMACK: I promised -- I have got one more slide -- I promised to draw four conclusions. The second one I already mentioned. That is the power supply reliability has played a critical role and is a fertile area for reduction of challenges to both the control and the safety system.

The third one I have already also mentioned. That is that our findings are that each of these transient series is a complex. Most of these contained complicating factors relative to the bounding analyses which are already done for safety system design.

The fourth is that there is a great deal to be gained from a continuing and rigorous analysis of transients with positive feedback to the system designer, the analyst, and the operator.

(Slide.)

We are discussing a number of ways to do this, and this is one that might be of interest to Dr. Okrent. We have looked at, based on what we've learned from doing the small-break guidelines, at the possibility of following-through procedure in which we would make those difficult decisions that Dr. Bender was talking about, by preparing event trees of the sort that I showed you earlier, but considerably more complex, based on principles such as the ones I enunciated to you, and relying both on engineering judgment and on a continuing feed-in of plant experience.

We would then use those event trees for several purposes. One would be to communicate to the others in the process of making potential design and safety improvements the decisions that were being made about paths to follow and paths to ignore. They're a good communications tool, and they will help make these decisions accessible for review and discussion between architect engineers, the utilities, the ACRS, if you will, and the designers.

Having made some selections based on plant experience, we would then perform realistic analyses to confirm behavior along certain of those paths sufficient to give a description, a general description, of system behavior, which could be communicated among those parties who have a responsibility and interest in this whole process.

In the process of doing those, a confirmation of installed equipment performance with an output to technical specifications and plant limits and precautions is an important consideration. It's essential that actual plant performance match the behavior-determining analyses which go into one's description of system behavior on which you base the remainder of this, which has the objective to prepare good plant procedures for operation with the largest margin to safety that one can obtain.

Having described the system behavior, one then takes this system behavior and basis for operation and prepares a draft guideline.

The next element of the process is a rigorous review for communication with the plant operating staff. This is the review that Dr. Okrent, I believe, was referring to earlier, when he asked the question have we looked at places where the operator might be deceived, have we actually taken a guideline and walked through the control rooms.

We believe that's a desirable part of this process. From that, we would expect to come some potential modifications to the guideline, but also perhaps recommendations on the operator-hardware interface which could improve the process of operation.

With these guidelines complete and comprising both the system of description behavior and a procedural portion, the actual plant procedures would be prepared by the utility. This process would not terminate there. It's important that the loop be cl sed; therefore, we are looking at the possibility of reviewing those, having engineering staff which prepared this guideline review all object procedures and continuing on a continuing basis, month to month and year to year, to make comparisons of actual transient experience in these plants against these engineering bases and procedural bases to see whether on a transient-by-transient basis they do in fact continue to be valid predictions and adequate operational approaches for safe and productive operation of the power plants.

This is one idea that we are discussing at B&W, and we thought it would be worthwhile to present it, to answer some of the questions which you asked today.

DR. CARBON: Paul

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DR. SHEWMON: These things always look so neat and logical when you put them on the board.

One of the things that came up in talking to the Three

Mile Island operators was the fact that hassled by the aux feed-water pump being valved off and a few other things, there were 60-11 different alarms that went off, this overwhelmed the computer system, and they went back and had a single button they could turn them all off with and then see which ones kept yelling at them.

What sorts of thoughts have you had on trying to decrease the number of alarms? Or, if that's a dangerous procedure, to try to get across to the operator which ones he should really pay attention to and which ones he can let go until next time around?

DR. WOMACK: That particular question is, in my opinion, worthy of individual attention. I think that this process, which will involve a series process through a number of transients is going to produce some very valuable results on an individual basis.

In addition to that, our thinking is that this deserves a careful look in an integrated way as far as the way alarms are presented to the operator now.

I think Dr. Roy intends to address this, or perhaps touch on it, in his recommendations.

DR. SHEWMON: Thank you.

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DR. CARBON: That winds it up then?

DR. WOMACK: Yes, sir. Thank you for your time.

DR. CARBON: Let's go to Dr. Roy.

I wonder, would the committee like to have a presentation of the other B&W actions, or simply ask questions?

DR. SHEWMON: Why don't we ask questions?

DR. CARBON: Let's try, by asking que ons of you, rather than having a specific presentation.

DR. ROY: I believe if it would be helpful, Prof. Carbon, I could probably give a good overview of what we have done and are doing and plan to do, and cover positions on most of the ACRS recommendations, probably with three slides. That might help. And I can run through those very quickly.

DR. CARBON: Go ahead.

DR. ROY: I would be glad to answer questions.

DR. CARBON: Go ahead with the three slides, anyway.

DR. ROY: That's what I wanted to do, was just to cover what we are doing and have done and plan for the future. It is not meant to be a representation that the learning process is over. There are going to be lessons to be learned we haven't even thought of yet. I do believe --

(Slide.)

-- That the items and generic issues which have arisen in the wake of TMI-2 cover the spectrum from accident prevention through accident mitigation to accident recovery. We have items of work in each of these areas under way right now. Let me review them for you very briefly.

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I think we will cover, as I said, a number of the positions that you asked us about with respect to the ACRS recommendations.

With regard to accident prevention, we have already, and through our customers and with the NRC, increased auxiliary feedwater reliability in the operating units. There will be further work in this area. This is arranged from rather extensive modifications that are coming through the addition of auxiliary feedwater indications.

In the control room, we have mentioned already providing criteria for securing the safety system operation, principally directed at HPIs, and discuss revision of high-pressure reactor trip and PORV set points.

Items which are under way: the ICS reliability study, which we have heard already. Let me just make one quick comment here about the operating experience data base. That's been a very useful operation for us, is the gathering of the data. It points back to the fact that accident prevention, I think, is much more than just reducing the frequency, say, of moderate frequency events, Class II events. What we're really finding is that, I think, to make real strides in understanding the safety impact of actual events that occur in the field, you've got to get more than down deeper, just to the main feedwater kind of an incident, but what are the root causes. TMI-2, of course, is a good example.

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A procedure dealing with the transfer of rosins from the condensate polish trips. I think we've got to get down in this operating experience bace to the kind of level that Dr. Womack displayed to you in looking at actual equipment malfunctions, places where maintenance procedures, service or test procedures do form traps which in themselves may not initiate an incident that would even lead to an LER but nevertheless they are deserving of perhaps more than remedial action, but perhaps corrective action, because I believe that many of these, if not all of these, which on the one hand reduce availability, contribute lost-capacity days, but could somewhere in them, lurking at some probability level, an incident of major safety significance.

So, I guess what I am really saying is I believe there is a coupling between availability and safety in these units, and that it would be worthwhile to focus our attention on building up systematically and logically a good operating experience data base and looking at that, putting some priority attention and resources to it, and start building our images of what incident sequences may be developed from the real-life circumstances.

537 238

I do believe, however, that that is going to require us as an industry, you, the NRC, the vendors and suppliers to rearrange some of the priorities. We had a great list of items to consider in the pre-TMI-2 regime. As a consequence of TMI-2, many new issues and concerns, I think, quite relevant and even more relevant to safety than some of the items which were considered in the pre-TMI-2 era are going to have to rejuggled. Some priorities are going to go up, and I think some of them have to go down.

I think that process we will keep in mind, but I believe over the next couple of years there is going to be a heavy drain on the resources of the total industry, and I would say that looking at the experience data base, the real-world events and what their safety significance might be and their acceptance criteria might be for them is the place where perhaps we would want to raise the priority, and we have may have to reduce it in some other areas.

We are looking at a system for improving auxiliary feedwater controls, and it has to do with the fact that we may not be able to achieve the best system behavior by just controlling to level alone, but a feedback circuit which allows us to gain the kind of temperature and pressure response on the primary side when aux feedwater is initiated. That could be a very important in cutting down the overcooling transients or undercooling transients that follow some of these incidents in the plant.

537 239

Quantification of safety goals. We will be looking at this in quite detail at B&W. We hope to be working shortly with the EPRI group that's been very active in this particular area. I just mention here one of the prime reasons why I think it's of considerable importance. If the single-failure criterion is in question and perhaps is no longer a valid basis for safety analysis, regulation, and review, we've got to ask what are we going to replace it with.

I think this is going to cause us to take a much more detailed look at the quantification of safety goals, the use of risk methodology, to sort out some of these sequences that Mr. Bender was talking about. We have an active program in looking at emergency safety system status monitoring, both preactuation and post-actuation the principles of Reg Guide 147 apply; that is, looking not just at component status, equipment status, but at system status, and if one system is down, to look at what other systems may be rendered inactive as a consequence of some other support system being donw.

As you can tell from Dr. Womack's presentation, operatting experience feedback is going to loom rather large in our plans for accommodating generic issues in the post-TMI-2 era, both as it affects system design, both as it affects the preparation of guidelines.

Looking at the sources of safety incidents that ought to be generated. We are reviewing in-house our own R&D plan to determine what changes and additional R&D needs we might have. I must mention here with respect to the small break, I did have a slide; it is in your package, with some ideas that are worthy of pursuing. They in particular have to do with the verification of the phenomena of natural circulation, if we will call it that, and the bubbly 2 phase, and the reflux boiling mode.

The small break of small break standard problem of the LOFT and semiscale series, and particularly we want to address and work with the NRC on just how those representative those systems are of the B&W system.

(Slide.)

With respect to accident mitigation, control grade trips, and loss of mainfeedwater and turbine tri have been added to the plants. Our operators are also committed and we are working with them to upgrade these to safety grade trips on these two items.

Natural circ..ation has been provided. This is for controlled initiation of natural circulation to the plant, and we've discussed the small break.

Instrumentation to follow the accident. Many of the subcommittee members, many of you here, saw the prototype saturation meter demonstrated a couple of weeks ago. We're making some modifications of this, and preparing this now for offer to our customers.

537 241

Reactor vessel level. We are actively considering reactor vessel level. We do not believe it's necessary for safety, but we have concluded it may very well be a desirable addition. We will be running, repairing some conceptual designs for this vessel level measurement, principally looking primarily right now at delta P from the candy cane to the bottom of the reactor vessel as part of our examination of the pros and cons on how this might be done conceptually, how it might be interpreted or misinterpreted and what use it might be in managing particular small breaks.

end#19

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RMG 1

The recommended expansion in the use of in-core thermocouples, the hook-ups at the plants that is not now required in the operating units; we have expanded the read-out range of the in-core thermocouples; provided software for the computer packages to our customers that permit readings of up to 2300 degrees Fahrenheit.

PORV position indication, we are actively pursuing that. We will begin testing in our Alliance Research Center next week on two delta P techniques plus a noise technique.

We are selecting, and we hope to have a firm recommendation for our customers in the next few weeks.

DR. SHEWMON: Would you say that again?

DR. ROY: On the pilot operated relief valves.

DR. SHEWMON: We have talked about limit switches, and some people apparently use these, but you didn't mention either.

DR. ROY: There is not, there is no way to physically install limits. So we are going to have to detect this on the process variables itself -- flow in the pipe, a noise pickup of flow in the pipe.

We are making two noise tests, one acoustic one, one using accelerometers, and two delta P measurements, one across the 22 degree elbow, and one on the vertical leg of piping that goes to the discharge header. We are going to be testing that at our Reliance Research Center.

RMG 2

DR. LIPINSKI: How about alternately replacing the valve?

DR. ROY: We are also looking at that. We are taking a look at hermetically sealed valve, it's a known off valve type, to see whether that might be an attractive alternative.

As a matter of fact, we have some very good experience with a very similar valve used in the spray control mode at the Oconee station which has given excellent service.

Yes, we are looking at that, too.

MR. BENDER: Setting aside the valve actuation, and these things, how about something that measures mass flow?

DR. ROY: Well, we were looking at some device, some way that we could do it without having to cut into the piping to install the device.

Now, we might be led into something like that, but we think that particularly with the noise techniques that we are going to be able to get a good operable signal on picking up flow and perhaps even leakage in the valves. We are not looking at a flow device right now to actually insert in the line for this pickup.

By the way, those transducer ceramic microphones that have been the basis for the auxiliary flow indicate a pickup on aux feedwater flow, and that is a little different situation. We will be finding out just how feasible that is

RMG 3

very shortly.

Containment isolation criteria.

We have already recommended to our customers those who were not tripping lines open to containment atmosphere on both high containment building pressure 4 psig and 1600 psig ESFAS initiation, we now have provided recommendations on what lines to trip and to use both the ESFAS initiation and high building pressure.

We have gone beyond this. We are looking at a multi-level concept which I think was mentioned here already, tripping some lines, say, on low reactor pressure trips; some other lines on ESFAS trip; other lines on high building pressure or high, high building pressure.

We have got some work underway now to try to come up with a matrix of what lines are desirable to keep open under what circumstances, and to look at a multilevel or multi-phase containment isolation system.

With respect to pressurizer heaters, yes, we do agree that the pressurizer is a preferred way to maintain pressure. It is not absolutely necessary, but it is certainly preferred, and it is a much more comfortable way for the operator to manage it. We have recommended it, and do take the position that offsite and onsite power supply should be available for the pressurizer heaters.

Improved diagnostic information.

537 245

RMG 4

Let me just expand that to say we are backing up and taking a look at what we can do and what is feasible given these operating control rooms as they are today.

What is feasible to get in there and to improve both what is displayed, how it is displayed, where it should be located in the displays.

To go beyond just the reactor vessel level, assuming that if you were to arrive at a poor position in the reactor vessel level, but to look at the total man/machine interface and the human engineering approach to the layout of these control rooms.

Obviously, there are going to be a lot of things that can be done with today's technology if you were starting from scratch to design a control room that you might not be able to do.

But one in particular that I believe we must do something about is alarm differentiation and display, someho to differentiate the nuisance alarms, to be able to unload the computer and be able to get the focus of attention on those alarms that are important; that is one of the first things we are taking a look at with respect to this control room, possibilities.

MR. BENDER: Before you take that off, a question about the reactor vessel level.

The Committee, in its letter in which it drew

RMG 5

attention to the need ior pressure level indication, was not very explicit about what it meant.

You talk about the pressure level. What do you think is important to know about the pressure level?

DR. ROY: Reactor vessel level? It's important to know, to me, that I am beginning to lose inventory.

As a matter of fact, gererally when I write down the term reactor vessel level, I often put in parenthesis or see inventory.

What it is really important, and what we really want to know is what is in the hot leg, and whether we are beginning to lose inventory in that hot leg and at what rate. And if I have taken action to try to restore inventory, is it working. Am I, you know, illing up again?

I don't know what that says with respect to the accuracy requirements of the device. I'm not sure it has to be, you know, a highly accurate kind of device, but I want it to tell me that, that I am losing inventory, I am forming those voids, and not just necessarily in the head of the vessel.

As a matter of fact, I am probably more interested that I am losing it in the candy canes.

MR. BENDER: Do you want to know whether the core is uncovered?

537 247

DR. ROY: Well, if we get down to the point --

For example, if I just added some delta P cell

RMG 6

measuring the level across the core, I think everything is going until I am just above the top of the core. It is probably too late for me.

I want to know when I am losing inventory in that system, and if I have taken an action, have I taken an action that is restoring to the greatest extent I can, the inventory in the system.

It is not enough just to measure, you know, across the core.

I don't want to uncover the core, and if I am uncovering it and my HPIs are going full up, that is all I can do.

The basic guideline here, which I think -- at least I am much more comfortable with, now that it is in place -- it says when the ESFAS is initiated, don't turn it off if you are not subcooled. I guess we have got finetuning to do on that.

MR. BENDER: Your line of thought troubles me a great deal.

Because it invariably leads you in the direction of having preestablished the course of the event. That's the only way in which I can rationalize acceptability of the approach you are suggesting.

537 248

I think you really ought to think more about it.

DR. ROY: At the same time, I certainly prepredict;

RMG 7

that's the basis for focusing on the fundamental principles of keeping the core cool.

With respect to the safety system and initiation and leaving it running, I can't prepredict all sequences. I can't provide guidelines for everything I think the operator is going to be confronted with.

That's why I think the procedures, as ours does, can be broken down to focus on the fundamental principle of keeping the core cool. If I am in doubt, keep the core cool.

But on the reactor vessel level, we also did not preclude the ability, Mr. Bender, to follow, you know, that inventory down, even to the core. And if the core uncovers, with a properly vessel level measuring system --

MR. BENDER: Neither one of us is designing the level right here. I am certainly not trying to do it.

It does seem to me that since one of the things we are very much interested is being sure that we have adequate time to alert the public if things have really gotten out of hand, that is something slightly different than just knowing whether you have done all you can do. You need to keep that in mind.

537 249

DR. ROY: In the design of a vessel level, I agree fully with that. But design of it is what I would say that we would want to determine, more than just, but including the level in the core.

mte 1
fls RMG 7

DR. LIPINSKI: I have a question. You have containment isolation criteria on your list. Are you considering the integrity of the primary system boundary in terms of criteria? And let me be a little more specific. In a normal reactor, you have fuel failure. The primary system boundary provides a barrier to retain the fission products. If that barrier fails, then the containment provides your next barrier.

You now have identified some areas of improving the containment isolation. In the case of Three Mile Island, your control system had a failure, namely the PORV, that provided a hole in the primary system boundary. That hole in turn induced fuel failure. Consequently, you had loss of both your barriers and had to fall back on the containment isolation.

Are you considering that criteria for that primary system boundary?

DR. ROY: With respect to the containment, let me just remark on the pilot-operated relief valve. It took more than the pilot-operated relief valve to cause core damage.

DR. LIPINSKI: Plus the philosophy of providing the hole.

537 250

DR. ROY: Of course, we've taken one action that addresses that already: Get the PORV out of the way for moderate frequency events.

But with respect to this containment isolation, no, we hadn't addressed it from that standpoint. I'll be giving that some thought with respect to a containment isolation system.

DR. LIPINSKI: You still have PORV, and really, the question that I'm raising: Are you still anticipating the need for the PORV for your normal anticipated transients, or will you look at your system to try to prevent the PORV from contributing to mitigate these transients?

DR. ROY: With the set point change, that has changed. We do not depend upon nor need -- the reactor is going to trip on the moderate frequency events now. It's going to take something more than that to drive the system pressure up to the PORV.

Now on the small leaks, yes, we do say, you know, open the PORV. If auxiliary feedwater flow is delayed, it's going to go to the PORV.

Is your question whether maybe we ought to just remove it entirely?

DR. LIPINSKI: No, just do a complete transient mitigation study and see whether it can be eliminated. As part of your integrated control system now, the way you're going to call for secondary system trips onto the reactor, you're going to reduce the requirement for the PORV to function in most of those cases. But it's not at all clear that this covers all cases.

DR. ROY: We haven't laid out any plans to do any exhaustive study of what all the kinds of upsets that might lead to the PORV. We know of some that do. Small break or just a total loss of feedwater will drive you to it. Is the PORV required for that? This is the logic process you're asking me. For that particular one, no. You drive it onto the safeties.

Are there some events on through reactor trip that would have enough inertia behind them to go up and lift the PORV, turn over and come down? I don't know. We have not studied that and I don't know any. Right now, say, with a full loss of main feedwater, we trip at 2355 now, 2350.

MR. TAYLOR: 2300 psig.

DR. ROY: At 2300. And the pressure rise is expected. The overshoot is something like -- on one trip we observed something like 35 psi. We predict something in the range of maybe 50 to 60 psi overshoot with those kind events.

I don't know of any -- and that's ATWS aux feedwater delay. Other than those, I don't know of any. Right now we don't plan to try to search through and see what would cause them.

DR. WOMACK: As we go back to this objective of bringing the system performance, by producing those challenges to the reactor protection system, we certainly will give consideration to your point.

There are alternatives, of course, to peak pressure rise mitigation, to relief valve operation, such as additional spray.

DR. LIPINSKI: The only reason I bring it up is that if I saw a list, an item on your list saying that you're going to look at the integrity of the primary system boundary in terms of your criteria, then I will cite the criteria, namely, in designing a control system, I will not violate the primary system boundary by control system actions in trying to mitigate a transient.

DR. ROY: This particular item deals with the containment, isolating the containment.

DR. LIPINSKI: I'm talking about adding another criteria pertaining to the primary system boundary. I'm just citing the fact that you've recognized containment as a problem. But I did not see primary system boundary criteria.

DR. ROY: That's not included in here, that's true. I think we'll have to give some thought to that with the new set point change; how big an issue is that going to be?

(Slide.)

Just a few words on accident recovery. We have established a task force to assist in the TMI-2 recovery program that has been established. I think that's going to be a way to usefully assess lessons learned as we get into that exercise.

With respect to reactor coolant system remote venting, we are looking at the pros and cons of adding that feature. Our system has available, at the top of the candy canes, at the middle of the 180-degree bend, small vents, about 11 and roughly a little less than half an inch high. They have a .815-inch bore. Right now they're equipped with manual valves. We're looking at what would be involved in motorizing those add providing piping either to the waste system or the containment building itself.

Looking at the pros and cons, again, we don't think they're necessary for safety. But they certainly might be desirable in certain circumstances.

Emergency communication circuits. Mr. McMillan mentioned to you in his April 16th address that that was a major area of concern. We do have a major program of looking at how to interface with the owners of the plants in the event of an emergency, what kind of preplanning and prearrangements, say for security, physicals, what have you, health physics checks, for teams that would be available on short notice to get to the site; as well as looking at how we would be communicating with an owner-operator in the event of an incident; and in what condition those kinds of teams should be called out and those communication circuits should be used, what's the criteria for them.

Finally, we are taking a look at the design basis for the decay heat removal system and how would that basis change, and what we could do with the systems that exist now to harden them in the event that we had to call upon them with a high contamination in the system.

The TMI-2 recovery plant itself, as I mentioned already, would be a source, I believe, of a number of items that would be useful in helping to recover from an accident.

Any questions?

DR. CARBON: Fine. Yes, I have at least one.

On your first slide there's a copy of the operating experience feedback, and I wanted to inquire: Have you had before Three Mile Island, and will you have in the future, some arrangement whereby you look at, for example, LERs or any operating problems or difficulties that have been encountered at one of your reactors and to evaluate these events and pass the information on to the other reactors?

DR. ROY: Let me answer. Very much so. We have done that through our site problem report procedure, to make a review of an incident, to make a determination as to whet it has cross-contract applicability. Can that system be strengthened, can it be used in a much more generalized way, much more fully? Yes.

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We have, for example, requested now LERs for all pressurized water reactor events that come in for systematic review.

DR. CARBON: Did you do that prior to Three Mile Island?

DR. ROY: No. We did requests for those LERs after TMI-2. We did not systematically receive LERs from our own plants or from all the other PWRs.

Principally, it was through our site problem report on our units themselves, not systematically done. It was done, in some cases, during the normal review of an LER, but not as a system approach for examining the operating experiences and looking at their consequences, both on availability and on the safety significance and sending them out to the customers with respect to LERs and with respect to SPRs, site problem reports.

But they were more oriented to the specific events occurring at our own sites. We're looking, thinking about a concept now that systematizes that. That ties back to another thing which was on your package, another recommendation, for the presence at each site of an adequate event recorder data logging system that can automatically transmit that data to our own computer in Lynchburg. We can quickly get the plots that are available on key system parameters and make an assessment of you know, what's happened, what recommendations we can draw from that event, and to share that among all of the operator-owners. We're looking at that concept now.

DR. CARBON: Related to that, that had to do with operating experience. Suppose one of the operators of one of your plants writes in in the future and says, gee, we're uncertain about something or we're confused about something. We don't know the answer to this. And I'm referring to the kind of thing where TVA wrote to you. Would you systematically expect to pass that kind of information on, answers to questions from one operator?

Would you expect to clarify things for the other plants?

DR. ROY: Yes. I think one of the enhanced sensitivities, of course, is to this cross-contract applicability of issues that are raised from whatever source -- operating utility owner, a plant that's in a backlog contract mode. I think there's an enhanced sensitivity to that throughout the entire industry and through the regulatory agency itself.

How we would do that systematically I couldn't speak to now. We could say, a letter that just came in from somewhere.

The sensitivity to its implications and response has applicability across contract, either standard plants or plants in construction stage and operating plants. I think it would be considerably heightened by systematically being able to bring those up.

We do have a procedure where, if there were safety concerns raised like that, then the recipient has the obligation to prepare, say, a preliminary safety concern, gets it out, gets it visible in the system. But I would say yes, we would be much better.

DR. LAWROSKI: Did you have a program such as, for example, looking at how many outage days were representative at any LERs for reactors that you sold? You know, I guess--what is it, 900 megawatt plant replacement power is half a million dollars a day? It's $25,000 an hour. It seems, you know, like in retrospect, well, it took a $1.5 billion accident to bring about some expenditures, and yet many plants do you have.

It's not just your own. Other vendors just casually look at LERs. It shows many places where hours and days are lost because some component that three days earlier had also clearly performed -- it wasn't necessarily a safety thing, although it was in this case. It did run into a safety event.

DR. ROY: Dr. Lawroski, we're very sensitive to those items which cause lost capacity days in the units. Three years ago we implemented what is a systematic availability improvement program, an availability improvement action program, in which we track the contribution of various equipment such as pump seals, control rod drives, other items, to their contribution to lost capacity days and to implement an action plan to drive those lost capacity days down. The source for that was principally the SPRs, but sometimes it was just direct input from the site itself.

The fuel handling equipment. That program, I think, has safety implications, because I think corrective action when equipment malfunctions is a direct contribution to the safety of the plant. And yes, those are highly systematized and considerable priority in B&W. The approach is from the availability standpoint.

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

DR. MOELLER: In terms of accident prevention, you list here increased auxiliary feedwater reliability. I wondered if you were also looking at the condensate demineralizer systems, or is that part of your role?

DR. ROY: As part of lessons learned, entitled "Driving Down the Frequency of Transients," it's one of the first entries on that list, is reliability of main feedwater systems: what can be done, what's feasible in plants? What is the root cause.

This is a lot of work. We're finding with the program we have under way now on the ICS it's a lot of work to drive to the root causes of these transients. We have to get down to the work orders and interview the personnel and build this data base. That's going to be very fruitful, I think, with respect to the steam plants. And yes, sir, the main feedwater system and its contribution to upsets, de-aerators, auto bypassers, condensate polishers. What other means can we use to try to reduce the probability that we're going to terminate total feedwater flow to both generators?

DR. MOELLER: Could you tell us whether the condensate demineralizer system at Three Mile Island 2 is similar to that on your other B&W plants?

MR. TAYLOR: I can speak to that. That system, Dr. Moeller, is not within our scope of supply. But there are basically two kinds of systems which exist on all of our plants. It's either the powdex system, which uses the granulated resin, or the deep bed system.

On the nine operating plants, or the nine that had operating licenses, it was split five and four, I believe.

I think that there's a significant item here, that demineralizers do tend to provide a source of trouble. We happen to have been the only ones on this vintage plant that have consistently used demineralizers, and it was because of the once-through steam generator water quality.

But I don't think there's any one plant or any one type that sticks out in terms of posing an abnormal amount of problems compared to the others. There are several manufacturers. There are two basic types. And we consider them pretty much the same.

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I think the thing that Dr. Roy has mentioned here which is very significant, he talked about our availability program and the emphasis that we've had. But I think the thing that, in terms of heightened sensitivity that he mentioned, the thing that has really come home to us recently, while we had an availability improvement program, it was oriented toward those components within our scope of supply. And now we're saying we can't stop at our scope of supply, because there are things outside our scope which are affecting the system, in virtually any system which runs continuously.

That can be a perturbation initiated, which can end up in the primary system putting some stress on the operator or the control system, and so on. So this is where we're headed, to take a plant-wide perspective in order to get down to the root cause. This, I think, is going to pay big dividends, not only in terms of improved availability, but also in terms of improved safety.

So there was a barrier there which we feel -- and it was not anything intentional. It was just the normal lines of responsibility, and we've got to go broader than that.

DR. MOELLER: Thank you.

DR. CARBON: Dave?

DR. OKRENT: I have a question that I think will go to the staff. Let me ask, was there any discussion yesterday about the Point Beach reservation, about pressurizer levels, pressurizer pressure?

DR. CARBON: No.

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DR. OKRENT: Let me ask the staff -- and I'll have to preface the question with a statement. My understanding from what I read is that at Point Beach they found that if they were to put ECCS actuation on pressurizer pressure only, in other words, to remove pressurizer level, as a second requirement for actuation on an enhanced system, that they could arrive at a situation that both reactors at Point Beach concurrently the signal for ECCS actuation, but that the diesel system is set up with shared diesel and the design basis is that only one of these can go on ECCS actuation. The other is only large enough for decay heat removal.

That's an old question. I can remember being unhappy about that kind of design years by. And if I remember correctly, the staff agreed with the applicant that you couldn't have a situation where both of these could be initiated at once, although I think indeed there are situations other than the one that was identified here.

I'd like to ask, in view of this potential problem that the Point Beach people have with the proposed change in their previous mode of actuating ECCS, is the staff going to relook at the whole question of shared diesels to see whether there is a family of situations where you might be called on for concurrent ECCS actuation in both plants at the same time, at sites where you're not designed for it?

MR. SCHWENCER: Would you like to have a comment on that now?

DR. OKRENT: If you're able to give me one, I'd be pleased to have a comment.

MR. SCHWENCER: If I may, I'd like to comment on the Point Beach situation particularly. The situation at Point Beach was that they had a combination of pressurizer pressure and pressurizer level taken three times. Without getting too complicated, the power supplies, two of them came from inverters, one came from a raw AC source. So long as they had two out of three and they were so arranged that a single one out of three problem, which our Bulletin 79-06 gave and it called for to take care of -- the one out of three would make it susceptible to simultaneous tripping and initiation of HPI in both Units 1 and 2.

By rearranging and changing and getting away from the raw power supply, Point Beach did resolve that specific problem. I can't speak specifically on whether the staff has looked at each diesel going backward. I can say on each of the plants where the one out of three pressurizer pressure is involved, that they've all been encouraged to come in and make a modification that gets them to two out of three on pressurizer pressure, which eliminates that problem.

At the time they're doing this, we're also looking at the available power supplies. So I would say that the question that you ra... .s somewhat still open, Dr. Okrent, on whether y~ can find a specific situation where simultaneously you put, say, the ECCS safety modes on both units simultaneously.

DR. OKRENT: I'm sorry, I thought there was going to be a specific situation if they didn't make a modification. So I don't think I have to find one. I think if I look for a while, I can find other ones.

But what I'm unhappy about is your response is narrow. It's the specific issue raised at Point Beach, rather than what to me is the more important generic question: In fact, are there facilities where they've been making this fundamental assumption that they would only call on one ECCS at a time?

Maybe that's not such a good assumption.

DR. SIESS: Dave, isn't your question more fundamental than that? Doesn't it start off somewhere with shared diesels?

DR. OKRENT: It depends on the extent to which they're shared.

DR. SIESS: If you don't have shared diesels, this is not a problem, right?

DR. OKRENT: I believe that's true.

DR. SIESS: So you're really addressing the question of the older plants with the shared diesels and what are the problems they can get into other than this sort of thing in that particular instance.

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MR. SCHWENCER: I think most of the plants are not in a situation where the diesel capacity is so small. But there are a few, and I don't know that those have all been looked at yet, Dr. Okrent, to determine whether or not there is some unique changes that would get you in a problem where you could have simultaneous safety actuation or any requirement for safety loads that require the diesels -- complete loss of all off-site power and immediately having to go to the on-site AC power capability.

DR. SIESS: Could you provide us with the following information: those plants that have shared diesels, and on that list those that can operate ECCS in both plants simultaneously with the shared diesels. Because I am sure we've been told of many plants that could have shutdown in one plant and ECCS in the other, and I don't recall a great many that could handle ECCS in both plants with shared diesels.

MR. SCHWENCER: We can provide that.

DR. OKRENT: I'd like to see that, and then I'd like to see why it's okay.

MR. SCHWENCER: Yes, sir.

MR. BENDER: I wanted to ask a somewhat general question of B&W that may or may not be answerable here. But it seems to me to be pertinent.

We have heard a great deal about what B&W is doing to enhance the systems it has engineered. I think we're always vulnerable to the question of whether the engineering capability will always be available for these plants, which are to run for a period of 30 or more years.

What has been done to preserve and assure the availability of the technology that is in the hands of B&W, and to make sure that it's accessible to the operating entity, should B&W or its stockholder-sponsors elect not to pursue the nucle r option any more?

DR. ROY: That is rather a broad question. The election has been to pursue that option. But of course, there's the requirement for the documentation associated with the plants, and that's changed as the years have gone along. It's much more thorough and systematic now with respect to documentation requirements. So that's, of course, one avenue. That really does not assume, I don't believe, and I think I can state that there's been no thinking about, you know, what happens in this unlikely event that the option cannot be pursued by B&W.

So the answer, I think, is no.

MR. BENDER: It not an unlikely event. Other vendors have gone out of the supply business, and I think it's not an unrealistic thing to think that some others might. I'm not saying that any one of them that I can name right now is a specific candidate today. But it's troublesome to me that we're not really sure that if the supplier disappeared from the scene, that the continuity of knowledge that's needed to protect the public in any of these kinds of events is in hands that would assure it's continuity.

DR. ROY: That's a legitimate issue. As a matter of fact, to deal with -- I think all vendors deal with that on a lower level, a much narrower level, with respect to sub vendors, vendors that supply equipment to them. We have a purchasing department that does wrestle with the business of sub-vendors, who are much more likely, you know, to go out of business, and to get that transfer of information.

That's also affected by the way -- how specifications are written today, the documentation requirements from our sub-vendors, with just that kind of thing in mind.

So yours is a much, much broader and deeper question that still is faced in many avenues today with respect to procuring equipment.

MR. BENDER: I wasn't expecting you to answer for the record, but I thought it would be a good time to lay it on the table.

DR. ROY: Certainly I won't forget the question.

MR. TAYLOR: I think, Mr. Bender, that's an interesting question to ponder as further plans are made with regard to emergency planning, because our perception right now -- I think we mentioned it at the Subcommittee meeting and we passed it on to some of the lessons learned task force people, that our perception is right now that the reactor vendor has a very unique and vital role to play in something like this, and we found doubletime utilization for 250 people digging up information, making special analyses, et cetera, during the first few days after the TMI incident. So I think it's something that deserves a lot of consideration.

DR. ROY: One side issue of that we are attacking is the building in-house, not just the drawings and as-built information for our scope of supply, but having ready access for the balance of plant drawings, PNIDs and other information in the as-built condition, pulling that together in a central location for each of the units. Those are no small issues.

DR. CARBON: Gentlemen, if we've asked enough, let me thank Mr. Taylor and his company, and declare a break until 5:15.

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(Brief recess.)

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DR. CARBON: Let's reconvene a couple minutes early. The staff has transportation problems and is anxious for us to move ahead.

DR. SHEWMON: If you wait 'til 7:00 o'clock, traffic will be all gone.

(Laughter.)

DR. CARBON: I see other solutions.

Go right ahead.

MR. BECKMAN: Gentlemen, my name is Beckman. I'm a reactor inspector in the King of Prussia Region 1 office, and this presentation contains a transient which occurred at the Beavery Valley Power Station on January 18th. To perhaps refresh your memories, Beavery Valley is a three-loop Westinghouse pressurized water reactor rated at 852 megawatts electric, and is equipped with 85 percent capacity steam dump valves.

(Slide.)

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The transient was initiated from 92 percent power when a high-level dump valve on a heater drain tank opened and failed to reclose, causing a low level on the heater drain tank, consequent to drip of the heater drain pump. The heater drain pump provides about 30 percent of the condensate flow contribution to the main feedwater pump suction.

With the loss of this 30 percent flow, the feedwater pump low suction pressure alarm was received within the first several seconds, followed shortly by the main feedwater pump trip if operator action is not taken.

(Slide.)

This is the sequence of events of the transient. The heater drain pump tripped at the beginning of the event. Within the first minute, the operator took action in accordance with his alarm response procedures to reduce generator load by 100 megawatts, to attempt to match steam water feedwater flow mismatches.

Recorded data indicates that the power began stabilizing at about 80 percent and held there for approximately two to four minutes, at which time the condenser steam dump valves began operation. This operation over the period of the next 30 seconds caused a peak increase in steam flow of approximately 22 percent over the 80 percent limit level. Contined operation of this condenser steam dump valve eventually resulted in low steam pressure, which, coincident with the high steam flow, initiated a reactor trip, ECCS actuation and the additional events shown.

This particular transient, which corresponded to about a 12 percent load reject, was within the design load reject capacity of the plant, and in fact slightly larger transients at the same rate had been experienced previously without the system upset which occurred here.

The engineering safety features all appeared, from the recorded data and operator interviews, to have operated properly.

Approximately one minute after the trip, at five minutes into the event, the operator manually shut the main steam line trip valves, isolating the balance of plant from the NSSS. This action was taken because: one, the main steam trip valves did not shut on the high steam flow-low steam pressure signal, which I'll discuss in a moment; two, the operator was as yet unsure as to the second plant status.

Approximately three minutes after the trip, the operator assessed the situation, reset the safety injection and containment isolation signals, and secured the low heat SI pumps. At this time, pressurizer pressure and level were being controlled by the high head pumps, both of which were operating.

One of the two operating auxiliary feed pumps was secured. The other feed pump continued to maintain stable steam generator level.

Approximately ten minutes into the event, pressurizer level and pressure continued to increase, and the operator, anticipating actuation of the power-operated relief valve, secured one of his high head injection pumps. The power-operated relief valve on the pressurizer did in fact actuate, and we suspect that it actuated on a rate-sensitive circuit. The valve appeared to have reseated properly and no further problems were encountered as a result of its actuation.

At about ten minutes into the post-trip period, the operator secured one of the three operating reactor coolant pumps, to limit plant heatup. Steam generator pilot-operated atmospheric reliefs periodically cycled to maintain steam generator pressure and plant temperature through the remainder of the recovery. And over the next several hours, what appears to be a very normal recovery to hot shutdown conditions took place.

(Slide.)

The problems identified during the review of this transient are shown on this next viewgraph. The initiator, the heater drain pump trip, was, as I mentioned, a result of the high-level dump valve failure. This high-level dump valve has had a history of unreliability which appears to be attributed to the actuator and valve combination being undersized to close against the flow and DP forces that exist with the valve full open.

The second problem area encountered was the steam dump valve response. The steam dump valves, as I mentioned earlier, c erated about two minutes after the end of the downward step load change. It appears to have been somewhat of an anomaly. We would have expected them to begin operating during or immediately before the completion of this load change.

This operation also appears to have resulted in some over-response on the part of the valves. There are two possible causes for this which we've identified: the first being caused by ice in the air operating lines to the valve actuators. This was due to sub-freezing building temperatures and a problem history with water entrainment in the instrument air system. I'll discuss these a little further in terms of the corrective action.

The second possible explanation for the lag in operation was caused by control rod motion, initially responding to the down transient and apparently controlling the temperature for the first several minutes of the event.

During this two to four-minute period during which the steam dumps initially did not operate it appears that the rod control system may have been hunting, due to its internal circuit characteristics.

The third item which I listed under problems, but may not specifically be considered as a problem, is the lack of closure of the main steam trip valves. The trip valves did not automatically trip shut on the momentary safety injection signal, even though they come from the same source. The reason for this is there's no latch-in feature on these particular valves.

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The signal lasted for approximately 20 milliseconds, and experience by the licensee over the last year, as well as discussions with its contractors, indicate that the valves require about 2 to 500 millisecond signal duration to droop far enough into the flow stream for positive closure assisted by steam flow.

(Slide.)

PROF. KERR: Fxcuse me. Were you going to elaborate any more on what you referred to as hunting of the control rod control drives due to an internal circuit feature?

MR. BECKMAN: Yes, I can do that.

PROF. KERR: Was this normal performance?

MR. BECKMAN: I hesitate to use the word "normal." I would rather use the word "typical" of the performance of the rod control system at Beaver Valley.

(Slide.)

PROF. KERR: Was the rod control system at Beaver Valley typically abnormal or typically normal?

MR. BECKMAN: I think it's slightly abnormal, but it appears to be an inherent characteristic of the circuit. And to use one of the words that Babcock & Wilcox used earlier today, it appears to be somewhat of a tuning problem with the circuit.

In essence, the rod control speed control circuit on this very simplified diagram takes a nuclear power-steam power mismatch signal and acts on it to provide an naticipatory rod speed signal.

PROF. KERR: This is something a nuclear stea: system supplier supplies as standard equi.pment, isn't it? Does each one of them have to be individually tuned?

MR. BECKMAN: That is my understanding, yes sir. Beaver Valley, for example, has Westinghouse Instrument Service Company representatives essentially permanently on site who --

PROF. KERR: That's the problem?

MR. BECKMAN: Yes, sir.

Who is continuing to tune the circuits as they get operating experience.

The supposition is that the signal, as determined impulse pressure and nuclear power began to dampen tow? ls the end of the transient caused by the load change, provided a rate-adjusted signal to the signal summer. The engineered versus impulse pressure circuit did not provide sufficient circuit to overcome the other circuit because of the hunting rate sensitivity, resulting in rod motion hunting approximately three and four steps on the controlling bank during the period.

The data available from the control room recorders and computers is very sketchy in this area. We do know that the rods were hunting. We do know that there was a significant temperature error generated in the steam dump controller, which caused it to actuate.

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I don't know if that spe.ifically answered your question. But in general terms --

PROF. KERR: I think I have more data now with which to be confused than I had before. Thank you.

MR. BECKMAN: Fine.

(Slide.)

In terms of corrective action taken by the licensee for the problems that I spoke of earlier, in terms of the building freezing conditions, the licensee has established additional administrative controls for the control of turbine building ventilation during winter operation. And a word of explanation. The turbine building wall adjacent to the steam dump controllers consists of about a 50-foot tall by 100-foot long wall of dampers which are individually actuated by the respective ventilation exhaust fans.

During this time period, mid-January, temperatures were well below freezing and a number of these dampers were open, due to apparent unauthorized operation of the balance of plant ventilation.

DR. OKRENT: Before you run from that. I think I can recall other incidents at other plants where something froze in the wintertime. Is there some kind of a systematic review that's performed with regard to the possible effects of cold weather?

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It seems to me, of the various things that we have to anticipate at a nuclear power plant, one of the easier ones to analyze is the effects of a cold day, with or without a damper or a window open or whatever. So I guess I'm a little bit surprised that we continue to see this.

Can you help me?

MR. BECKMAN: Let me answer the question in two parts. I am personally not aware of any portion of our review process in Licensing or Inspection and Enforcement that looks directly at freeze protection. There very well may be. And that perhaps only indicates my lack of experience with the Commission.

The licensees typically do develop freeze protection programs. I think Sam McKay is in a position to respond to the first part. Let me finish my thought.

The licensees do develop a freeze protection program on the basis of economics as well, for the non-safety-related portions of the plant, in addition to whatever else may be required of them for the safety-related portions.

PROF. KERR: If we referred to freeze control as environmental qualification, would you recognize it?

MR. BECKMAN: Yes, I would. In terms of additional action taken to protect equipment, again, I'm not personally familiar.

Sam, could you respond to that?

MR. MC KAY: We've recently been looking into this quite vigorously and I've obtained a computer printout on all freeze events that we've had in the history of all of our reactors. There are over a hundred such events.

What we're in the process of doing right now is preparing a circular. At least, Licensing is preparing input to a circular that we believe will be issued to all licensees, to look at all freezing problems. There are many of them.

MR. BECKMAN: Perhaps later information than Sam has: At headquarters this morning, I understand that has been upgraded to bulletin status, which will require a response from the licensees also.

MR. BENDER: That's kind of narrow when you say "freeze." Is that literally what you're going to look at?

MR. MC KAY: Maybe narrower than that. We're talking about freezing of the water, really.

MR. BENDER: That's what I'm bothered about.

MR. MC KAY: We're not just talking about this event; we're talking about all events which led to some safety-related incidents, and they have to do not only with the freezing of instrument lines, such as pressure sensors; they also -- well, we will try to deal with all of those events.

MR. BENDER: My suggestion is that if you're going to do it, deal with it in terms of temperature and changes of humidity, or even precipitation at low temperatures, so you get all the things you might want to know under those circumstances.

MR. MC KAY: Are you talking about boron precipitation?

MR. BENDER: No, no, I'm not.

MR. MC KAY: You're talking about rain?

MR. BENDER: I'm talking about rain, snow, sleet and all of those things that get into other parts of the system. It's fairly general. It seems to me that for some reason or another, you sort of missed the low-temperature end of the spectrum, that's all.

MR. MC KAY: Thank you, and we will consider that.

DR. CARBON: Go ahead, Mr. Beckman.

MR. BECKMAN: Thank you.

The second action that the licensee has taken in this particular instance is to restrict access to the fan controls by the addition of plexiglass covers, which is rather narrow and limited to this particular event.

PROF. KERR: The fix, then, is to institute administrative controls?

MR. BECKMAN: That's a partial fix. In terms of building temperature control, that is the exclusive fix. In terms of the instrument air quality, I'll address that at this point.

The instrument air system at Beaver Valley has had, again, somewhat of a history of reliability problems in terms of water entrainment and particulate contamination, part of which was caused by a considerable failure rate of the instrument air driers, specifically heater failures. The licensee is in the process of modifying the driers to improve their reliability by use of a different style heater. He's also making other changes to the overall system to improve its capacity and reliability.

DR. OKRENT: Is instrument error also a generic source of safety-related occurrences, the same way freezing is?

MR. MC KAY: We certainly have had certain problems with air, such as at Indian Point and the containment isolation valves. I do not know of any major generic effort on this issue right now.

MR. MICHELSON: Dr. Okrent, you should appreciate, of course, that until fairly recent times air systems haven't generally been classified as safety-related.

DR. OKRENT: You say they have not?

MR. MICHELSON: They have not been classified. A number of PWR plants do not have safety-qualified air systems. I believe these NRC gentlemen can probably verify that.

MR. BECKMAN: That is in fact the case for Beaver Valley.

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MR. MC KAY: The fact that Beaver Valley is -- that no air is required tc operate safety grade.

MR. MICHELSON: That's something that ought to be looked at pretty closely, particularly on auxiliary feedwater. In these systems you will find numerous air-operated valvess. Yet somehow they say that they don't need air to operate these systems. They talk about going in and doing it manually. And it's a pretty tricky operation.

DR. OKRENT: How would one best ascertain the degree to which non-safety grade air systems are really being depended on not to cause trouble? I'll put it that way.

MR. MICHELSON: The kind of analysis you need to do is to go in an assume the total loss of air and apply it and then study all the various motions of ventilation dampers, valves, and so forth that will occur as a result of loos of air, and then do a total analysis of what you have won to make sure you can still safely shut down.

It gets real bad in the ventilation systems.

DR. OKRENT: Will a total loss of air assumption cover all the things you're interested in?

If you get dirty air, does that lead to the same effect as the total loss of air necessarily?

MR. MICHELSON: Not necessarily. It could be a different effect.

DR. CARBON: Go ahead, Mr. Beckman.

MR. BECKMAN: The sluggishness of steam dump control system response has been addressed in two separate directions by the Licensee:

One, the circuit has been retuned to increase its gain and sensitivity to temperature deviations. This was intended to provide more prompt and definite response of the valve circuit.

A second aspect has been a rather thorough overhaul of the control system during the current outage, which has included a complete diagnostic check and recalibration of both the electronics and the pneumatics portions of the system.

Heater drain system reliability and stability continues to be somewhat of a problem at the plant, and the Licensee is taking both short term and long term corrective action.

The heater drain tank high level dump valve which initiated this particular transient and has also initiated several other minor load rejections has been disabled to present similiar closure failures.

It now requires operator action to mitigate a high drain tank level, but it does give the operator more time to respond to the event.

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Then he wou.d have, should that valve fail to open and induce a feedwater pump trip, a new valve and actuator are being sought for installation during the fall '79 major

major modification outage.

Prior to the shutdown on the seismic stress issue, the management of the plant had intentionally limited power levels following this event to those which would permit avoidance of a plant trip or inadvertant ECCS actuation on a heater system upset.

They limited power levels to below 90 percent to avoid repetition of this type of transient.

The main steam line trip valves, which I noted did not close automatically, have been evaluated on several occasions by the Licensee, and no corrective action is considered necessary at this time, based on the existing safety analysis.

The existing safety analysis requires, as I mentioned earlier, the trip valves shuts within five seconds of the actual main steam line break accident, during which a continuous actuation signal is assumed to be present.

The valves do operate correctly with about a 200 to 500 millisecond signal duration.

DR. OKRENT: What does that mean? Do you think that you have to examine whether the existing criteria are adequate? Or are you saying that the existing criteria are adequate?

MR. BECKMAN: I am not intentionally commenting on the existing criteria. I'll refer that to Mr. McKay.

Sam, do you have a response for the question?

MR. MC KAY: I'm not sure what criteria we're referring to here.

DR. OKRENT: Your words, not mine.

PROF. KERR: I thought you were saying that the criteria was one which said if you had a break in the main steam valve, you'd get automatic closure. If you had a break, you'd have a continuous signal which would last more than 200 milliseconds.

Is that --

MR. BECKMAN: That's correct.

MR. BAER: I'm not that familiar with Beaver Valley, but as Don said, it's typical of our analysis that we assume that steam generator inventory is lost for a full five seconds.

MR. BECKMAN: That's correct.

MR. BAER: In the analysis, both the system analysis and the facility safety analysis --

MR. BECKMAN: The facility safety analysis report states the assumption that the steam dumps do not close within the first five seconds of the actual event. That's been applied by the Licensee as the criteria by which to accept this 200 to 500 millisecond closure.

Does that answer your question? 537 287

DR. OKRENT: No.

MR. BAER: Don, may I ask a question?

Would this incident have been any better if the main jl 5

steam line isolation valves closed?

MR. BECKMAN: This particular incident doesn't appear to have been affected by their closure or failure to close.

Sam, do you have any comment on that?

MR. MC KAY: I'm not sure what the concern is here, whether it's for the response time or whether the valve closure time, or just where it is.

DR. OKRENT: The question is should there be any concern? Maybe there shouldn't be. On the other hand, this case, had it been combined with one more anomalous characteristic, might have gotten into a position where the operator was well equipped to cope with it. I don't know.

I have not analyzed this myself. I saw a statement. I was trying to understand whether this said everything is hunky-dory under all circumstances, or just what.

And I don't know what you're telling me.

PROF. KERR: Does the staff see any safety significance in the fact that there was no actuation?

MR. MC KAY: Yes, we do.

One of our criteria is that once a safety feature is actuated, it should go to completion. And there was some question here as to whether or not it was actuated to begin with.

What we consider this to be is that the actuation did not take place in the first place. It was a 20 millisecond signal.

PROF. KERR: I didn't express my question very clearly.

I'm not talking about the staff's rules; I'm talking about the safety significance. What I'm asking is, is there something about this incident which strikes you as being unsafe?

Would it have been safe had you gotten closure?

MR. SCHWENCER: I think there are at least two ways that you would continue to get a continuing signal. I think the hypothesis that the signal would not continue is probably a false one.

As long as the steam dump valve stay[illegible] open, it would continue to get that differential signal, and the safety -- the second safety is lifted. That was the status on the secondary safeties.

MR. BECKMAN: The second code safeties did not lift; the smaller, pilot-operated, atmospheric steam reliefs did lift momentarily, but with very small steam flows.

MR. SCHWENCER: The three valves combined were worth about 10 percent of the steam line flow, which is a condition which would be less than steam line break, which has been analyzed.

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I guess the way I view it, there would be at least two ways that you would continue to get the differential signal that would be there for a significant period of time to actually -- to do the tripping.

DR. CARBON: Paul?

DR. LIPINSKI: I have a question.

Going back to you previous sheet of problems on the main steam trip valve closure, it says valves did not automatically trip shut on a momentary 20 millisecond signal. How many other signals are there that called for the main steam trip valve to close?

MR. BECKMAN: This is the only signal that I'm aware of.

Sam, are you aware of any others?

MR. MC KAY: Any containment isolation.

DR. LIPINSKI: Well now, does the 20 milliseconds still apply. Do you still have a problem in not having a 200 to 500? In other words, should this circuit be modified to latch in on a momentary signal?

MR. MC KAY: We did not see any problem with having a 200 to 500 millisecond response time on that valve actuation.

DR. LIPINSKI: That's not the question.

If you have a 20 millisecond, momentary signal going to this valve, and it does not respond in 20 milliseconds, do you need an intervening circuit that will accept 20 milliseconds and latch in and then transmit the signal to the valve, which

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requires 200 to 500?

MR. MC KAY: No, we can't conceive of any need for such a device. The valve is required to close in five seconds, so even if it's 200 to 300 milliseconds of response time, there's still plenty of time to close the valve in the event of a signal which calls for valve closing.

DR. LIPINSKI: Somewhere I'm missing something.

DR. SIESS: You're not.

DR. LIPINSKI: The 20 milliseconds is a trip signal given to the valve to command it to close, and you're telling me the valve didn't even see the 20 milliseconds, it didn't move.

MR. MC KAY: There are hundreds of relays in the plant that don't respond in 20 milliseconds. We depend on them to do all kinds of jobs.

DR. SIESS: Are there any that should? You said there are hundreds that don't.

MR. MC KAY: That's right, and there's no need for that kind of response time.

DR. SIESS: If you'll listen to the question, you'll have a much better chance of answering.

Are there any that should respond to a 20 millisecond signal? You said there's hundreds that don't; are there any that should?

MR. MC KAY: I don't know of anything in the plant that needs to be that fast, based on the transient analyses that we looked at.

DR. SIESS: You don't know of any circumstances where a very short signal is important?

PROF. KERR: Have we now extended this to why?

MR. MC KAY: We're talking about the spike now that comes and goes away.

DR. SIESS: We weren't getting anywhere on this valve. I sort of extended it.

PROF. KERR: I am sitting here and wondering what the question is. I must admit I'm almost as puzzled as the staff.

DR. LIPINSKI: My interpretation of the 20 milliseconds is that there's a 20 millisecond spike which goes to the valve and commands it to start to close, but the valve doesn't respond to the 20 millisec d window. It just sits there, and the window disappears.

PROF. KERR: We've had a statement which I thought said that if one wanted the valve to close, namely one would have a main steam break. This would give a continuous signal, which would be longer than 20 milliseconds.

Hence, this tells me that the only time you want it to close is when you've got a main steam line break. 20 milliseconds is irrelevant

DR. LIPINSKI: I extended the question to ask whether there are other conditions, other than the one where they said the signal's duration would be long enough.

I simply asked, are there others?

MR. MC KAY: None that we know of.

DR. LIPINSKI: That answers the question.

DR. CARBON: Does that cover everything now on this topic?

MR. ETHERINGTON: I have a few questions.

DR. CARBON: Go ahead, Harold.

MR. ETHERINGTON: What did the operator respond to?

Presumably he didn't respond to a signal that the [illegible]ated drain pump had stopped. Was it a drop in steam pressure? Or what did he really respond to?

MR. BECKMAN: Based on the interviews with the operators, their response was based on two things: The heater drain pump tripped, which is enunciated; and the feedwater pump suction pressure alarm, which is also enunciated.

To put this in perspective, because of the problem history with this portion of the balance of plant, they have been very sensitive to the these alarms. And the plant has also been sensitive, so they were very quick in responding. They were perhaps unusually familiar with what to do in the circumstances.

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MR. ETHERINGTON: That answers that question, because it didn't seem a very likely sort of accident.

What's the significance of the decreasing by a mere hundred megawatts? Is that important?

MR. BECKMAN: The hundred megawatts was an attempt by the operator to match the steam flow and the narrow, reduced feed flow. It's not significant in and of itself other than it was in the downward direction.

Procedures recommended that they reduce power to somewhere below 70 percent, and experience has shown that by approximately 100 megawatts they can get to a point where the plant will stabilize out, and they can take less drastic, slower load changes to trim the plant.

MR. ETHERINGTON: Now, one more question.

What happens on a high level in the reheater drain tank? The high level dump valve opens, presumably; does the extraction steam for the reheater close?

MR. BECKMAN: Yes. I haven't been able to find a specific transient analysis, as such, for this particular circuit. But my understanding of the logic diagrams is the heater drain tank level increases; the dump valve does not open. The moisture separator begins to flood, and eventually you will get a crossover steam isolation -- crossover steam between the HP turbine and the LP turbine, which I believe will result in turbine trip.

MR. ETHERINGTON: Don't they isolate the extraction steam?

MR. BECKMAN: Yes, sir. This is, I believe, actually heated by bypass main steam, as well as extraction steam; and it does, in fact, isolate it, yes.

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MR. ETHERINGTON: Thank you.

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DR. CARBON: That covers it, Harold?

MR. ETHERINGTON: Yes.

DR. CARBON: Thank you, Mr. Beckman.

MR. BECKMAN: Thank you.

DR. CARBON: Let's go to the ACRS future agenda. Bob Baer's letter of June the 14th indicates that there's nothing on for the next four months. The question I'd like to get clarified, however, is, are we or are we not on the critical path for Palo Verde?

I was informed yesterday by the Palo Verde representatives that they urgently need a CP letter from us at this meeting. But I've asked this question from Mr. Baer and I think we're getting a different answer.

MR. BAER: Okay. I'd like to also bring up a couple of other items for the Committee's consideration. But let me address the Palo Verde situation first, since you brought it up first.

Palo Verde's schedule indicates that they plan to start construction in January of 1981, and I guess their hope was to start a hearing some time this fall in anticipation for fairly lengthy hearings although most of the contentions that have been admitted by the Hearing Board are in the environmental rather than the safety area.

The feeling of the staff -- and we do have a representative of Palo Verde here, Don Carner. I think he ought to have an opportunity to talk also. But the perception of the staff is that a letter this month is not needed in order to maintain Palo Verde's schedule. I guess I could go as far as to say, with the staff resources being very severely limited, the staff resources available for casework being very severely limited by reassignment of people for Three Mile Island and various task forces and investigations, that it would be doubtful that we'd have much in the way of resources to react to a Committee letter if it were written at the end of this month or after this meeting.

DR. CARBON: I asked if you'd be able to put that word "doubtful" on a more firm basis. Can you do so one way or the other?

MR. BAER: could be pretty specific, that if we needed reviewers to clean up any open items on Palo Verde, I know it's not on our priority list for the coming month. I'm not that familiar with the number of open items that were addressed in the SER, since I wasn't involved personally. But usually there are half a dozen or more open items that we have to resolve after the SER has been written. And I know that Palo Verde is not on our priority list for the upcoming month.

DR. SIESS: Mr. Chairman, in view of the so-called moratorium that Harold Denton has imposed on licensing, in order to be sure that there's no Three Mile Island 2 issues that should be resolved on a particular plant before the license is issued, does the staff intend to prepare an SER supplement addressing Three Mile Island issues in relation to, I guess, first, construction permits; second, operating licenses, before they continue with the licensing process? Or are we to assume that the staff is through with it and it is now up to us?

MR. BAER: Well, the staff is concentrating right now on seven operating license reviews, six of which have been through the Committee. And it is our intent on each of those, as far as I know, to issue in the supplement of the SERs, to deal with lessons learned on Three Mile Island as soon as the Task Force on Lessons Learned --

DR. SIESS: This would be the ordinary post-ACRS letter supplement, or a pre-ACRS letter supplement?

MR. BAER: On the six cases that have been through the Committee, I think it would be up to the Committee. We certainly intend to keep the Committee fully informed of what we're doing.

The three task managers were down to speak to the full Committee yesterday, and I expect we'll be down virtually every month hereafter. Certainly it'll be up to the Committee. I don't think there's any doubt.

MR. FRALEY: In those six cases, it will be post-ACRS.

DR. SIESS: Since the letter is already written.

It is only the Sequoyah one that isn't written.

But to get back to Palo Verde a minute. Is something similar t. 'e done on a construction permit, or is that considered to be not affected by Three Mile Island?

MR. BAER: I don't think we've thought exactly how we'd handle the construction permits yet. Are you asking whether it would come back to the Committee on something like Palo Verde?

DR. SIESS: I'm merely interested in knowing whether the initiative is in our hands or your hands on, say, a Palo Verde construction permit letter; two, a Sequoyah operating license letter. Should we even consider acting until the staff has come back and said, look, not we're ready to go ahead; what do you guys want to do?

MR. BAER: Certainly on Sequoyah, which I wanted to talk about, we would like a letter, not necessarily this month, but hopefully next month, that would go through the logic of that.

DR. CARBON: Let me interrupt just a second. We were informed yesterday by Sequoyah that they had a hold-up and they won't be loading until at least October. So that's out as far as any rush is concerned.

MR. BAER: Except -- I agree for this month, but in order co meet an October fuel-load date -- and that may not be obtainable either by the licensee or by us. But if we were

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to meet that, if we got an ACRS letter, for example, after the August meeting and it required any work by the staff whatsoever, we could not meet an October date. Our management and legal review of an SER and SER supplement and the printing and the typing runs nearly a month. So an SER supplement, in order to meet a mid-October fuel-load date, which is what Sequoyah is projecting, we need to have a supplement essentially complete by mid-September.

And if we got, for example, an ACRS letter in August, at the end of August, and it required any additional staff work, there just wouldn't be time for it. So it depends on which way one looks to the schedule.

DR. CARBON: Did you finish the answer you were giving on Chet's question on initiative?

MR. BAER: I guess I don't have an answer. I think it will be up to the Committee as to whether they want us to come back on each and every case based on lessons learned from Three Mile Island. Certainly, we're going to address them on OLs and CPs. But the exact format I don't think has been determined at this point.

DR. CARBON: Dave?

DR. OKRENT: Mr. Chairman, it seems to me that this is a fairly important question. I myself, speaking individually, would find it untenable to propose to say that the staff should address the lessons of Three Mile Island and deal with them in their supplement. In other words, the matter should be resolved by the regulatory staff. The Committee may disagree. But I wouldn't concur with that approach.

In fact, I think I would find I'd be hard put to see how the Commissioners would find that a suitable approach, everything considered, especially when I see them asking rather narrower questions of the Committee on the specific cases.

So I would suggest, in fact, that the Committee, one way or another, indicate that they think a procedure should be worked out whereby, for cases which the Committee has already seen but where an operating license has not been issued or a construction permit has not been issued, a procedure be worked out -- perhaps it need not involve each one singly, if that's not necessary -- that the Committee in fact look at the proposed staff resolution and either agrees or has suggestions or whatever, prior to the Committee having completed its action on those cases, even though the Committee has already written a letter.

And for those where the Committee has not written a letter yet, like Sequoyah or Palo Verde, if a letter is written, it will have some kind of a hole that might let a Hearing Board begin on environmental issues. They began on the offshore nuclear plant, for example, before everything was begun.

But I can't see it making sense for the Committee to say: We're done. We'll leave it to be resolved by the regulatory staff.

DR. SIESS: Dave, it seems to me there can be some distinction made in this process between an OL and a CP. It's about eight years difference. The OL, it seems to me they've got to come back to the Committee on an OL, for the reasons Dave gave.

There's no way, under these circumstances, that the staff should write an SER supplement and then ask us if we think it's okay, because they're going to get another letter and they're going to have another supplement. You're just adding three or four months to the process. It's certain that we're going to do it.

But on a CP, it seems to me there could possibly be some different procedure. I don't see what it is. I just don't see the sense of urgency there. They're not going to operate for eight years, and we might well have another Three Mile Island before then.

PROF. KERR: It's sort of refreshing that we're still not saying another Browns Ferry, isn't it? That's progress.

(Laughter.)

MR. FRALEY: I'd suggest that the Committee request of the staff a supplementary SER for Palo Verde and Sequoyah before you proceed to write the letter, and that the supplemental SER would address the lessons learned from Three Mile Island. That'll get the thing back where it belongs. The staff can inform the Committee what it feels is needed on both of these plants before the Committee writes its letter.

Now, with respect to plants where the Committee has already written its letter, perhaps -- I know Dr. Okrent would like the staff to come back. But I would think it would be even more important that they come back on plants with operating licenses that are operating --perhaps that could be settled at a different time -- on the basis of more like back-fitting requirements rather than at this time.

But I would think, before the Committee writes letters on Palo Verde and Sequoyah, you ought to require a supplementary staff report.

DR. CARBON: Bill?

PROF. KERR: I'm always more interested in protocol than I am in what gets done, and it seems to me that Sequoyah is at a point where we are holding up eventual operation of a plant, which I assume is eventually going to operate. The problem is back-fitting.

I don't know. It's hard for me to see how Sequoyah is very much different from any of a number of plants that are now operating in that respect. And I can't see why we can't work out some procedure that lets TVA go ahead with whatever testing and criticality they need, unless we're concerned that it's going to have to be something that is changed, that radioactivity will interfere with, and that is a consideration.

But there is a good bit that probably can be done before that becomes a problem. If we can avoid holding them up, I would like to try and see us do it. It seems to me that we're going to look not only at Sequoyah but at operating plants as well and come up with some proposed fixes. They'll be implemented in some fashion, I would guess.

DR. CARBON: Let me invite the gentleman from Palo Verde to comment here.

MR. CARNER: Thank you, Mr. Chairman.

Let me identify myself. My name is Donald Carner, senior licensing engineer for Arizona Public Service Company.

I think it's important to note one point on Palo Verde 4 and 5. That is, as replicate plants, they are rather unique. I believe at the Subcommittee meeting we informed the Subcommittee that it was our intent to file an FSAR for all five Palo Verde units in October of this year in support for an operating license for Palo Verde Unit 1. That's still our intent.

And as replicate units, certainly by that time or before, the lessons learned will have been identified and would be factored in in the review of Palo Verde Unit 1 for the te 10

operating license. As replicate units any modifications that would be made for Unit 1 or Unit 2 would be incorporated in Units 4 and 5. So I think that the Committee will have their second shot or third shot, whatever you will, at Units 4 and 5 via the FSAR review for Unit 1 and its operating license. I think that's a rather unique situation for these units and probably should be taken into consideration.

I might also point out that the FSAR for 4 and 5 is, I think, very clean. We've been working with the staff since it was issued in order to clean up the four open items that did remain. I believe we're very close to doing that. Subsequent to TMI, we made an attempt to minimize the amount of review or input needed in order to clean the remaining items up, recognizing that staff time was very valuable in evaluating TMI.

I think we're very close and that a supplement could be issued at this point cleaning up the open items that remain. Certainly the reviews are nearly finished or are finished, and all the supplemental information is submitted.

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DR. OKRENT: Sometimes I hear a statement that we should be looking at the operating plants before we look at, let's say, the plant is almost ready for operation with regard to impacts of Three Mile Island.

When, in fact, I think the staff is, in its way, looking at the operating license. They send out lots of bulletins and so forth.

And if the ACRS has specific recommendations for the operating plants, and it's had a few, certainly, it has made them, or it should make them -- I'm not myself opposing any moratorium on putting new plants into operation or new plants into construction. That is the result of ACRS's lack of action.

What I do think is that the ACRS should look at what it is the staff says should be done to those plants which are operation, to those plants which are close to operation, whether we've written a letter or not, for those plants like Sequoyah for which we have not written a letter, and for those plants to be constructed.

And I am dissatisfied with the proposal just made that we look at Palo Verde 4 and 5 when we're looking at Palo Verde 1, 2, and 3 as sort of FSAR.

And at the moment, although I understand the point of view of replica plants, I don't know that we know enough about what it is we might be interested in to know that we'll be able to swing the balance in favor of the advantages of having all plants the same, as compared to some possible advantages for plants to be constructed being somewhat different at the same site.

I think we just don't know. So, I'm not saying they should be different. I'm saying we ought to know what it is is the basis for the decision.

DR SIESS: You mean that 4 and 5 might be better than 1, 2, and 3?

DR. OKRENT: That's right, because they have not yet begun construction. It's possible.

DR. KERR: When I made my comments, I did not mean to disagreeing with what I interpreted your point of view to be. I agree with you.

My point was that if there is something maybe even a little bit out of the ordinary, compared to what we usually do, which we can do, which at the same time permits TVA to go ahead with somethings but does not interfere with the review. I think we ought to think about that possibility.

DR. OKRENT: I agreed with that, and I tried to suggest a possible thing of that sort before, maybe a zero power letter or whatever. But I do have fairly strong personal convictions about the other part of it.

DR. SIESS: Let me go back to Dave's point on Palo Verde. I think it's a sticky one. I think it's important.

I would be perfectly willing to approve construction of Palo Verde 4 and 5 with the requirement that they would be backfitted with whatever changes were made in Units 1, 2, and 3 as a result of, say, Three Mile Island, plus anything else, I guess.

That, in effect, ratchets them to 1, 2, and 3. But at the same time, it represents a commitment by the committee, if we write such a letter, that 1, 2, 3, 4, and 5 shall be the same. And what's good enough for 1, 2, 3 is good enough for 4 and 5.

Now, Dave's point, as I understand it, is that he would prefer to wait until 4 and 5 come up for an operating license and see if he decides whether at that time, whether being the same as 1, 2, or 3 is good enough.

DR. OKRENT: No, you misunderstood.

What I said was that since 4 and 5 have clearly not begun construction yet, it may be that where four plants where construction has not yet begun, that the NRC staff or the Commissioners, or the Presidential Commission -- I don't know -- is going to recommend something different be done, and that can be done for 4 and 5 that just is impractical to backfit on 1, 2, and 3.

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DR. SIESS: Okay.

DR. OKRENT: I'm not prepared to endorse anybody's proposal along these lines, but I can see advantages in having them the same. For example, operators are more likely to look at all the plants the same and not have a problem of misinterpreting -- also, maintenance men and so forth -- there are some advantages of that sort which I think are not trivial.

But until I know what the other things that people might have in mind are, I don't want to judge that it all goes one way. The decision is obvious, and anyway I want to see what the staff is going to recommend.

DR. SIESS: We can't defer a decision on Palo Verde 4 and 5 forever.

DR. OKRENT: But the staff isn't ready to give them a CP. They've said they're not.

DR. SIESS: But if we approve it now, there's a minimum of backfits to 1, 2, and 3. They couldn't get too far along before the President's Commission and the NRC decide what they want to do.

You know, as far as something that couldn't be done except for a plant that was under construction -- you can't quite visualize it except by moving it.

DR. SHEWMON: For a plant which is going to operate in 1987 or come back for an OL eight years down the pike, I don't see why we can't go ahead and write a letter saying we have reviewed it, we have looked it over and find that, by our current criteria, satisfactory, putting in the caveat that will cover anything else that will subsequently develop out of jl 5

Three Mile Island, if indeed some of the members of the committee think that is necessary.

But to sit he e, sort of month-to-month, saying, "Gee whiz, maybe we'll learn something more next week that will protect us," for a plant that's only going to go into proceedings for its hearings for construction, I have great difficulty understanding it.

DR. SIESS: Dave, I see your point.

Le me ask you something more specific. At what point in time would you think we would know what design 4 and 5 should go ahead on?

You mentioned the President's Commission. That's October.

DR. OKRENT: I was not proposing that we necessarily wait for the President's Commission report. But it seems to me we should know what the staff is going to recommend for 4 and 5.

DR. SIESS: I agree with that. I have already suggested -- and Ray has suggested -- that the staff come back with SER supplement on Palo Verde 4 and 5 before we right a letter.

Is that acceptable to you?

DR. OKRENT: Yes.

PROF. KERR: Only if the SER supplement tells what the staff is thinking.

DR. SIESS: Well, I believe that was implicit and explicit in Ray's statement.

MR. FRALEY: More important, what they plan to require, not necessarily what they're thinking.

MR. BAER: I guess I'd like to say, again, that our thinking thus far has been concentrated on the OL.

Dr. Mattson, yesterday, said he hopes to have a tentative list of short-term requirements for the OL plant about the first of July and then start thinking much more about the longer-term requirements -- I guess for all OLs and CPs.

So my guess, and it isn't much more than a guess at this point, is that it will be awhile before the staff comes back on a CP requirement simply by they way we'll set our priorities.

There's a lot of unknowns. NRR is to get approximately 25 additional people from Standards and Research to aid in this TMI crunch. There has, I guess, been congressional talk -- and I don't know to what extent there's been action -- of talking about a hundred more reviewers. No one seems to know whether they're from other agencies or not.

DR. SIESS: Bob, once the staff has said that they're going to come back with long-range changes, whatever the terms were, which would presumably apply to a plant like Palo Verde -- once they're on the record as saying we're going to have those sometime in July or August, or whatever, I don't see how, even with an ARCS letter, they can go to a hearing until they've come up with those changes and evaluated Palo Verde against them.

They've made a commitment that they can't get day one in a hearing without fulfilling it.

MR. BAER: Let me remind you that 10 minutes ago I said that we were much more interested in a letter on Sequoyah.

And I would like to go back and talk about the OLs, because our thinking is toward the OLs, not the CPs.

I think a hearing could start on some of the contentions; but I agree with you, I don't think a hearing could be completed until the staff defined exactly the changes they wanted on Palo Verde as resultant from Three Mile Island.

DR. SIESS: I don't think the committee wants to see any radioactivity generated at Sequoyah until they know what the staff wants to change on it.

DR. OKRENT: At levels higher than a few watts.

DR. SIESS: Well, radioactivity would make changes difficult. I didn't say energy.

DR. OKRENT: You said any.

DR. SIESS: Oh, yes.

MR. BAER: If I could follow up on one of Dr. Okrent's comments -- he said that the staff perhaps ought to come back to the committee on a generic basis. Again, I'm thinking of the OLs. It turns out just coincidentally that the first five -- the next five projected OLs are all Westinghouse, in this order: Salem, North Anna, Diablo Canyon, Sequoyah, and McGuire.

DR. SIESS: Ice condensor off the head injector.

MR. BAER: The last two, Sequoyah and McGruire, are in that category. The other three are not.

It may be possible to come back on a generic basis. I think certainly the staff's intent to keep the committee informed as to what our thinking is on the new requirements -- you see, I'm having trouble seeing Sequoyah as the issue. I foresee the first issue being Salem or maybe Three Mile Island 1, which I wanted to talk about and find out what the consensus of the committee is -- Salem 2, I'm sorry.

MR. BENDER: What about all the operating plants?

MR. BAER: Proceeding on the bulletins, yes; that's where the staff has put it's very priority, yes.

MR. BENDER: Nobody has said how long the operating plants could operate without responding to the lessons learned from Three Mile Island. And that seems to me to be the question the staff ought to be addressing first.

It looks to me like that's a century away.

MR. BAER: It seems to me that we have about 80 percent of the staff on the various task forces looking at that.

DR. LAWROSKI: Mr. Chairman, in order to get something done about this, I move that we take the suggestion made by Mr. Fraley, which is to the effect that we wait and obtain from the NRC the SER supplement for both Sequoyah --

DR. SIESS: Or a suitable generic.

DR. LAWROSKI: Yes, as far as Sequoyah is concerned.

And then we will proceed to continue our review and address the matter of preparing a letter.

DR. CARBON: That was on both Sequoyah and Palo Verde?

DR. LAWROSKI: Yes.

DR. CARBON: There's a motion.

DR. SIESS: I'll second the motion.

It doesn't cover all the subjects, but it'll cover part of it.

DR. LAWROSKI: The two that were raised.

DR. CARBON: Bill.

PROF. KERR: This would preclude any sort of communication on Sequoyah until we see its SER supplement.

DR. SIESS: By "communication," do you mean a letter from us to the Commission? Is that what you mean by the "communication"?

PROF. KERR: Any letter which would permit TVA, perhaps, to go ahead with something or other if they have to have a letter from us to go ahead.

DR. SIESS: The motion addresses an operating license, I believe.

MR. BENDER: Mr. Chairman, I can't see the virtue of voting.

DR. LAWROSKI: Help for Sequoyal on the CP and Palo Verde 4 and 5.

DR. CARBON: Mike has the floor.

MR. BENDER: Mr. Chairman, I can't see the virtue of voting on such a motion. It doesn't settle anything. It only establishes a level of procrastination based on a lack of any information about what the staff is going to do. If we don't want to do anything, let's don't do anything. But why take a vote that decides not to do anything until the staff puts out a piece of paper that we'll probably be totally dissatisfied with?

DR. SIESS: I disagree, Mike, because what we're trying to say is that we're not going to do anything now about those letters, and we're telling the staff under what circumstances we will do something about it. And I think it is extremely helpful.

And I'd like to suggest, Mr. Chairman, that we table the motion for the time being, we think it over tonight, and come back tomorrow and reach a decision on Palo Verde, construction permit letter; on Sequoyah, operating license letter; and on what further review this committee wants to make for

for operating licenses on plants that we have previously written a letter on, and communicate that information to the Commission, tell them just what part we want to play in licensing over the next few months.

And I think we owe that to the Commission, and we owe that to the staff, whether it's yes or no. It can't be maybe. We'd need to tell them what we want from them and let them know that the Licensees know where they stand. I don't see how we can do less.

We can do less, but I think it's unconscionable.

PROF. KERR: Was that suggestion a motion to table?

DR. SIESS: I second it.

Can I move to table?

DR. OKRENT: I'll move to table.

PROF. KERR: I second the motion to table.

DR. CARBON: That takes precedence.

DR. SIESS: Undebatable.

All in favor?

DR. OKRENT: I discuss it.

(Laughter.)

DR. CARBON: All in favor, indicate by hands.

(Show of hands.)

DR. CARBON: It's carried.

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DR. SIESS: I move to adjourn.

MR. BAER: May I introduce yet another subject for your deliberation?

Mr. Fraley asked me what the staff's plans were regarding Three Mile Island 1, to start off. And I guess, based on a couple of telephone calls I made last night, it's going to end up bouncing the question back to the committee.

Right now the staff, unless directed by the committee, would not be coming back specifically asking the committee's permission to have Three Mile Island 1 reviewed before starting up. But we certainly would be willing to do so if the committee so desires.

Now, the schedule situation -- if the Applicant had his druthers, the Applicant would be starting on Three Mile Island 1 in mid-August.

We've already told them that that's a very optimistic schedule. They will be coming in to talk to the staff toward the end of June as to what plant -- specifically what plant changes and what procedural changes they will be making.

We're then coming in -- starting to talk to us toward the end of June on specific items. There'll be no way that we'd be prepared to come to the committee for the July meeting. August would be the earliest meeting, and there we wouldn't be having a written SER a month in advance. 537 314

DR. OKRENT: When would you have an SER?

MR. BAER: If we concur with the mid-August start-up, it would probably be about the first of August, I would think would be a reasonable estimate.

DR. OKRENT: Mr. Chairman, I have the feeling that Three Mile Island 1 is a little bit special.

DR. SIESS: It's going to be the safest operating plant there is.

(Laughter.)

DR. OKRENT: I hope so.

And I know we did not look at the restarting of the other B&W plants, but I don't think this is the same for several reasons. So I would suggest that if the committee agrees that it can arrange, at a minimum, a subcommittee review, with the possibility of a full committee, I really think it would be better, myself, to just schedule the two of them for the August meeting.

DR. CARBON: August or July?

DR. OKRENT: They won't be ready for July, so that's out.

PROF. KERR: I agree with Dr. Okrent. They might feel neglected if we didn't invite them to come.

DR. MARK: The subcommittee could be before the August meeting.

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DR. OKRENT: If they're ready August 1, the subcommittee could be a day or two before the August meeting. That's right.

DR. CARBON: There's appears to be a consensus on that. Heads are shaking "yes."

Is that agreeable?

(No response.)

DR. CARBON: Hearing no objections, I guess yes.

DR. OKRENT: I assume this is Harold Etherington's subcommittee.

PROF. KERR: Move to adjourn, or is that not yet in order?

DR. CARBON: Let me just ask one quick question before we do.

Is there anything that either Harold or Dave can -- on behalf of letters or comments on Three Mile Island, that they believe we urgently need to do tonight?

If not, we will adjourn.

DR. MARK: Is there anything we need from the staff?

DR. CARBON: I don't believe so.

DR. OKRENT: I wasn't here yesterday. I apologize. My daughter was graduating from high school. That took priority.

I don't know whether there is some expectation of preparing letter number 4, or whatever.

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DR. CARBON: We've had no discussion.

DR. OKRENT: Well, then I would only say if the members have items that they think should -- or consultants have items that they think should be in a possible interim letter number 4, if they have them ready, I'd like to get them. If not, they should have them tomorrow morning, otherwise --

PROF. KERR: You've seen the letter from Field and the letter from Ivan, have you not?

DR. OKRENT: I've seen those two.

MR. ETHERINGTON: Is there a clear indication to write letters?

DR. OKRENT: He's uncertain at the moment.

That's why I think it depends --

MR. ETHERINGTON: Whether there's anything to write about.

DR. OKRENT: That's my point.

DR. CARBON: Let us adjourn till morning.

(Whereupon, at 6:30 p.m, the hearing adjourned.)

end t25

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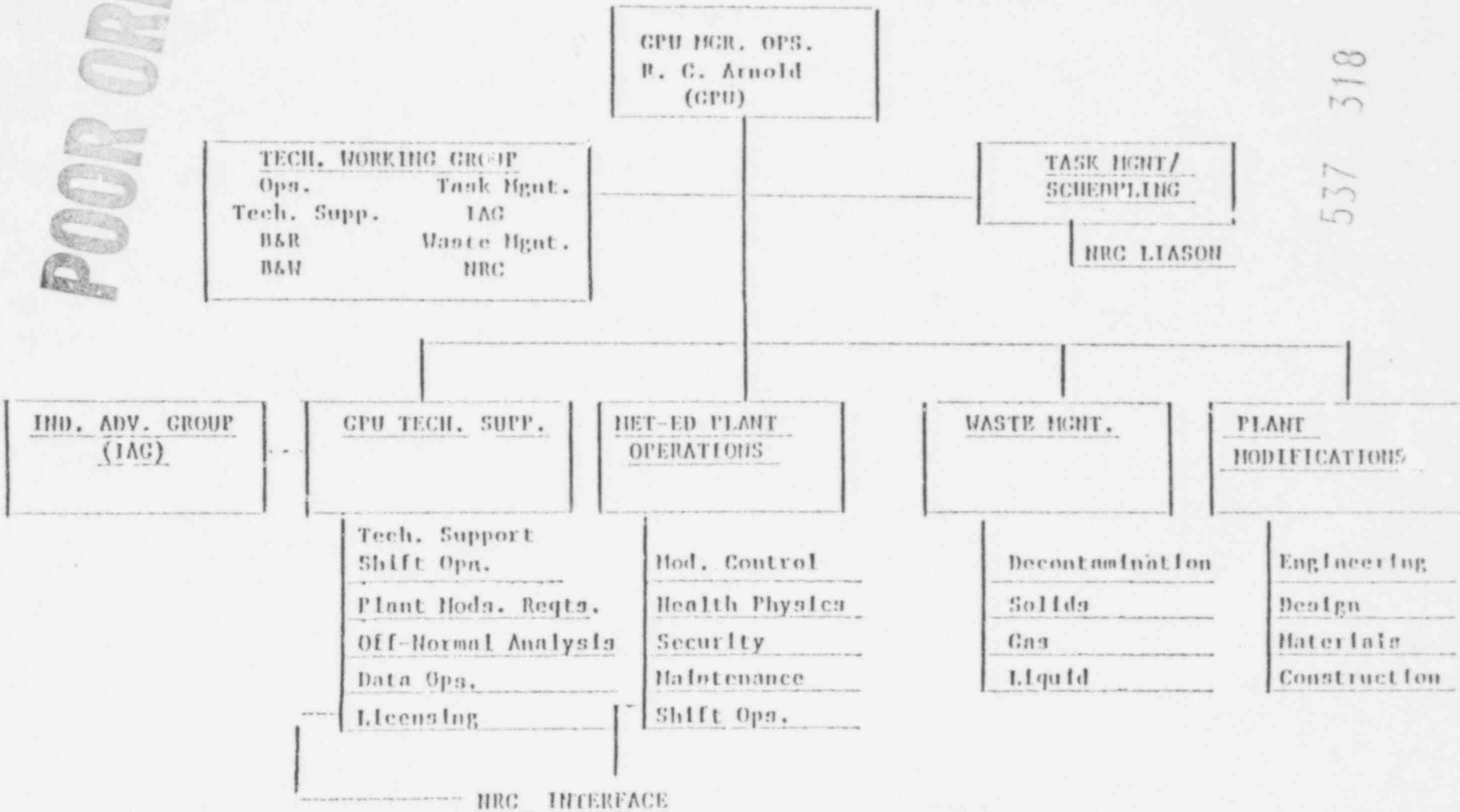
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R. C. Arnold
(GPU)
TECH. WORKING GROUP
Ops.
Task Mgmt.
Tech. Supp.
IAG
B&R
Waste Mgmt.
B&W
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SCHEDULING
NRC LIASON
IND. ADV. GROUP
(IAG)
GPU TECH. SUPP.
Tech. Support
Shift Ops.
Plant Mods. Reqts.
Off-Normal Analysis
Data Ops.
Licensing
MET-ED PLANT
OPERATIONS
Mod. Control
Health Physics
Security
Maintenance
Shift Ops.
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PLANT
MODIFICATIONS
Engineering
Design
Materials
Construction
NRC INTERFACE

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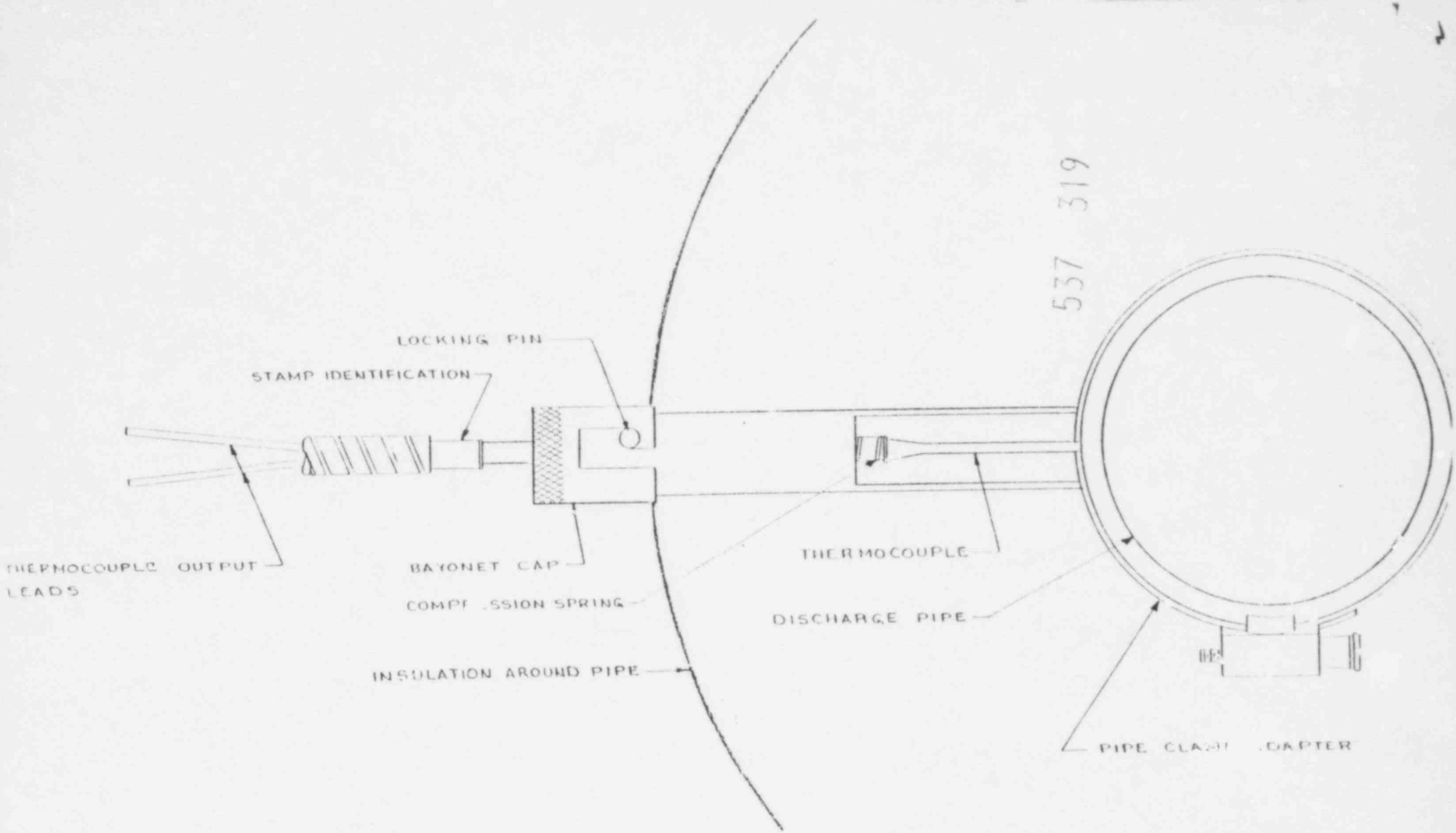
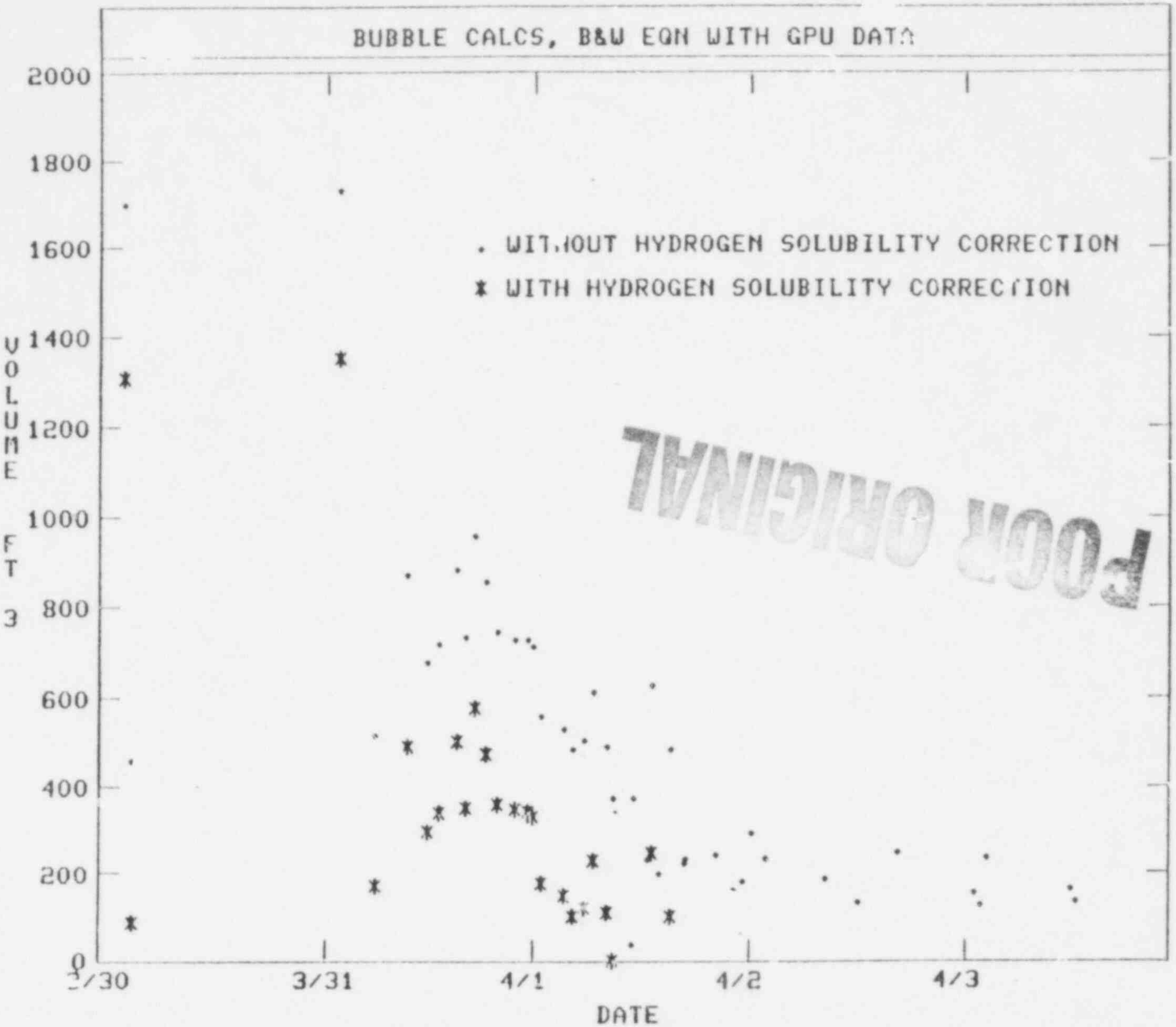


537 319

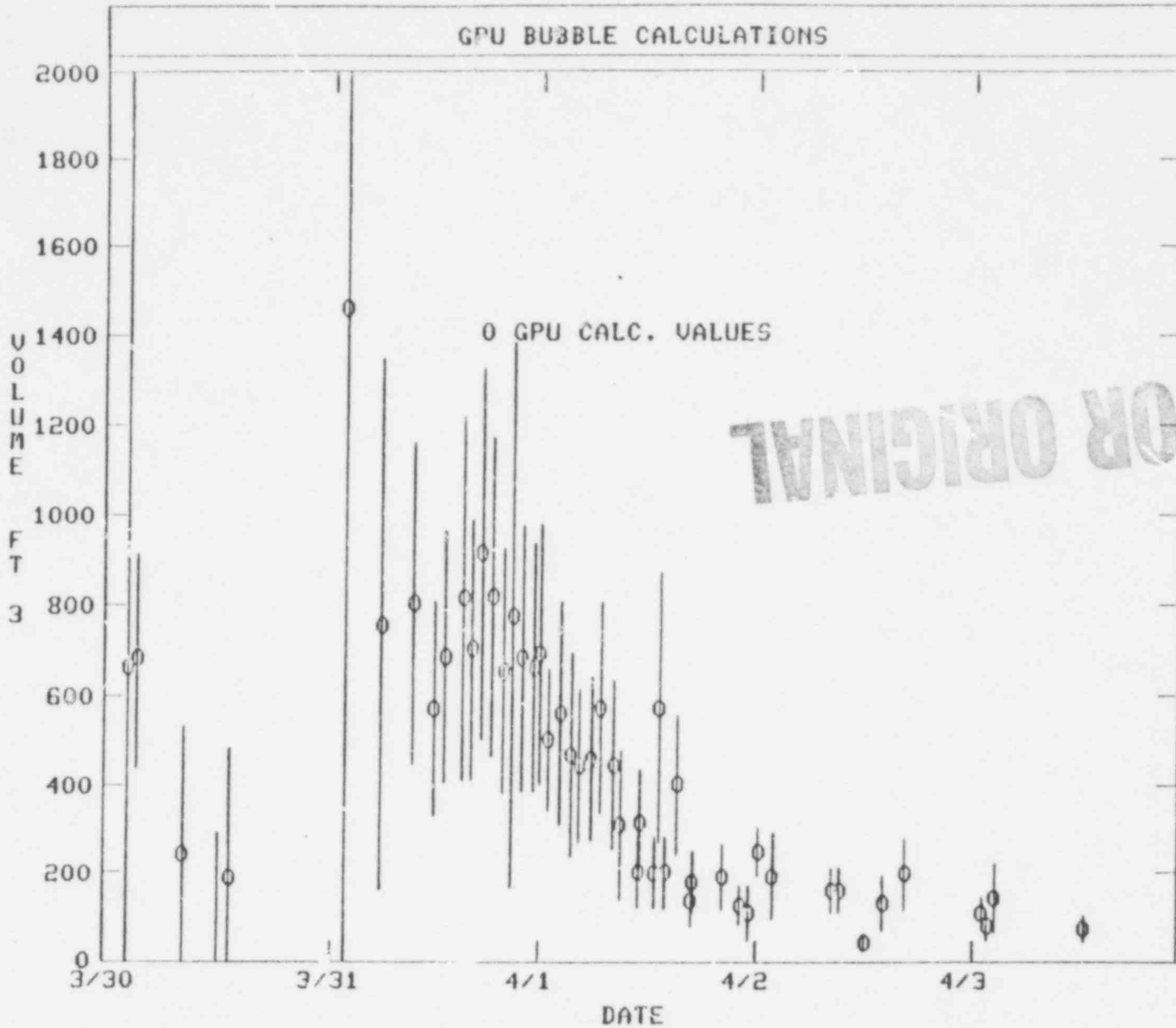
MOUNTING DETAILS FOR RC10-TE1

PRESSURIZER ELECTROMATIC RELIEF VALVE
DISCHARGE TEMPERATURE MEASUREMENT

POOR ORIGINAL


BUBBLE CALCS, B&W EQN WITH GPU DATA
. WITHOUT HYDROGEN SOLUBILITY CORRECTION
* WITH HYDROGEN SOLUBILITY CORRECTION
VOLUME FT 3
2000
1800
1600
1400
1200
1000
800
600
400
200
0
3/30
3/31
4/1
4/2
4/3
DATE

537 320


GPU BUBBLE CALCULATIONS
0 GPU CALC. VALUES
VOLUME FT 3
2000
1800
1600
1400
1200
1000
800
600
400
200
0
3/30
3/31
4/1
4/2
4/3
DATE

537 32

ERROR ANALYSIS

$$V_1 = fn\ (P_1,\ P_2,\ \Delta L^{mut},\ \Delta L^{pzr})$$

$$\sigma^2_{vi} = \sum_{i=1}^{4} \sigma^2_{x\,i} \left(\frac{\partial\ Vi}{\partial\ Xi} \right)^2$$

- Errors of instruments

Pressure Readings	± 0.3%
MUT Level readings	± 0.3%
PZR Level Readings	± 0.6%

Temper[illegible] correction of specific volume of RCS was neglected due to small ΔT during readings (max. 1°F).

- No correction for H_2 solubility change as function of Pressure was made in GPU analysis.

322

DETERMINATION OF VOLUME CHANGE

V = CHANGE IN VOLUME OF WATER IN THE PRESSURIZER AND MAKE UP TANK CORRECTED FOR THE DIFFERENCE IN SPECIFIC VOLUME FROM THAT IN THE REACTOR COOLANT SYSTEM.

THUS, $\Delta V = \Delta V_P + \Delta V_{MUT} + \Delta V_{N_2}$ SOLUBILITY*

WHERE, ΔV_P = CHANGE IN VOLUME OF WATER IN PRESSURIZER EXPRESSED IN FT^3 OF WATER AT THE TEMPERATURE OF THE REACTOR COOLANT SYSTEM

ΔV_{MUT} = CHANGE IN VOLUME OF WATER IN THE MAKEUP TANK EXPRESSED IN FT^3 OF WATER AT THE TEMPERATURE OF THE REACTOR COOLANT SYSTEM.

*NOT CONSIDERED IN GPU FORMULATION

SUMMARY OF RCS BUBBLE CALCULATION METHODS

$$P_1 V_1 = P_2 V_2$$

WHERE P_i = RCS PRESSURE AT TIME i
V_i = RCS GAS BUBBLE VOLUME AT TIME i

$$V_2 = V_1 + \Delta V$$

WHERE ΔV = CHANGE IN GAS BUBBLE VOLUME FROM TIME 1 TO TIME 2

COMBINING THESE EQUATIONS:

$$V_1 = \frac{P_2 \Delta V}{P_1 - P_2}$$

537 324

CONDITIONS FOR LOSS OF NATURAL CIRCULATION

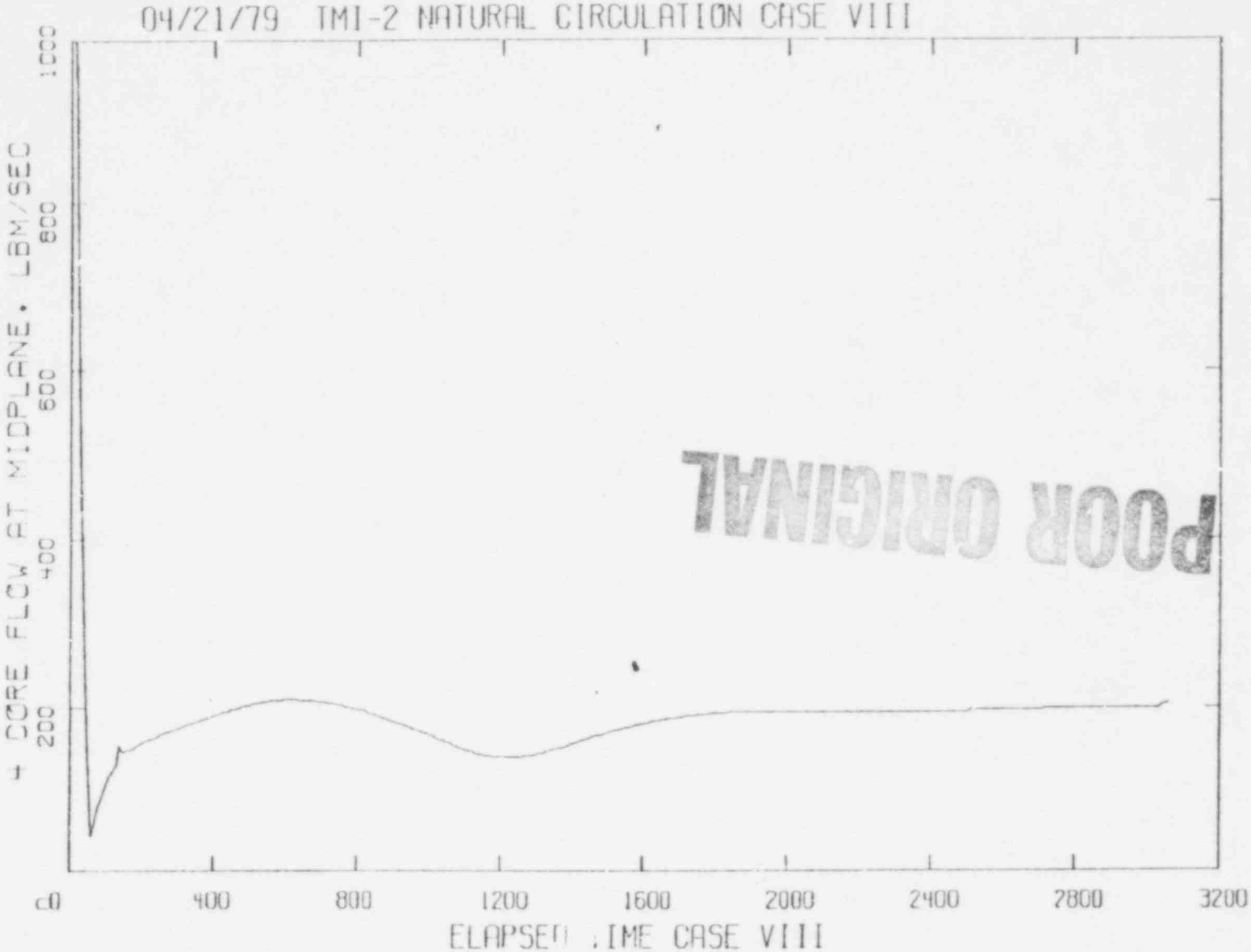
GAS AT HIGH POINT OF LOOPS

- NONCONDENSIBLE BUBBLE
- STEAM FORMATION AND COLLECTION

STEAM GENERATOR OPERATION

- TOO LOW WATER LEVEL IF STEAMING
- TOO LOW FLOW IF SOLID

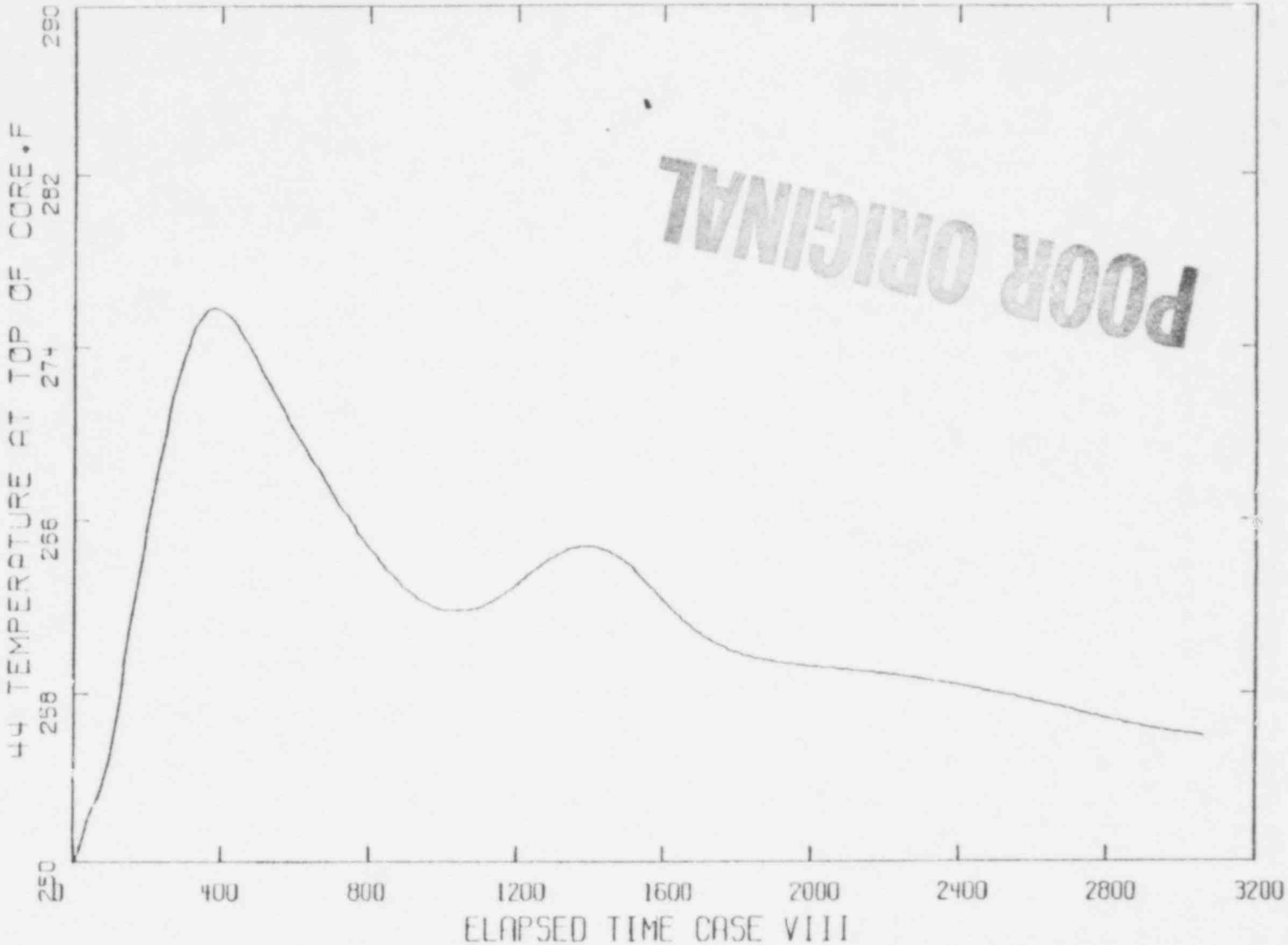
537 325



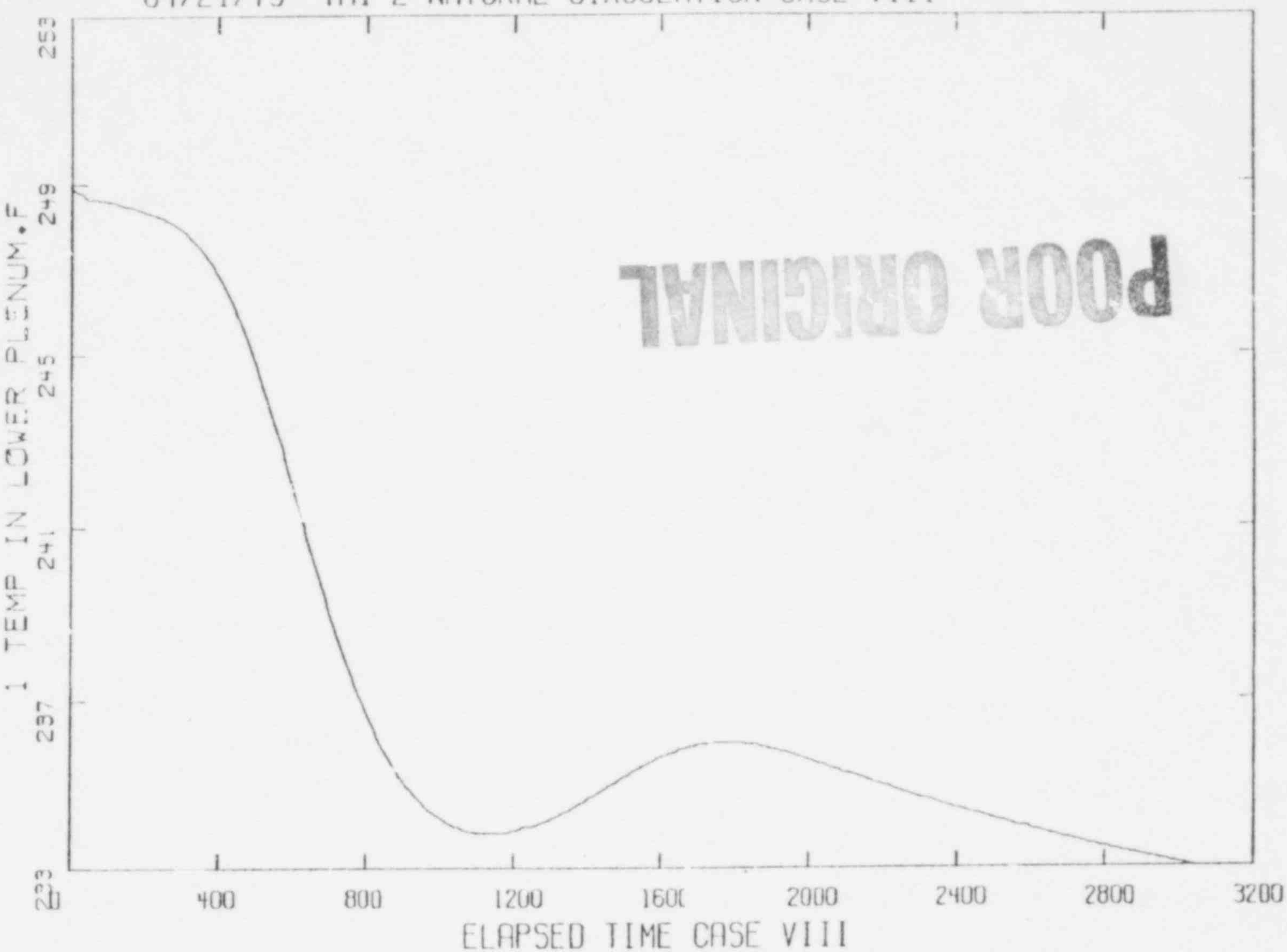
04/21/79 TMI-2 NATURAL CIRCULATION CASE VIII
+ CORE FLOW AT MIDPLANE, LBM/SEC
1000
800
600
400
200
0
400
800
1200
1600
2000
2400
2800
3200
ELAPSED TIME CASE VIII

537 326

04/21/79 TMI-2 NATURAL CIRCULATION CASE VIII



04/21/79 TMI-2 NATURAL CIRCULATION CASE VIII



537 328

POSSIBLE GENERIC IMPROVEMENTS

537 329

13

POSSIBLE IMPROVEMENTS TO OPERATIONAL INSTRUMENTATION

IN-CORE THERMOCOUPLES (EXPANDED NUMBER)

ADDED THERMOCOUPLES ON REACTOR COOLANT SYSTEM COMPONENTS

ACTUAL VALVE POSITION INDICATORS ON CRITICAL VALVES

POSITION INDICATORS ON RELIEF AND SAFETY VALVES

FLOW INDICATION DOWNSTREAM ON RELIEF AND SAFETY VALVES

SATURATION PRESSURE MONITOR AND ALARM

REACTOR VESSEL AND STEAM GENERATOR (PRIMARY SIDE) LEVEL (TO BE EVALUATED)

ON LINE BORON MONITOR

RADIATION MONITORS FOR CONTAINMENT ISOLATION

HYDROGEN CONCENTRATION AT RECOMBINER INLET

ADDED PERMISSIVE INTERLOCKS

EXPANDED USE OF NO.SE ANALYSIS

537 330

POSSIBLE ADDITIONAL DIAGNOSTIC EQUIPMENT

EXPANDED RANGE READOUTS ON PRIMARY INSTRUMENTATION

PROTECTION OF INSTRUMENTATION AGAINST POTENTIAL ACCIDENT ENVIRONMENTS

AREA RADIATION MONITORS - EXPANDED COVERAGE
- EXPANDED RANGES

IMPROVED SAMPLING CAPABILITY - AIR SPACES
- SUMPS

REMOTE TV MONITORS FOR CRITICAL PLANT LOCATIONS

HIGH SPEED COMPUTER MONITORING AND RECORDING OF ALL SIGNIFICANT PLANT PARAMETERS

POSSIBLE IMPROVEMENTS TO COMPUTER CAPABILITY

537 331

REDUNDANT SYSTEMS

LARGER/FASTER CPU

FASTER PRINTERS

EXPANDED USE OF CRT's

- COLOR CODING
- ALARM PRIORITIZATION
- PARAMETER TRENDING
- GRAPHIC DISPLAYS

EXPANDED HISTORICAL DATA FILES

POSSIBLE IMPROVEMENTS TO EQUIPMENT DESIGN

LARGER PRESSURIZER

MORE EXTENSIVE AND SELECTIVE CONTAINMENT ISOLATION SYSTEM

IMPROVED HUMAN ENGINEERING OF CONTROL ROOMS

HIGHER SETPOINT FOR STEAM GENERATOR LEVEL AFTER TRIP

537 332

SUBJECT -----------

MET-ED NUCLEAR EXPERIENCE

	No. of Employees with Experience	Years Experience	Average (Yrs/Emp.)
TMI			
Station Manager and Staff	4	62	15.5
Operations	142	877	6.2
Technical Support	26	150	5.8
Rad. Protection & Chemistry	39	262	6.7
Maintenance	112	692	6.2
Quality Control and Administration	17	186	10.9
Training	6	80	13.3
Subtotal	346	2309	6.7
Other Than TMI			
Corp. Tech. Support Staff	13	95	7.3
Fossil Generating Stations	3	28	9.3
Subtotal	16	123	7.7
TOTAL	362	2432	6.7

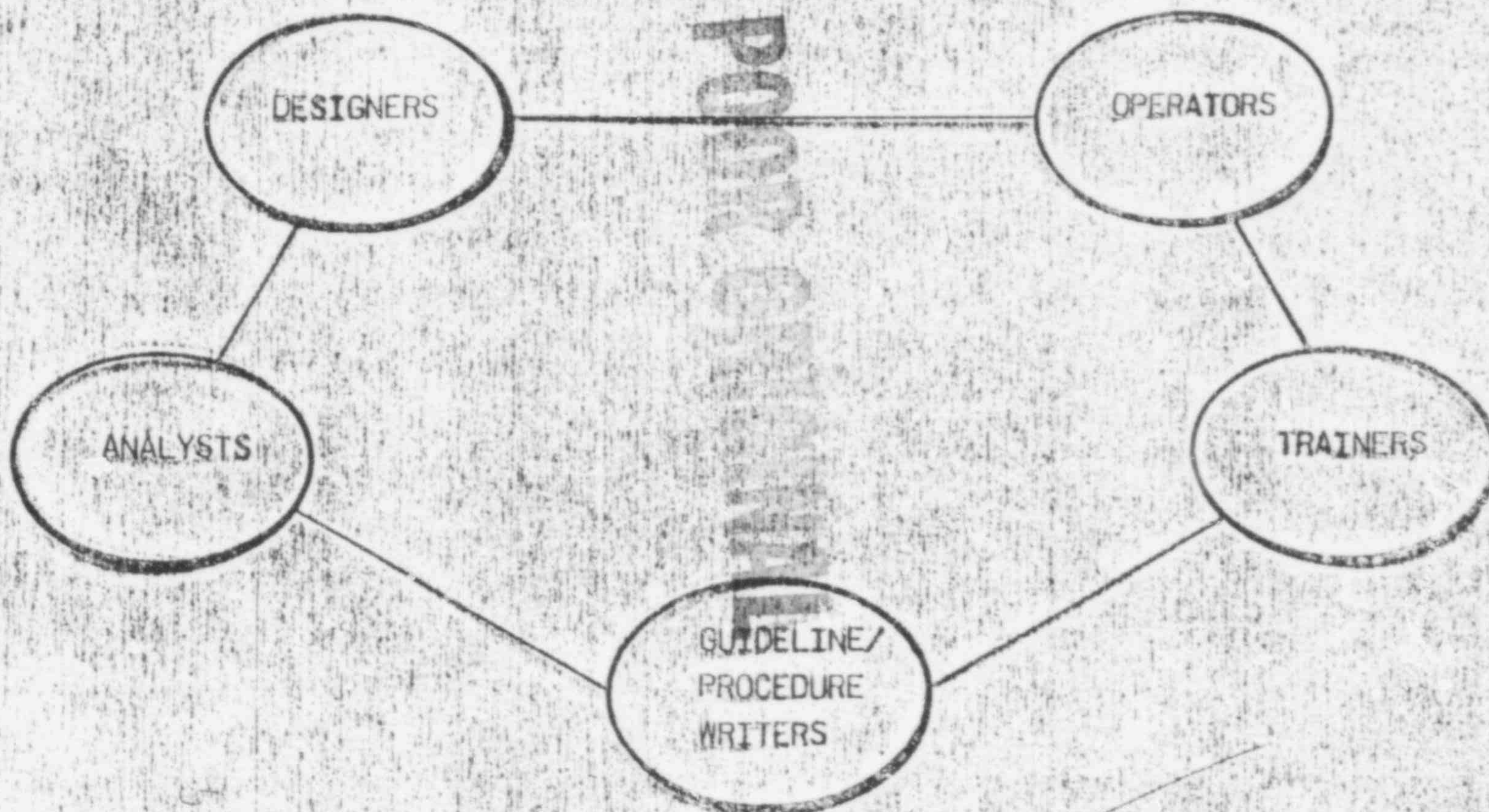
537 333

NOTES

GPU NUCLEAR EXPERIENCE

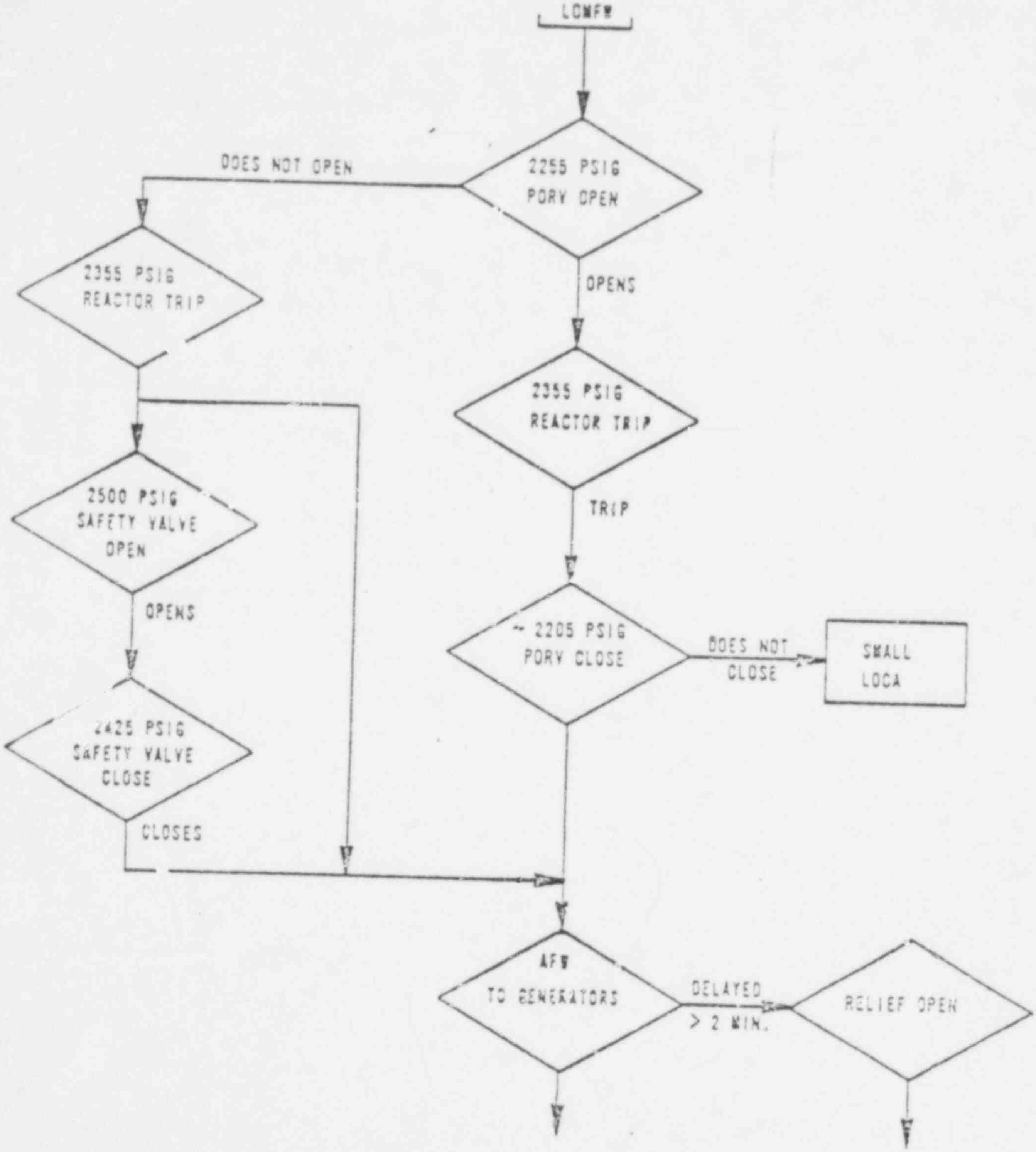
	No. of Employees with Experience	Years Experience	Avg. Years Nuc. Exp
TECHNICAL FUNCTIONS	128	1835.5	14
PRODUCTIVITY	3	46	15
CORP. PLANNING	10	115	11.5
GENERATION OPERATIONS	6	93	15.5
PROJECTS GROUP	19	649	24
ENVIRONMENTAL AFFAIRS GROUP	5	75.5	15
TOTALS	171	2614	15

Closing the loop
(Key participants)



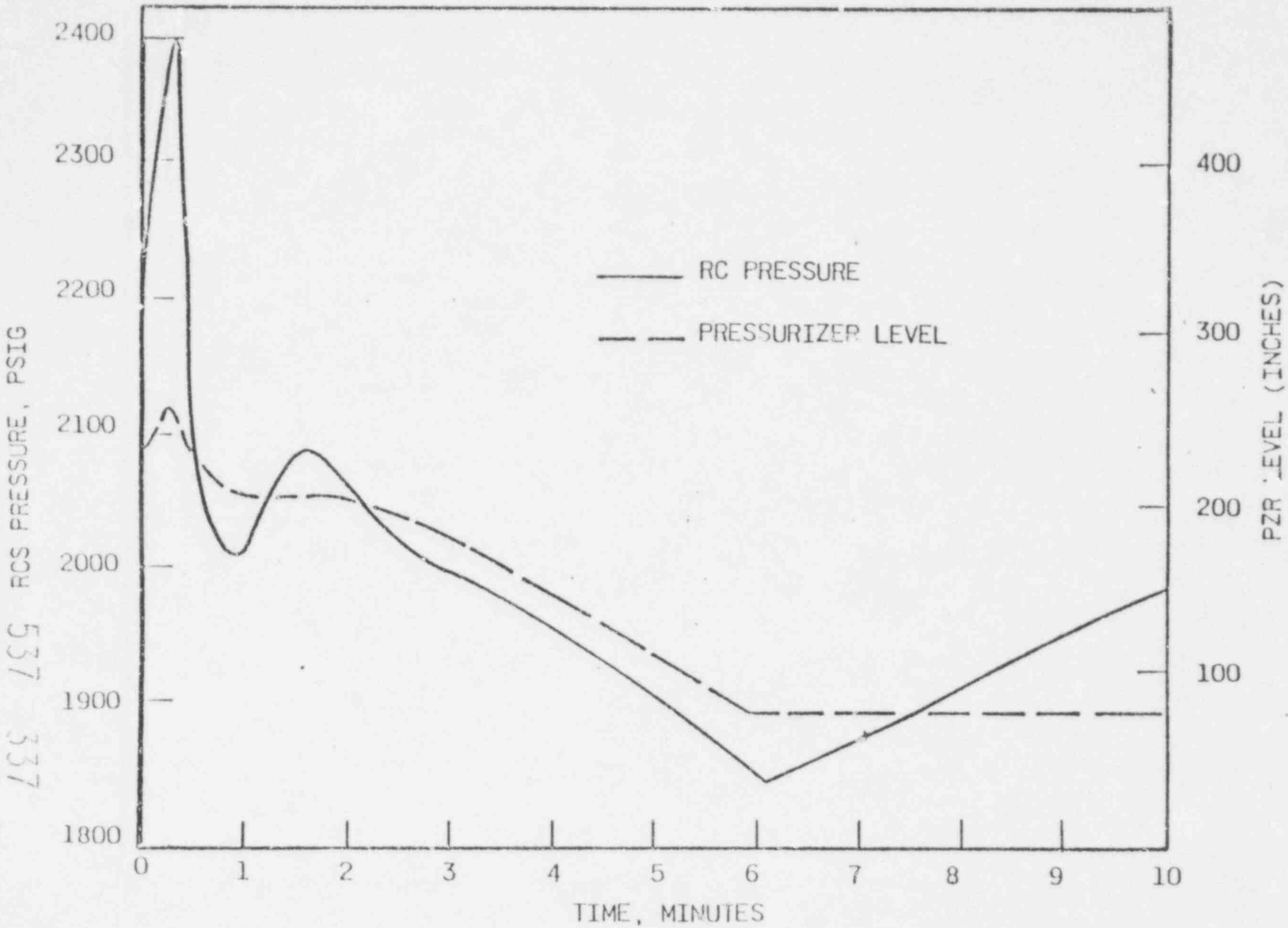
LOSS OF MAIN FEEDWATER
(SYSTEM RESPONSE PRIOR TO 4/21/79)

③



537 336

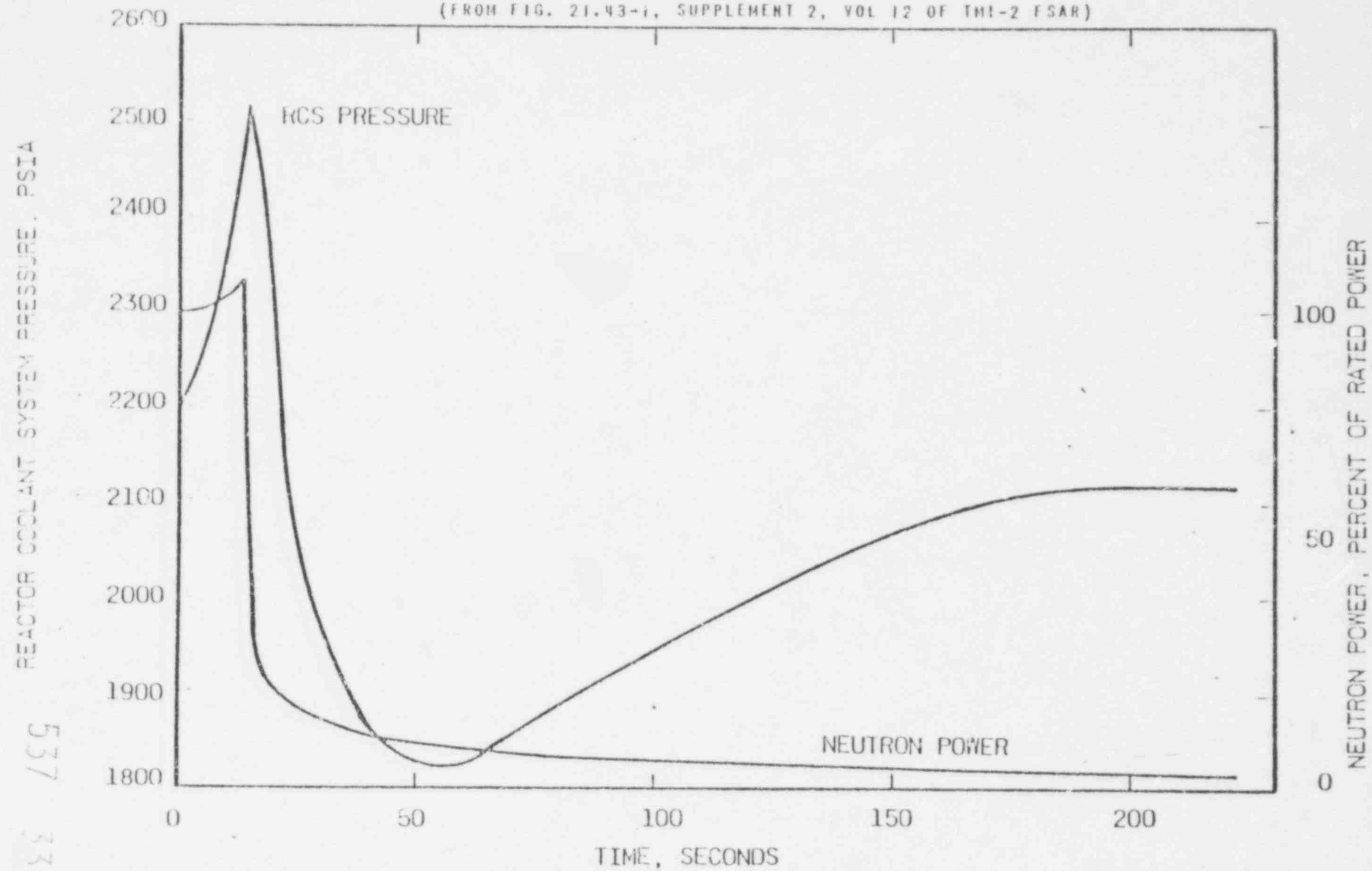
EXPECTED NOMINAL SYSTEM BEHAVIOR FOR LOSS OF MAIN FEEDWATER, BEFORE SETPOINT ADJUSTMENTS OF 4/21/79



537 337

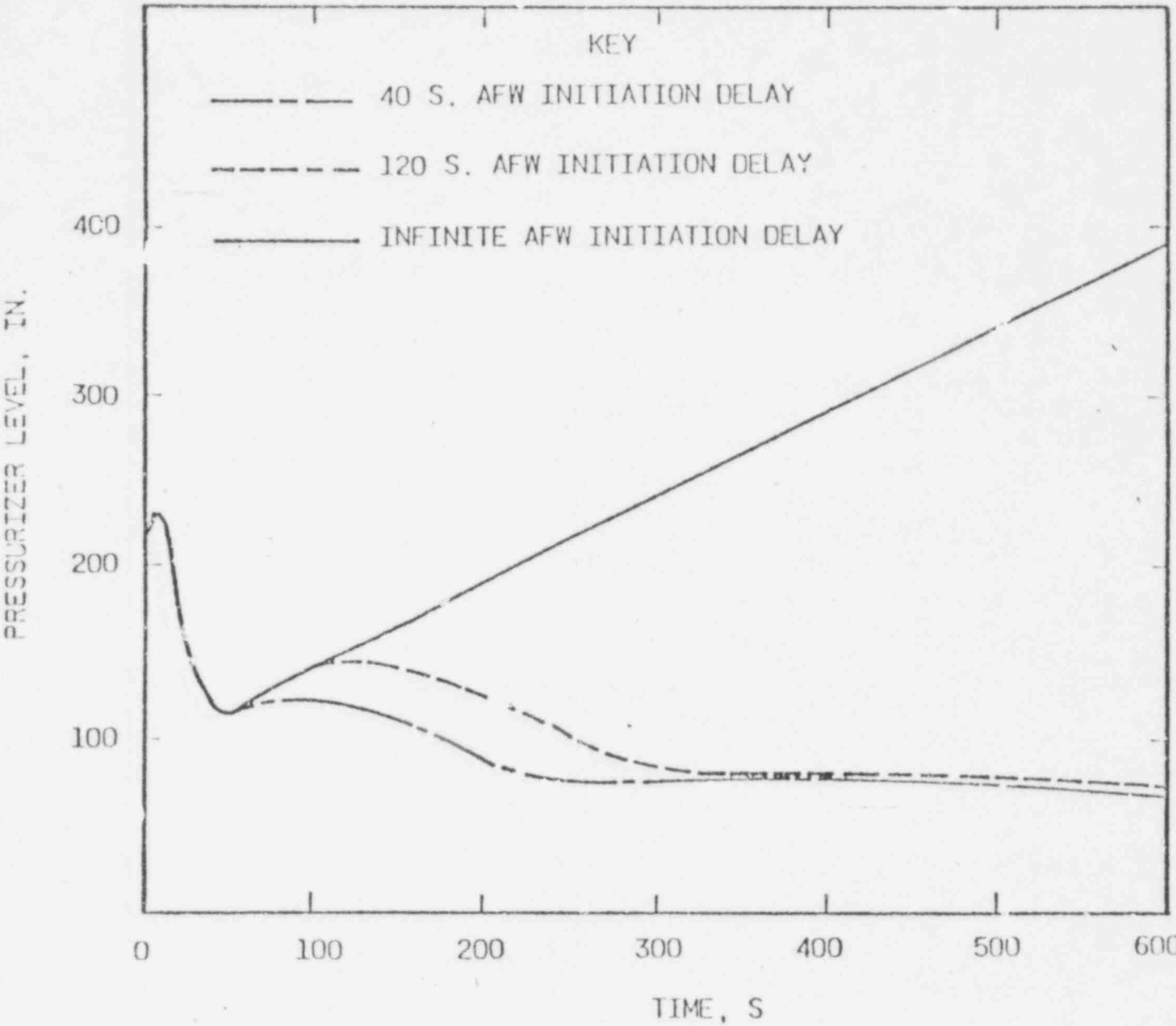
LOSS OF MAIN FEEDWATER EVENT-CONSERVATIVE FSAR ANALYSIS

(FROM FIG. 21.43-1, SUPPLEMENT 2, VOL 12 OF TMI-2 FSAR)



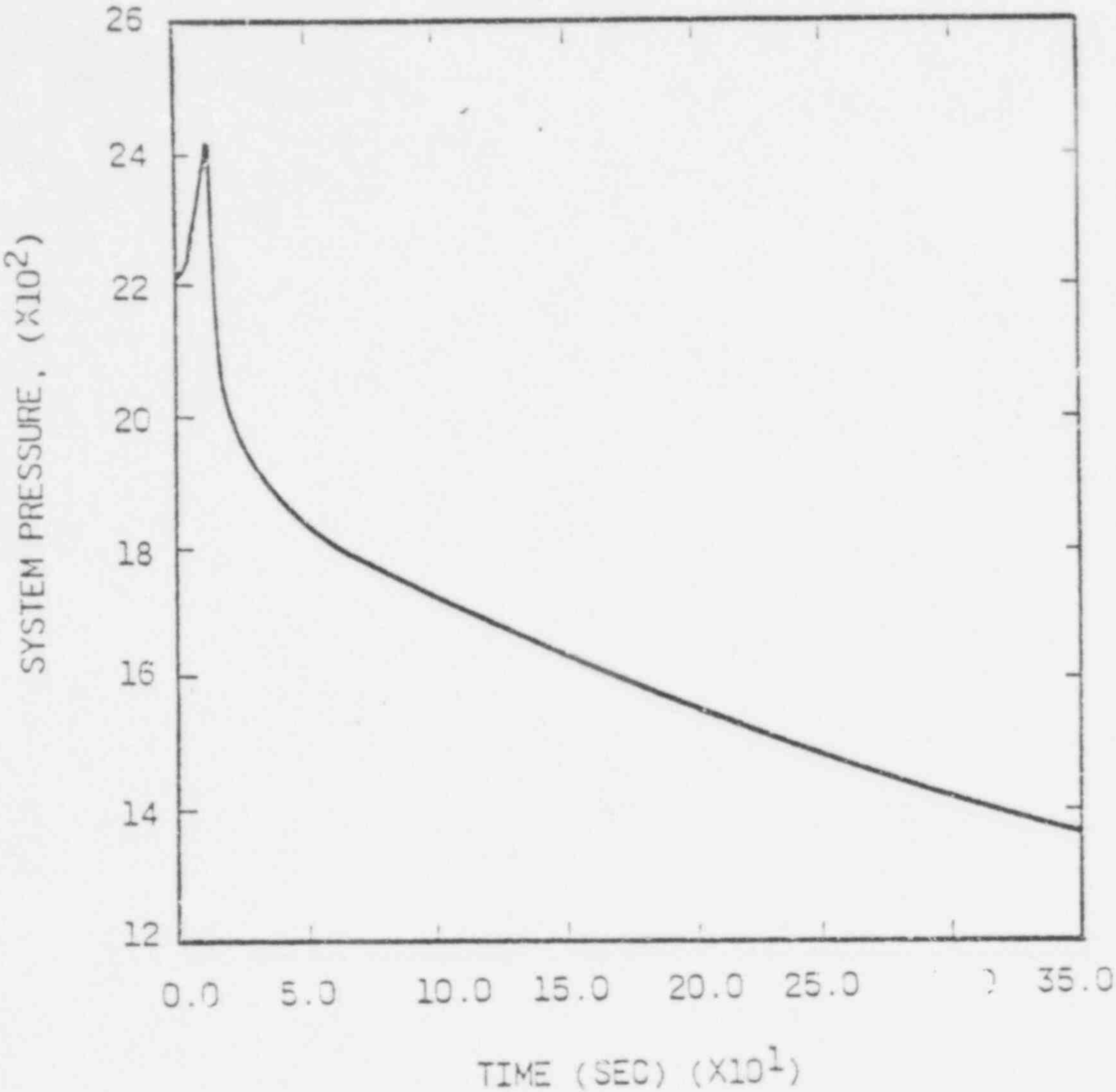
537 338

SENSITIVITY OF PRESSURIZER LEVEL BEHAVIOR TO DELAY IN AUXILIARY FEEDWATER INITIATION



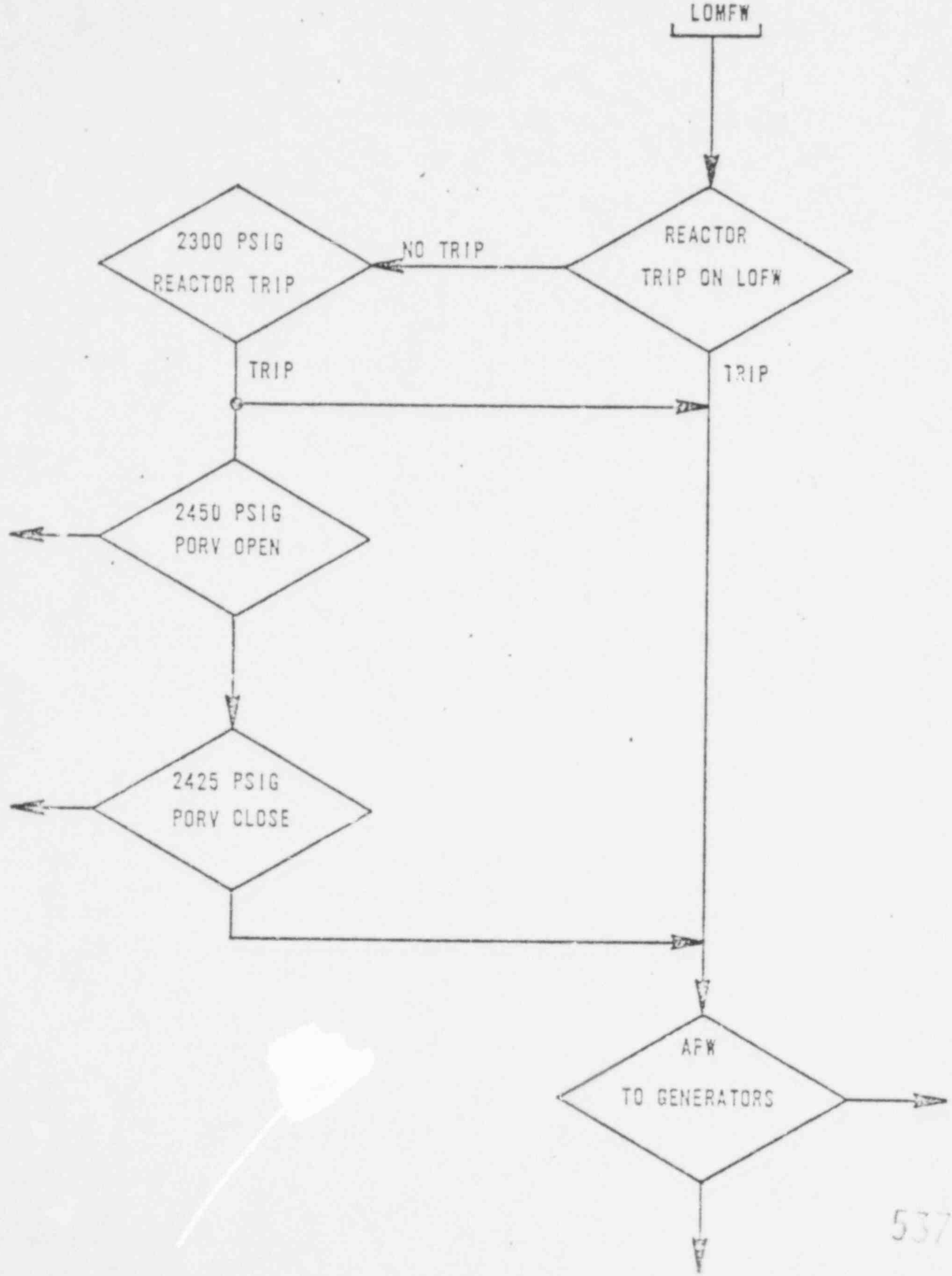
537 339

SYSTEM PRESSURE TRANSIENT
FOLLOWING LOSS OF MAIN FEEDWATER
AT TMI-2, 3/28/79



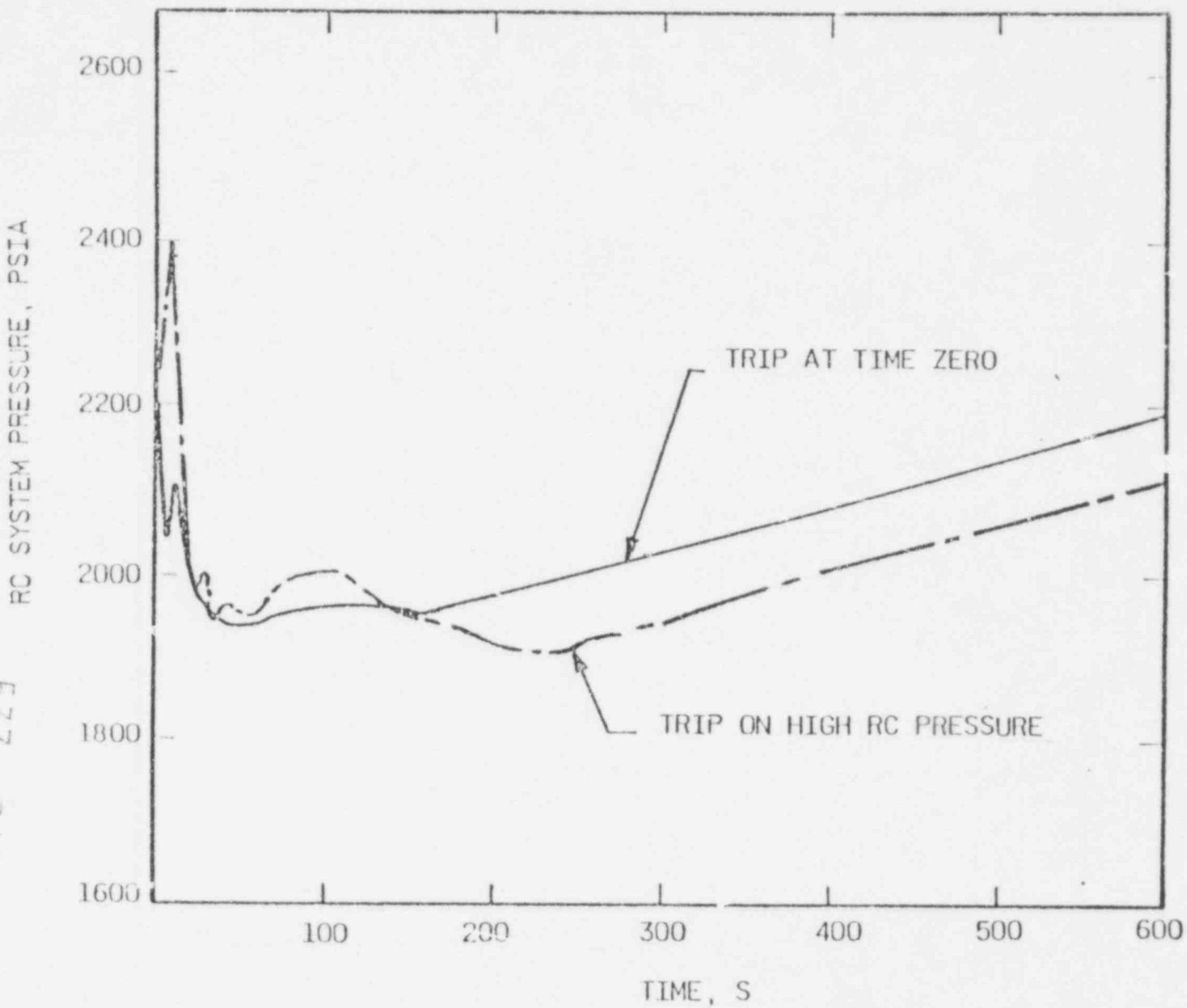
537 340

LOSS OF MAIN FEEDWATER
(SYSTEM RESPONSE AFTER 4/21/79)

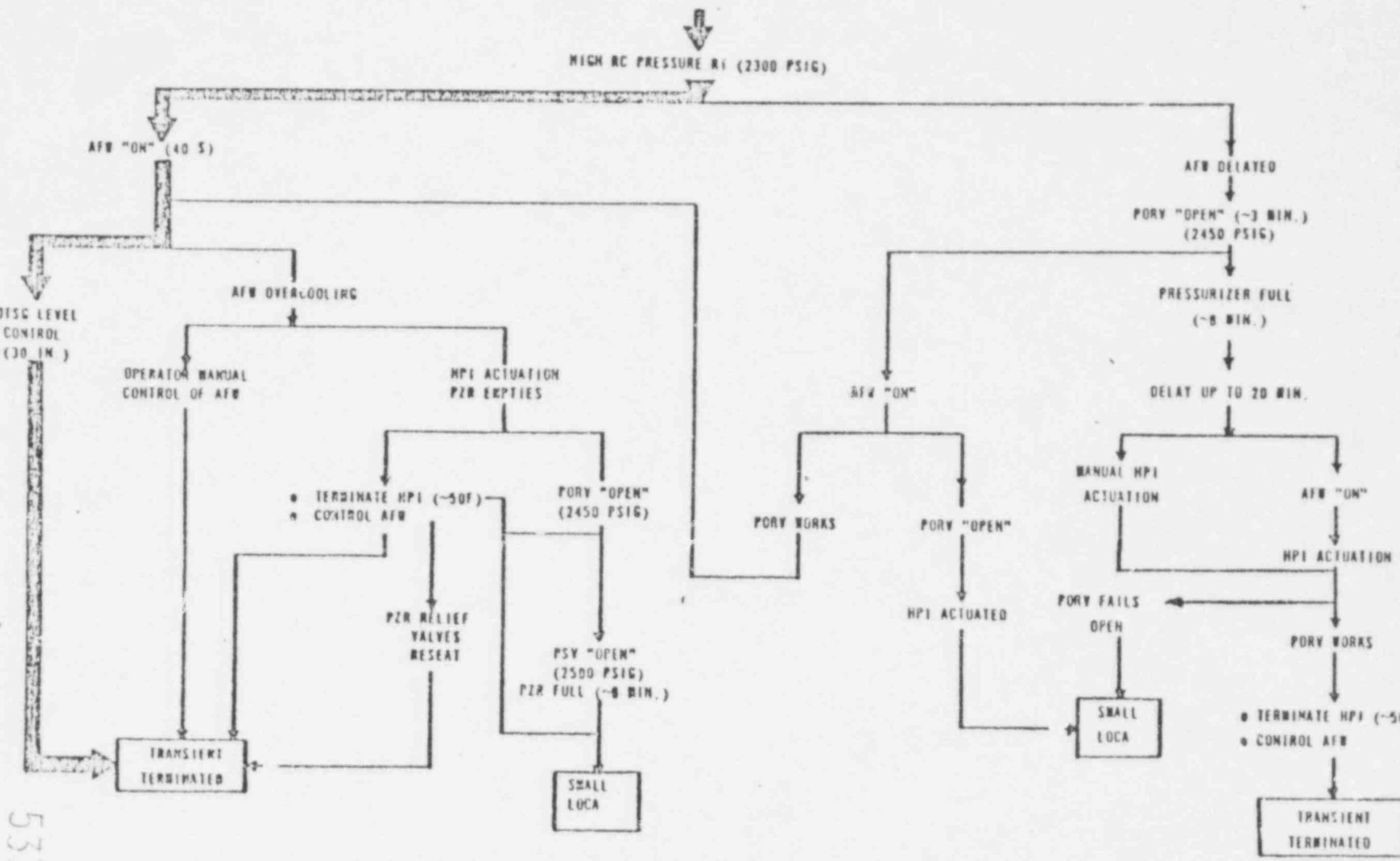


537 341

EXPECTED SYSTEM PRESSURE BEHAVIOR (NOMINAL) FOR TRIP AT TIME ZERO AND TRIP ON HIGH RCS PRESSURE



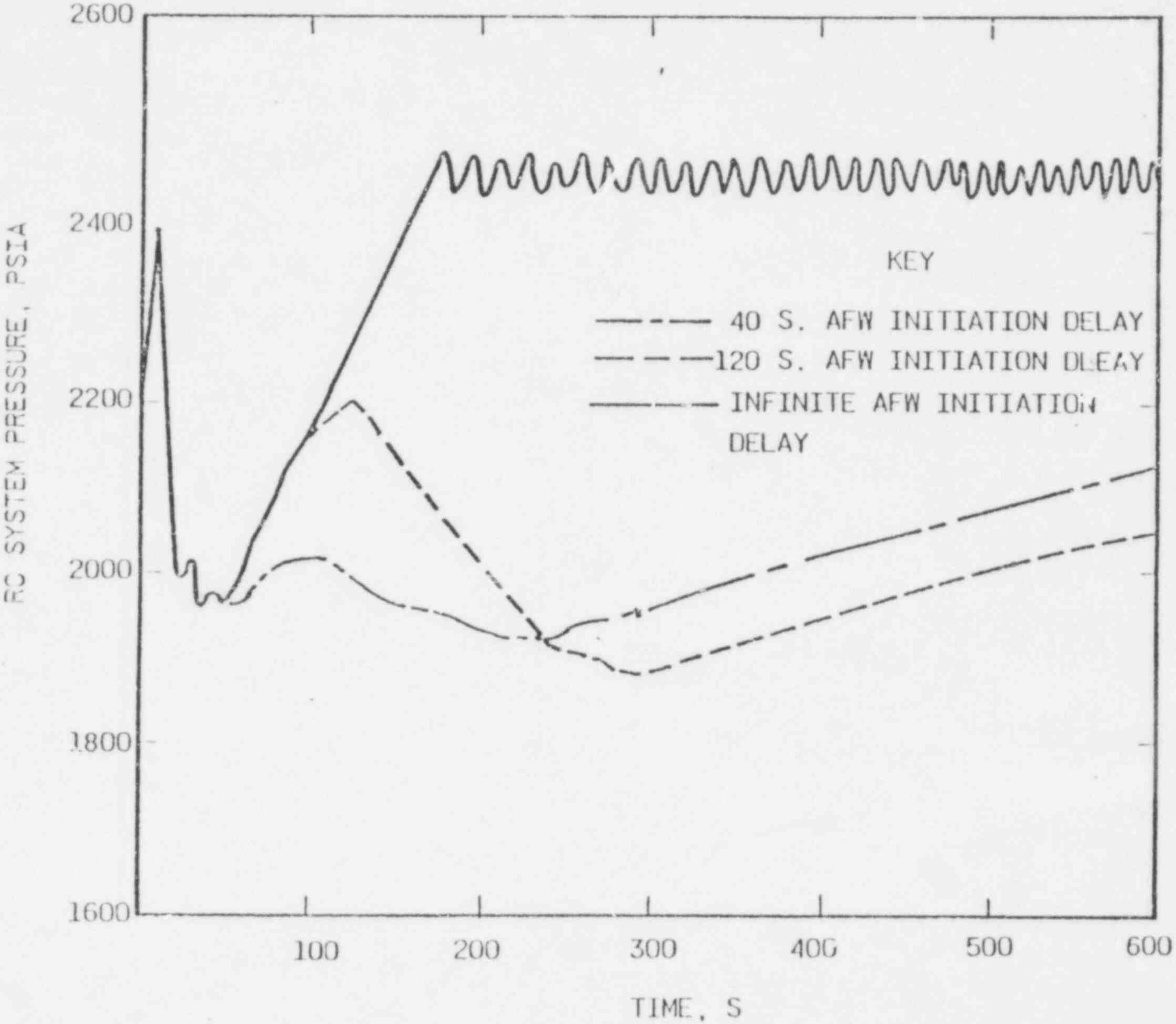
537 342



EVENT TREE FOR LOSS OF MAIN FEEDWATER WITH RC PUMPS AVAILABLE

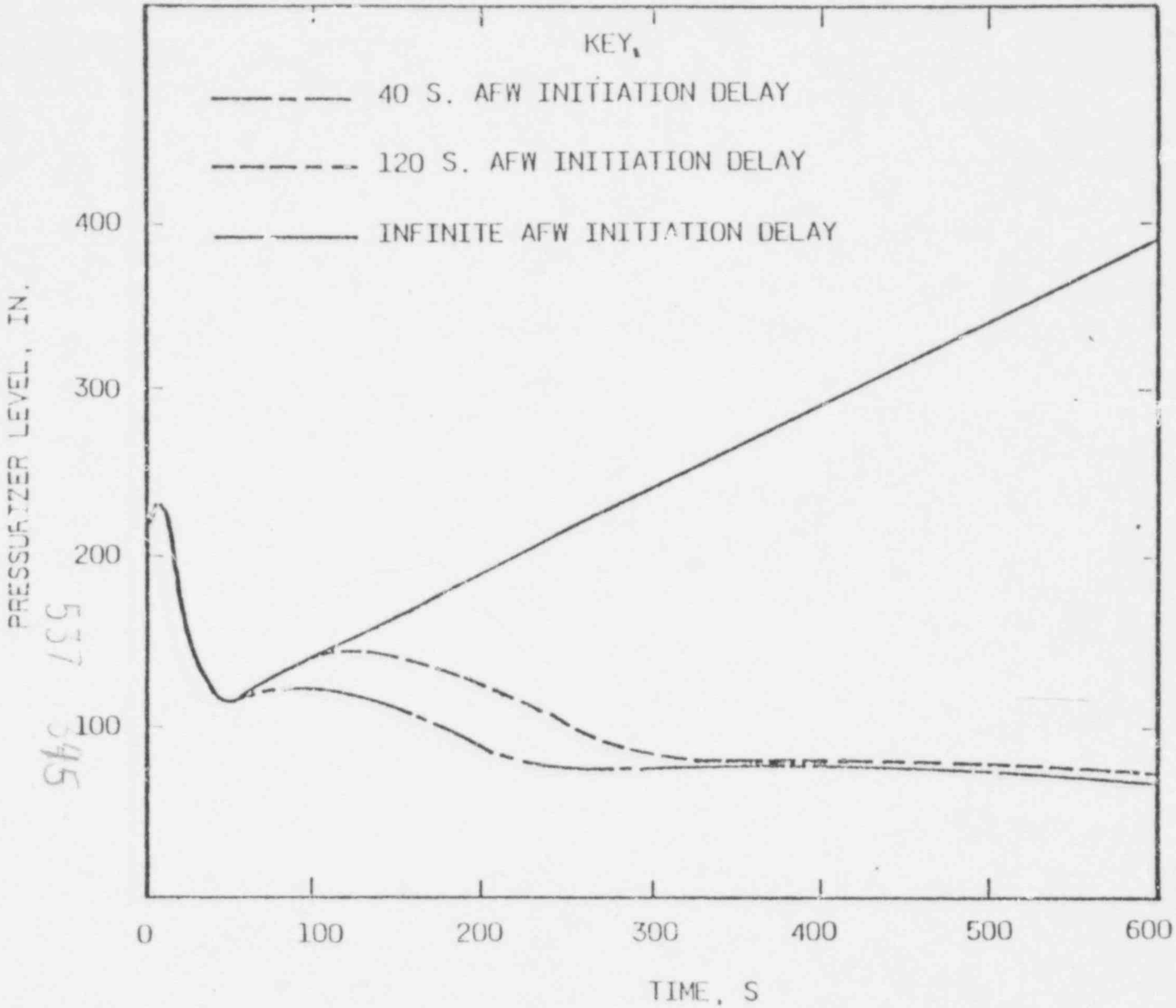
537 343

SENSITIVITY OF SYSTEM PRESSURE TO DELAY
IN AUXILIARY FEEDWATER INITIATION



537 344

SENSITIVITY OF PRESSURIZER LEVEL BEHAVIOR TO DELAY IN AUXILIARY FEEDWATER INITIATION



ACRS MEETING

JUNE 15, 1979

BABCOCK & WILCOX PRESENTATIONS

	INTRODUCTION	J.H. TAYLOR
15 MIN.	CHRONOLOGY OF EVENTS AND B&W SUPPORT	J.H. TAYLOR
15 MIN.	ACTIONS TAKEN TO REDUCE PROBABILITY OF TMI-2 INITIATING SEQUENCE	E.A. WOMACK
30 MIN.	SMALL BREAK PHENOMENOLOGY	B.M. DUNN
15 MIN.	OPERATING GUIDELINES	E.R. KANE
20 MIN.	TRANSIENT EXPERIENCE REVIEW AND ICS FMEA	E.A. WOMACK
20 MIN.	OTHER B&W ACTIONS TO DATE	D.H. ROY

CHRONOLOGY OF EVENTS - B&W ACTIONS

3/28/79

TIME	ACTION
0600	B&W SITE REPRESENTATIVE NOTIFICATION
0700	B&W REPRESENTATIVE ARRIVAL ON SITE
0745	B&W NOTIFICATION IN LYNCHBURG
0900	TASK FORCE FORMED 3 PEOPLE DESIGNATED TO GO TO SITE IMMEDIATELY
1030	FURTHER INDIRECT INFORMATION THRU MET ED SUPERVISOR IN TRAINING ON SIMULATOR
1145	FURTHER INDIRECT INFORMATION FROM OFFSITE B&W REPRESENTATIVE. MET ED REQUESTED RADIOCHEMISTRY SUPPORT - TWO PEOPLE DISPATCHED
1200	FIRST SPECIAL PROCEDURE WORK BEGUN REGARDING RC PUMP OPERATION
1330	FURTHER INDIRECT INFORMATION THRU OFFSITE REPRESENTATIVE
1400-1600	B&W REQUESTED GPU/MET ED SET UP COMMUNICATIONS BETWEEN SITE AND B&W. THRU TWO INDIRECT CHANNELS B&W PASSED MESSAGE TO OBTAIN AT LEAST 400 GPM HPI FLOW
1835	FIRST DIRECT TELECON WITH CONTROL ROOM; HPI FLOW AT 400 GPM; DISCUSSED LIMITS AND THEN STARTED FIRST REACTOR COOLANT PUMP

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31

Rev. 31
11:00 A.M.
4/2/79

(1)

POOR ORIGINAL

ASSIGNMENT KEY

Sft	Time
1	7 AM - 4 PM
2	3 PM - Midnight
3	11 PM - 8 AM

Dial beeper number
Hear beep
Speak Clearly & Distinc
for 10 seconds

DIVISION MANAGER
9-528-2922

OPERATIONS MANAGER
Embrey
Roy
Berger
Kosiba
9-528-5000 2191

ADMINISTRATIVE SUPPORT
Yates

SERVICE MANAGER
1 Spangler
2 Phinney
3 Hallman

ENGINEERING OPERATIONS MANAGER
1 Womack
2 Suhrke
3 Pryor
9-528-5005 2191

PROJECT MANAGER
1 Ward
2 Cobb
3 Pletke
2191

LICENSING MANAGER
1 Kane
2 Taylor
3 Finnin
9-528-5002 2195

EVENTS ANALYSIS
1 LaBelle
2 Yosburgh
3 Open

OPERATIONS ASSISTANT
1 Schuler
2 Fahland
3 Bohn
9-528-5001 3702

PLANT DESIGN/SAFETY
1 Karrasch
2
3
2251

FUEL/CORE
1 Andrews
2 DeMars
Montgomery
3 Tulenko

C&I
1 Dowling
2 Castanes
3 Shepherd
2833

FLUID SYSTEM
1 Merchant
Griese
2 Lee
Conklin
3 Erlliman
Turner
2611

RADIO-CHEMISTRY
Nitti
Bell
Coad
Bishop
Hicks
Stagg
2311

PUMPS
1 Kennedy
2 Dempsey
3 Anderson/Stanek
9-528-5003 2103

HEAVY COMP.
1 Burke
2 Tornow
3 Mitcho
2322
2982

PROCEDURES COORDINATION
1 Heniz
2 Frerichs
3 Quale
2316

PROCEDURE REVIEW
1 Ryan
2 McBride
3 Brockman
2222

LONG TERM COOLING
1 England/Lemmon
2 Carlton/Bohart

CONTINGENCY & SHORT TERM RECOVERY
Montgomery
1 Brazill
2 Glei
3 Donovan
4 Gene Michaud 3772

BURNS AND ROE
English

WASTE SYSTEM CONTINGENCY
1 Lamanna

SIMULATION
B. Bingham

537 348

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B&W PERSONNEL SUPPORT TO TMI-2

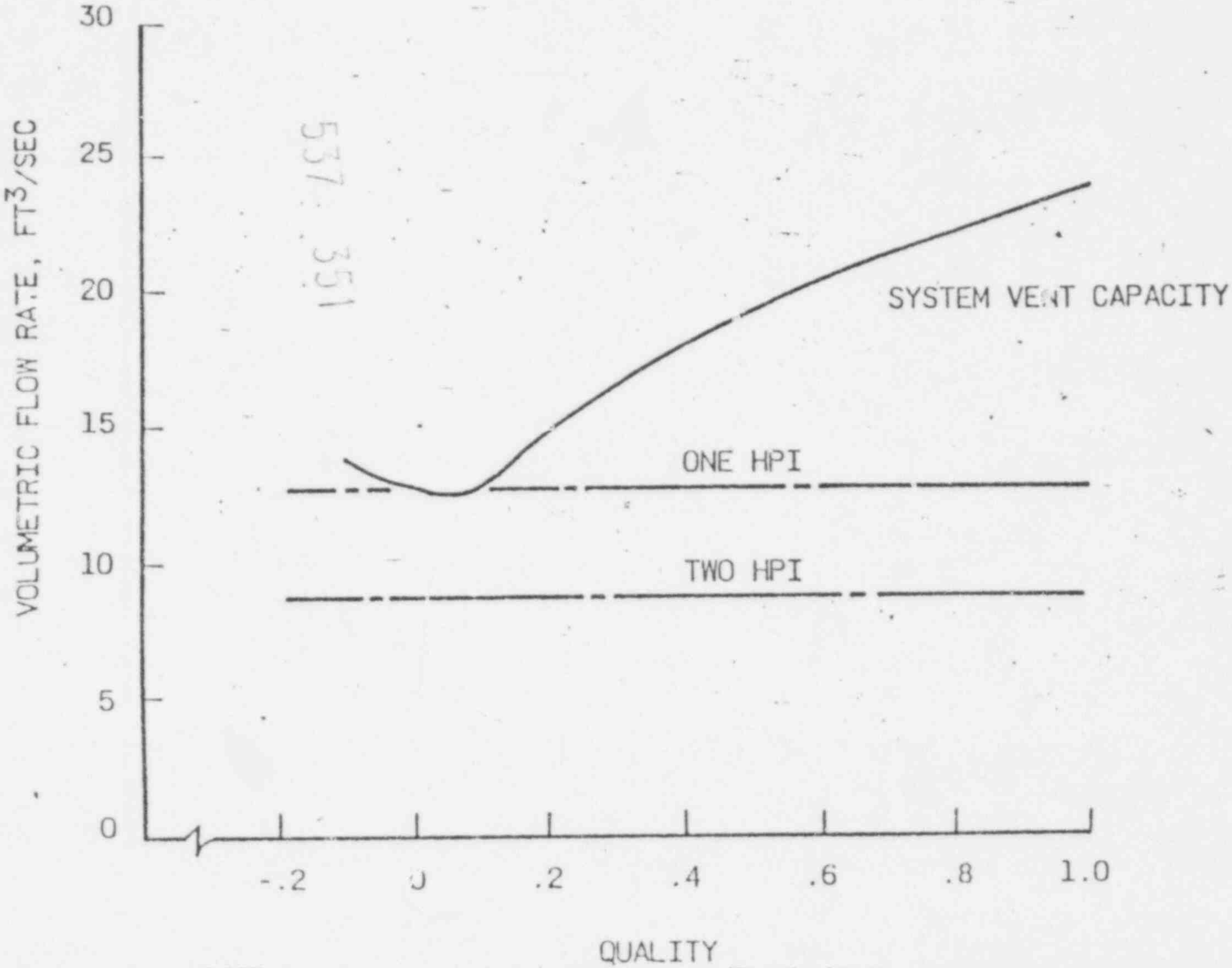
	3/29	4/5	4/12	4/23	5/7	5/24
SITE	12	25	47	35	43	36
LYNCHBURG	50	218	162	130	23	18
TOTAL	62	243	209	165	66	54

TYPICAL B&W ACTIONS/OUTPUTS IN SUPPORT OF TMI-2

- ANALYSES
  - NATURAL CIRCULATION
  - VESSEL RUPTURE
  - CRITICALITY CALCULATIONS
- EQUIPMENT TO SITE
- PROCEDURES
  - TMI-2 - VARIOUS OPERATING AND TEST PROCEDURES AS WELL AS CONTINGENCY CASUALTY PROCEDURES
  - OPERATING PLANTS -
    - HANDLING RCS VOIDS
    - SECURING HPI
    - SMALL RCS BREAKS
    - NATURAL CIRCULATION
- TRAINING
  - SIMULATOR
- SPECIAL TESTS AND LAB WORK
  - CRD RUPTURE TEST
  - CRD GASKET LEAK TEST
  - RADIOCHEMISTRY
- INFORMATION
  - EQUIPMENT SPECIFICATIONS
  - SYSTEM SPECIFICATIONS & DESIGN CRITERIA
  - INSTRUMENTATION QUALIFICATION, RANGES AND ACCURACIES
- CONSULTATION & DESIGN
  - SAFETY EVALUATION
  - BACKUP SYSTEMS
- COMMUNICATIONS
  - 24 HOUR OPEN PHONE LINE
  - TELECOPY

537 350

SYSTEM VENT CAPABILITY AT 2600 PSIA



537 351

35

PUMPS ON SMALL BREAKS

THERMODYNAMIC SYSTEM

SEQUENCE OF EVENTS

a. REACTOR TRIP

b. STORED ENERGY REMOVED

c. STEAM GENERATOR EFFECTIVE CONTINUOUSLY

d. SYSTEM STABILIZES AT OR BELOW STEAM GENERATOR PRESSURE

e. SYSTEM HOMOGENOUS

f. SYSTEM FLOW DEGRADES BUT RC PUMPS CONTINUE TO CIRCULATE FLUID

g. CORE COOLED BY FLOW

h. EQUILIBRIUM CONDTION

$Q_i + Q_{DH} = D_o + S_{SG}$ and

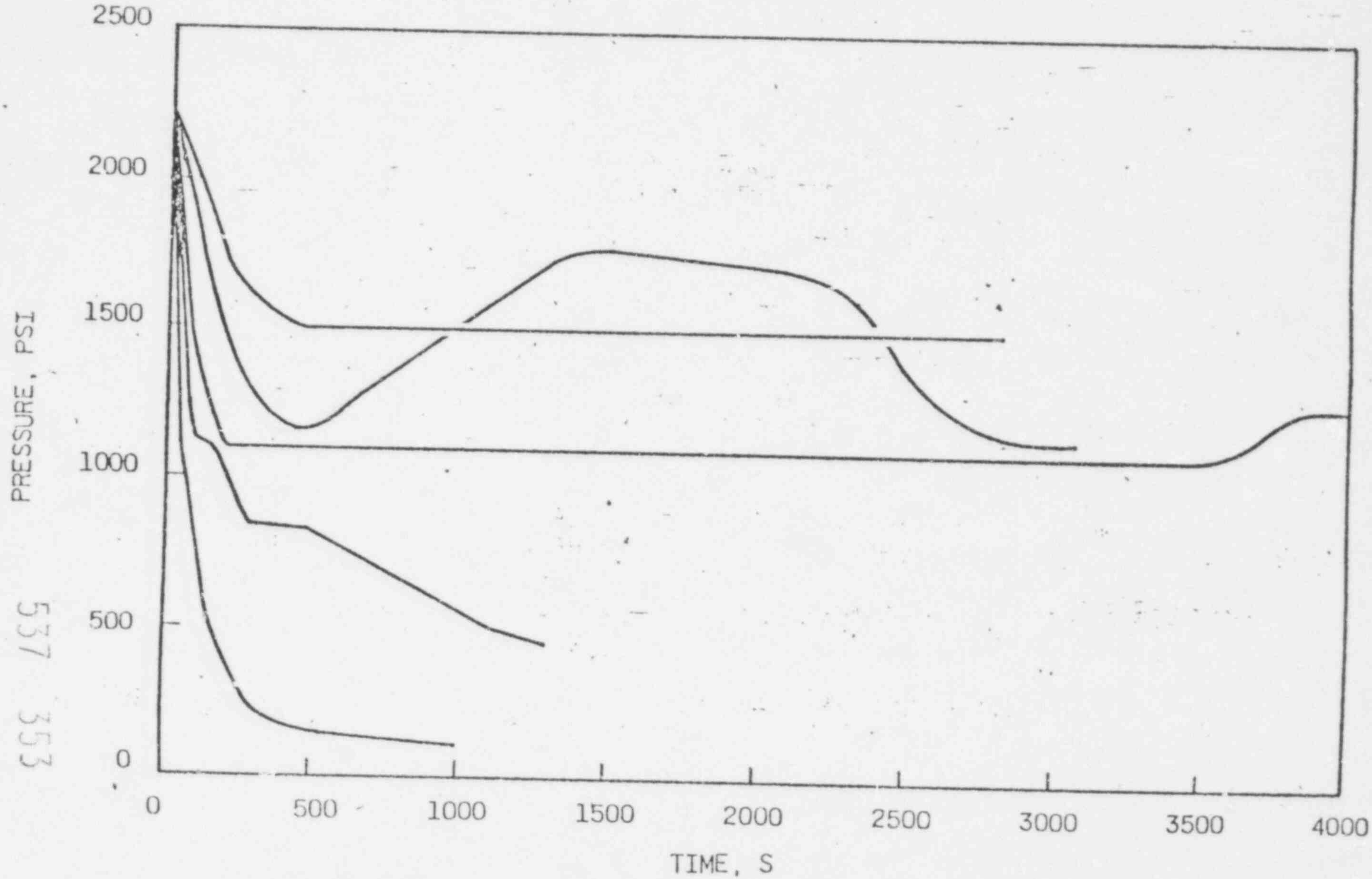
$M_i = M_o$, or

$Q_i + Q_{DH} = Q_o$ and

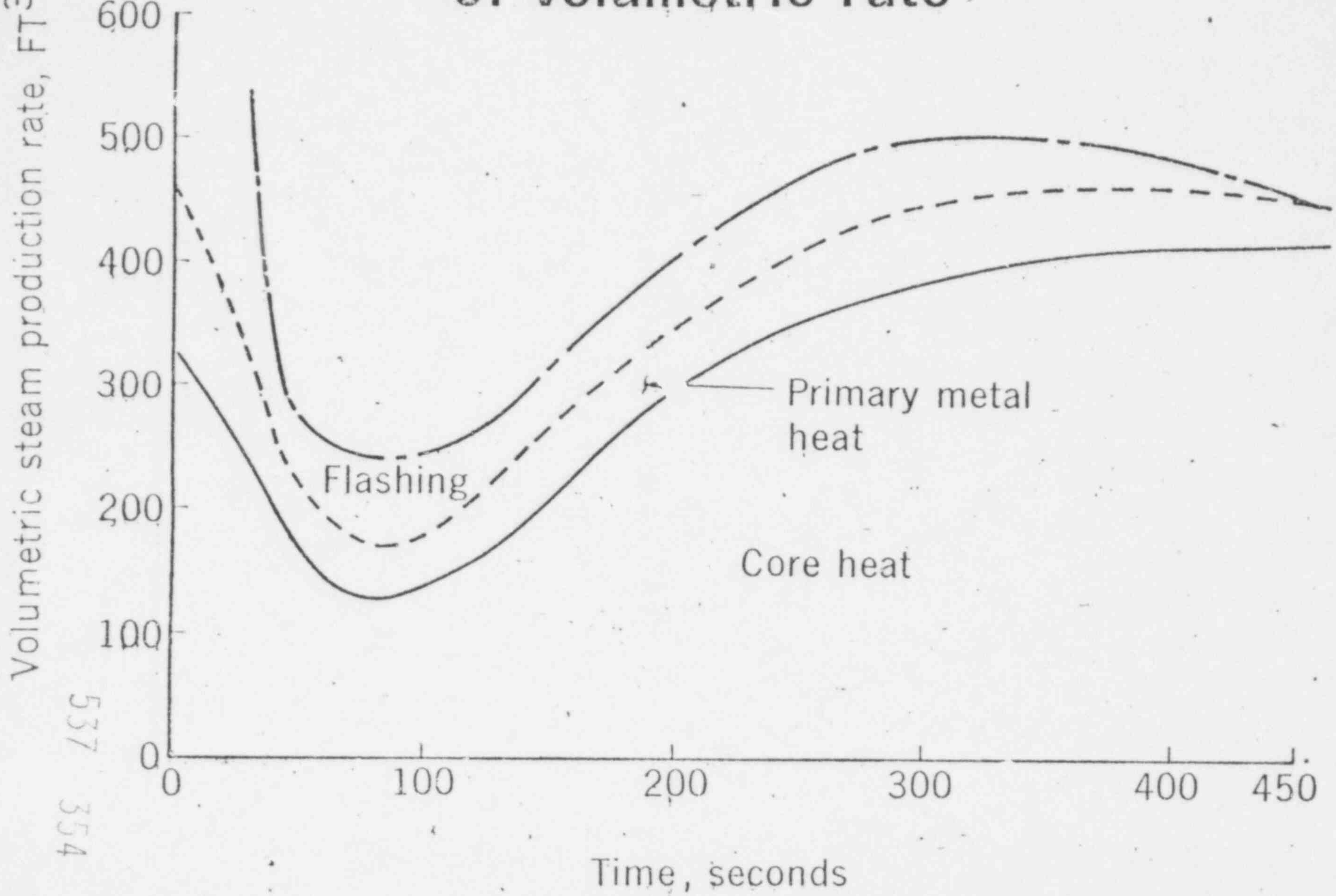
$M_i = M_o$

537 352

PRESSURE VS.. TIME - SMALL, BREAKS



Sources of steam production in terms of volumetric rate



Three phases of small breaks

I. Flow phase

a. System blowing down

b. Pumps coasting down

c. Cooling by flow process

d. Steam from Decay and fission heat
Flashing
Primary metal

II. Quiet blowdown

a. System blowing down

b. Pumps ineffective

c. Cooling by pool process

d. Steam from Decay heat
Flashing
Primary metal

III. Quiet long term

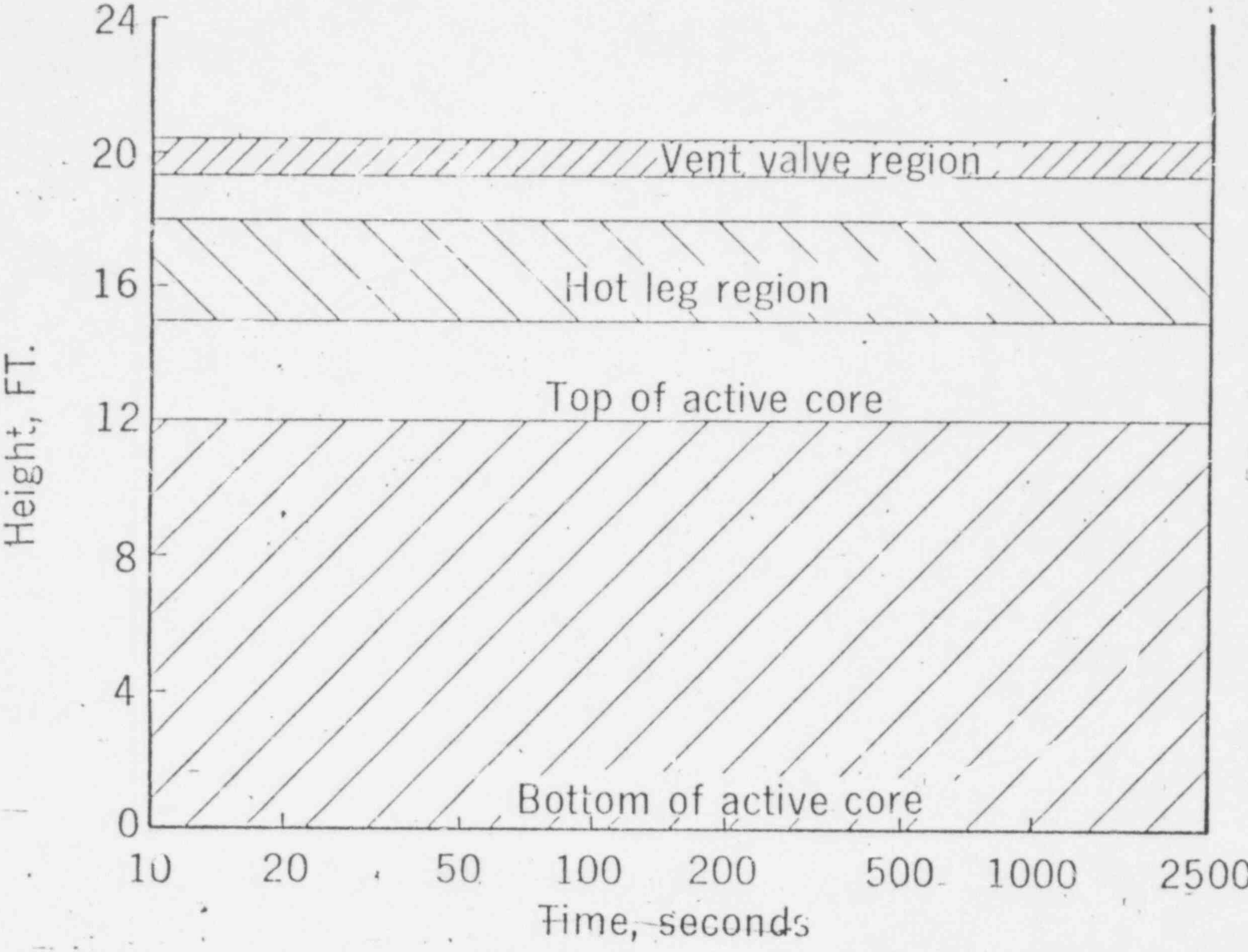
a. Blowdown completed

b. Cooling by pool process

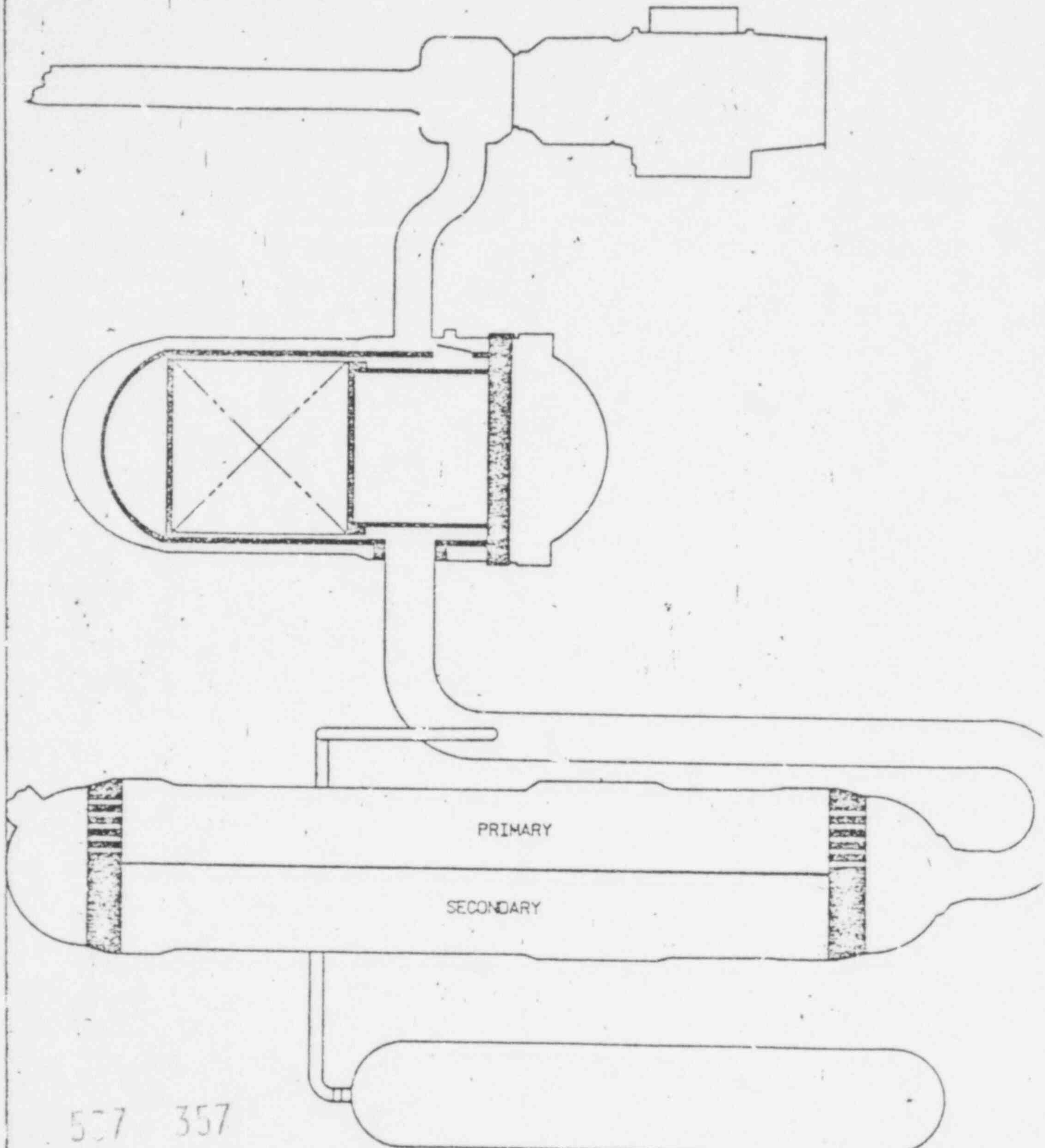
c. Steam from Decay heat
Primary metal

537 355

Relative vessel heights



537 356



557 357

PUMPS OFF SMALL BREAKS

I. THREE PHASES

A. PUMP COASTDOWN - NATURAL CIRCULATION

1. THERMODYNAMIC SYSTEM

2. IMPORTANT EVENTS

a. REACTOR TRIP & SHUTDOWN

b. REMOVAL OF STORED ENERGY

c. HPI INITIATION

d. AFW INITIATION

B. LOOP DRAINING

1. THERMODYNAMIC SYSTEM

2. IMPORTANT EVENTS

a. STEAM DISCHARGE TO BREAK VIA VENT VALVES

b. LOOP WATER DRAIN TO VESSEL

c. STEAM GENERATOR CONDENSATION

C. BOILING POT MODE

1. THERMODYNAMIC SYSTEM

2. IMPORTANT EVENTS

a. UPPER PORTIONS OF SYSTEM VOIDED OR AT STABLE WATER CONTENT

b. LONG TERM COOLING ESTABLISHED AS EITHER

$Q_i + Q_{DH} = Q_o + Q_s$ and

$M_i = M_o$, or

$Q_i + Q_{DH} = D_o$ and $M_i = M_o$

537 358

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PHENOMENA

DURING SMALL BREAKS

I. STEAM WATER DISTRIBUTION

A. STEAM GENERATOR PERFORMANCE

B. SYSTEM EFFLUENT

C. HIGH PRESSURE INJECTION EFFICIENCY

II. STEAM GENERATOR PERFORMANCE

III. COUNTER CURRENT FLOW

IV. VENT VALVE ACTIONS

V. PUMP MODELING

VI. CORE HEAT TRANSFER

537 - 359

SMALL BREAK LOCA

I. SYSTEM EVOLVES AS A SERIES OF QUASI STEADY STATE CONDITIONS

II. CATCH UP TRANSIENT AND INITIAL INVENTORY

III. KEY EXTERNAL INFLUENCES

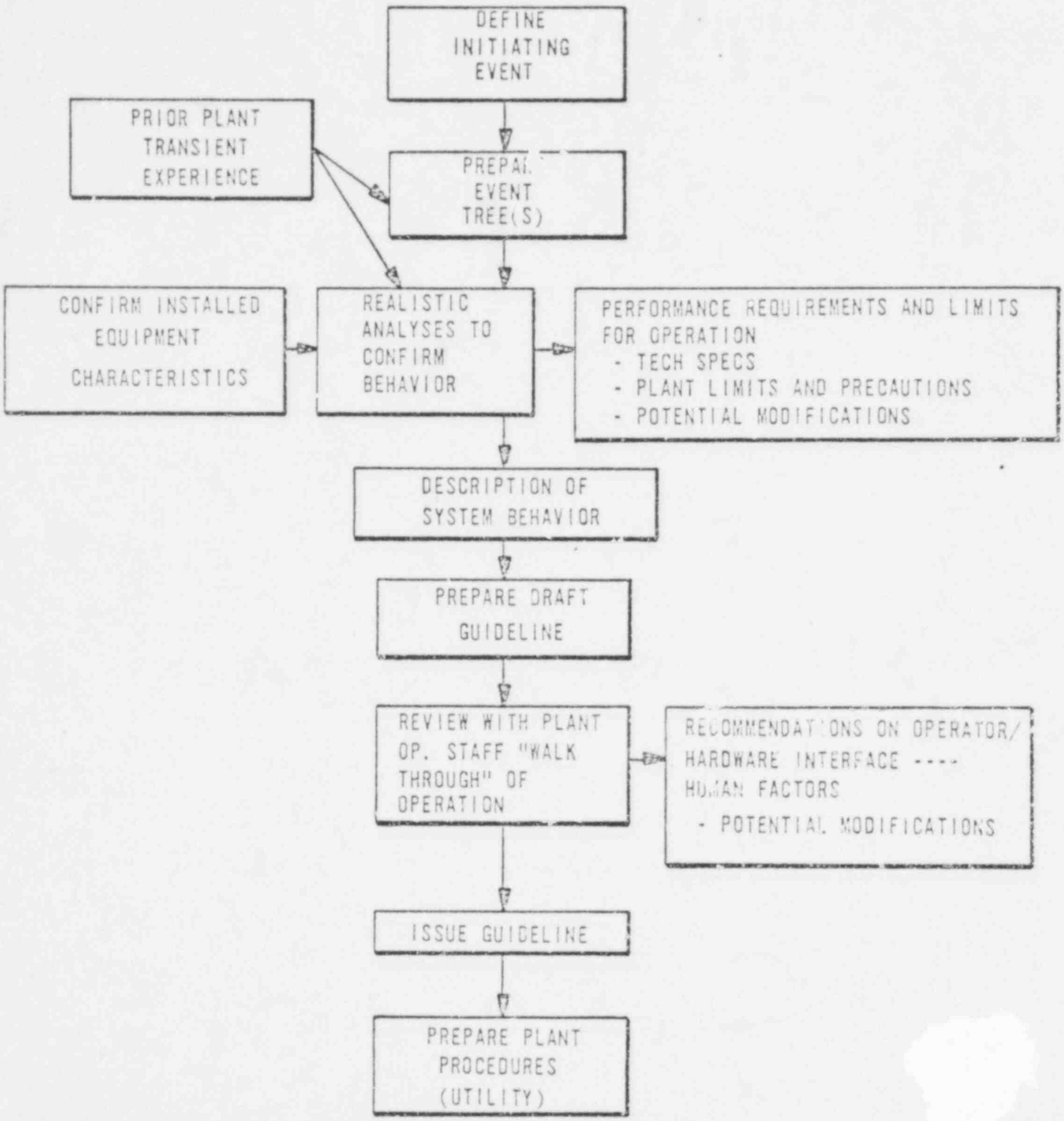
A. BREAK LOCATION

B. RC PUMP STATUS

C. STEAM GENERATOR FEEDWATER

537 360

Abnormal transient operation guidelines



INITIAL PREPARATION OF GUIDELINES 537 361

45

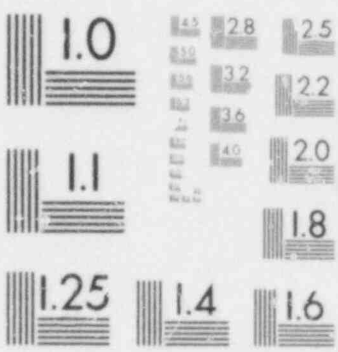
IMAGE EVALUATION
TEST TARGET (MT-3)

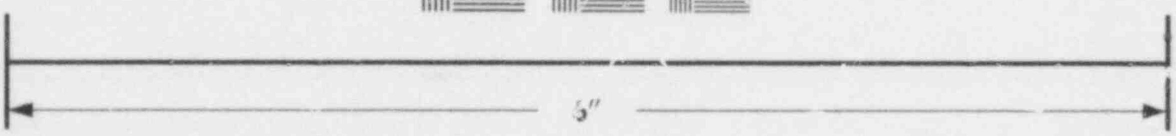
6"

IMAGE EVALUATION TEST TARGET (MT-3)

6″

IMAGE EVALUATION
TEST TARGET (MT-3)





SCOPE FOR A RELIABILITY ANALYSIS OF THE INTEGRATED CONTROL SYSTEM (ICS)

PURPOSE: TO PREPARE AN ICS RELIABILITY ANALYSIS INCLUDING A FAILURE MODES AND EFFECTS ANALYSIS (FMEA) AS COMMITTED BY BABCOCK & WILCOX. THIS ANALYSIS WILL IDENTIFY SOURCES OF TRANSIENTS, IF ANY, INITIATED BY THE ICS AND DEVELOP RECOMMENDED DESIGN IMPROVEMENTS WHICH MAY BE NECESSARY TO REDUCE THE FREQUENCY OF THOSE TRANSIENTS. THIS ANALYSIS WILL CONCENTRATE ON ICS FAILURE MODES THAT COULD AFFECT THE FEEDWATER SYSTEM, EMERGENCY FEEDWATER SYSTEM, PRESSURIZER LEVEL, AND REACTOR COOLANT SYSTEM PRESSURE.

SCOPE:

1. COLLECT AND ANALYZE OPERATING PLANT TRANSIENT DATA.
2. PERFORM FAILURE MODES EFFECTS ANALYSIS (FMEA).
3. SIMULATE FAILURE MODES.
4. EXAMINE POTENTIAL HARDWARE CHANGES.
5. ICS NORMAL TRANSIENT PERFORMANCE WILL BE CONSIDERED.
6. IEEE352 WILL BE USED AS A GUIDE FOR FMEA FORMAT AND CONTENT.

538 001

FORMAT FOR FMEA REPORTING (FROM IEEE 352) POOR ORIGINAL

Table A3
Failure Mode and Effects Analysis

Page ____ of ____

Functional Level System Typical Reactor Trip Function; Subsystem Sensor Circuit 1; Equipment ____

Diagram See Fig. A1

Program Typical Plant; **Report No.** IEEE Std 352-1975, Appendix A; **Prepared By** ____; **Date** ____ **Rev** ____

No.	Name	Failure Mode	Cause	Symptoms and Local Effects Including Dependent Failures	Method of Detection	Inherent Compensating Provision	Effect Upon RPS	Remarks and Other Effects
1	Pressure transmitter PT-1	Fail low	Corrosion wear, mechanical damage, heat effects	Low output to alarm unit; ac relays will remain energized for channel 1	Periodic test	Redundant channels, 2 and 3	Both trip paths 2/2 logic	Possible immediate detection
		Fail high	Misadjustment	High signal level to alarm unit; ac relays will deenergize for channel 1, with no trip	Periodic test	Redundant channels, 2 and 3	Both trip paths 1/2 logic	Partial trip alarm
2	DC power	Fail low or OFF	Transformer failure, diode failure	Removes operating power for transducer; alarm unit will sense low pressure; ac relay will open will open with no trip on channel 1	Periodic test, spurious trip alarm	Redundant channels, 2 and 3	Both trip paths 1/2 logic	Spurious trip if other channel failed 1/2
		Fail high	Heat effects, misadjustment	Transducer setpoint exceeds trip level; relays will remain energized for channel 1	Periodic test	Redundant channels, 2 and 3	Both trip paths 2/2 logic	
3	Alarm unit PC-1	Fail OFF	Transformer failure open circuit in output section, setpoint drift	AC power to ac relays removed for channel 1; ac relay open when no trip on channel 1	Periodic test, spurious trip alarm light	Redundant channels, 2 and 3	Both trip paths 1/2 logic	Spurious trip if other channel failed 1/2
		Fail ON	Short in output section, setpoint drift	Does not remove ac power to ac relay for channel 1 trip; ac relay remains energized. Both paths become 2/2 logic	Periodic test	Redundant channels, 2 and 3	Both trip paths 2/2 logic	
4	AC control relay, X1A	Fail closed	Contacts shorted or fused armature jammed wiring	Does not break circuit to dc relays on trip; dc relay remains energized for channel 1; trip path A becomes 2/2 instead of 2/3 logic	Periodic test	Redundant channels, 2 and 3	Degraded trip, trip path A, 2/2 logic	
		Fail open	Loss of ac power (instrument bus), coil failure broken wire or loose connection	DC relay opens when no trip on channel 1	Spurious trip on test	Redundant channels, 2 and 3	Both trip paths 1/2 trip logic	Spurious trip if other channel fails 1/2

7702 ... 538 002

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FMEA PROGRESS REPORT

1. OPERATING PLANT DATA HAS BEEN OBTAINED BY THE ENGINEER TEAMS FROM OCONEE, CRYSTAL RIVER, ARKANSAS NUCLEAR 1, RANCHO SECO, DAVIS BESSE 1, AND TMI. THIS DATA HAS BEEN ANALYZED, AND IS CONTINUING.

2. THE FMEA TASKS ARE IN PROGRESS. WORK TO DATE INCLUDES (STILL IN PROGRESS) -

   - IDENTIFICATION OF FAILURE MODES OF INPUTS AND THEIR PROPOGATION THROUGH THE ICS.

   - IDENTIFICATION OF FAILURE MODES WITHIN THE ICS, (MODULES AND GROUPS OF MODULES).

   - IDENTIFICATION OF FAILURE MODES OF THE ICS OUTPUTS.

   - SIMULATION ANALYSIS (POWER TRAIN IV - 177) OF ICS INPUT AND OUTPUT FAILURES.

   - ANALYSIS OF ELECTRICAL SHOP WORK ORDERS FOR ICS MODULES/ EQUIPMENT.

3. FMEA REPORT COMPLETION DATE - 29 JUNE 1979.

538 003

PORV ACTUATIONS FOR VARIOUS ANTICIPATED TRANSIENTS

ANTICIPATED TRANSIENT	NUMBER OF PORV EVENTS	% OF TOTAL
LOSS OF FEEDWATER (LOFW)	64	44
TURBINE TRIP (TT)	39	27
INSTRUMENT FAILURE/ICS[4] (IF/ICS)	9	6
LOAD REJECTION (LR)	5	3
ROD DROP (RD)	4	3
POWER SUPPLY FA' RE[3] (PSF)	4	3
LOSS OF OFFSITE POWER [1]	3	2
MANUAL/MISC[2]	18	12
	146	100%

NOTES:

1. LOOP CASES INCLUDE MOMENTARY LOSS OF RC PUMP POWER ON BUSS TRANSFER.
2. MANUAL/MISC CATEGORY INCLUDES CERTAIN CASES OF OPERATOR ERROR, .ADVERTENT HPI ACTUATION, ETC.
3. MAIN POWER SUPPLY FAILURE.
4. INSTRUMENTATION FAILURE/ICS INCLUDES ALL KNOWN CASES INVOLVING ICS AND/OR INSTRUMENT FAILURE THAT CAUSED ICS UPSETS.
5. TOTALS INCLUDE ESTIMATES FOR TMI-1 AND TMI-2 FOR EVENTS BEYOND 15 JULY, 1978.

538 004

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RUNBACK ACTIONS

EVENT	NUMBER	INITIAL POWER RANGE %	FINAL POWER RANGE %
TURBINE TRIP/LOAD REJECTION	14	15 TO 100	2 TO 22
FEED PUMP TRIPS (1 OF 2)	14	100	55 TO 75
ROD DROPS	4	100	50 TO 60
10% STEP LOAD INCREASES	4	17 TO 90	27 TO 100
10% STEP LOAD DECREASES	11	[illegible]7 TO 100	15 TO 90
	47		

DATA FOR ONE PLANT: 5½ REACTOR YEARS OPERATION

37 REACTOR TRIPS DURING THE 5½ YEAR PERIOD

538 005

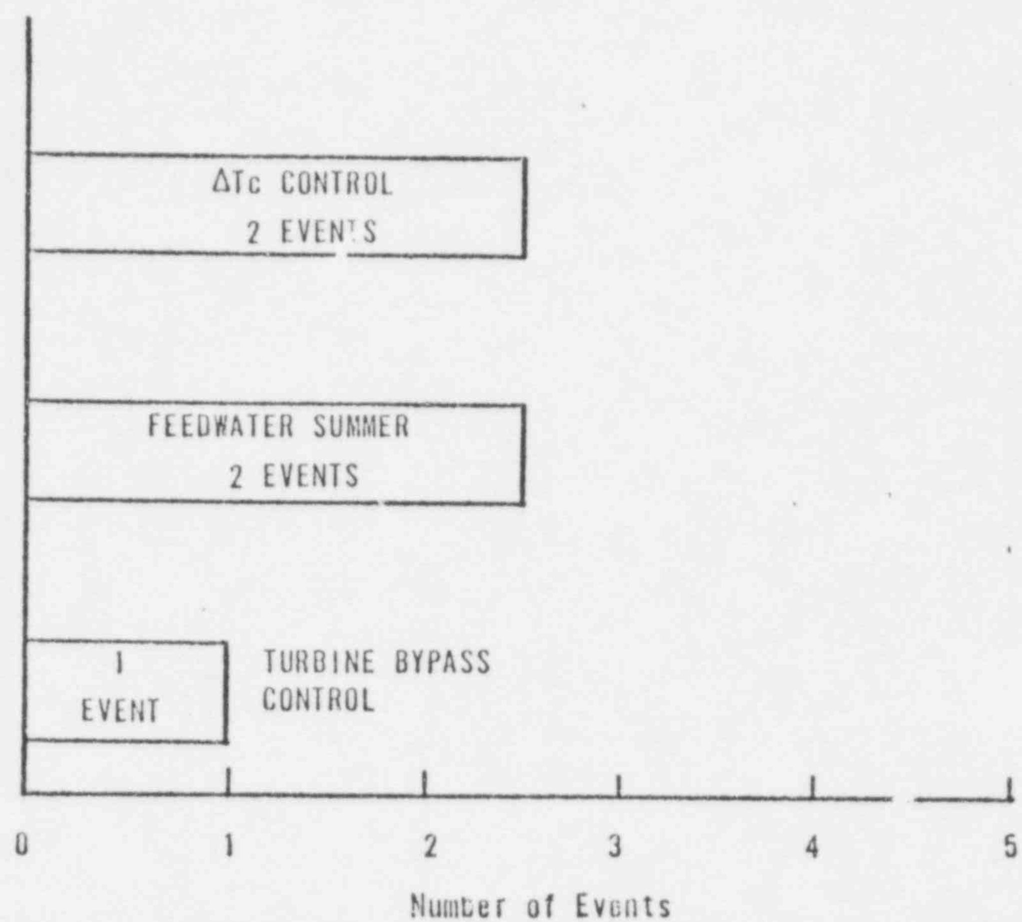
CHALLENGES TO RPS

ALL CAUSES (6½ YEAR AVERAGE)	7.1/YR.
LOSS OF FEEDWATER	2.1/YR.
TURBINE TRIP	1.9/YR.
ROD DROP	0.8/YR.
OTHER	2.3/YR.

533 006

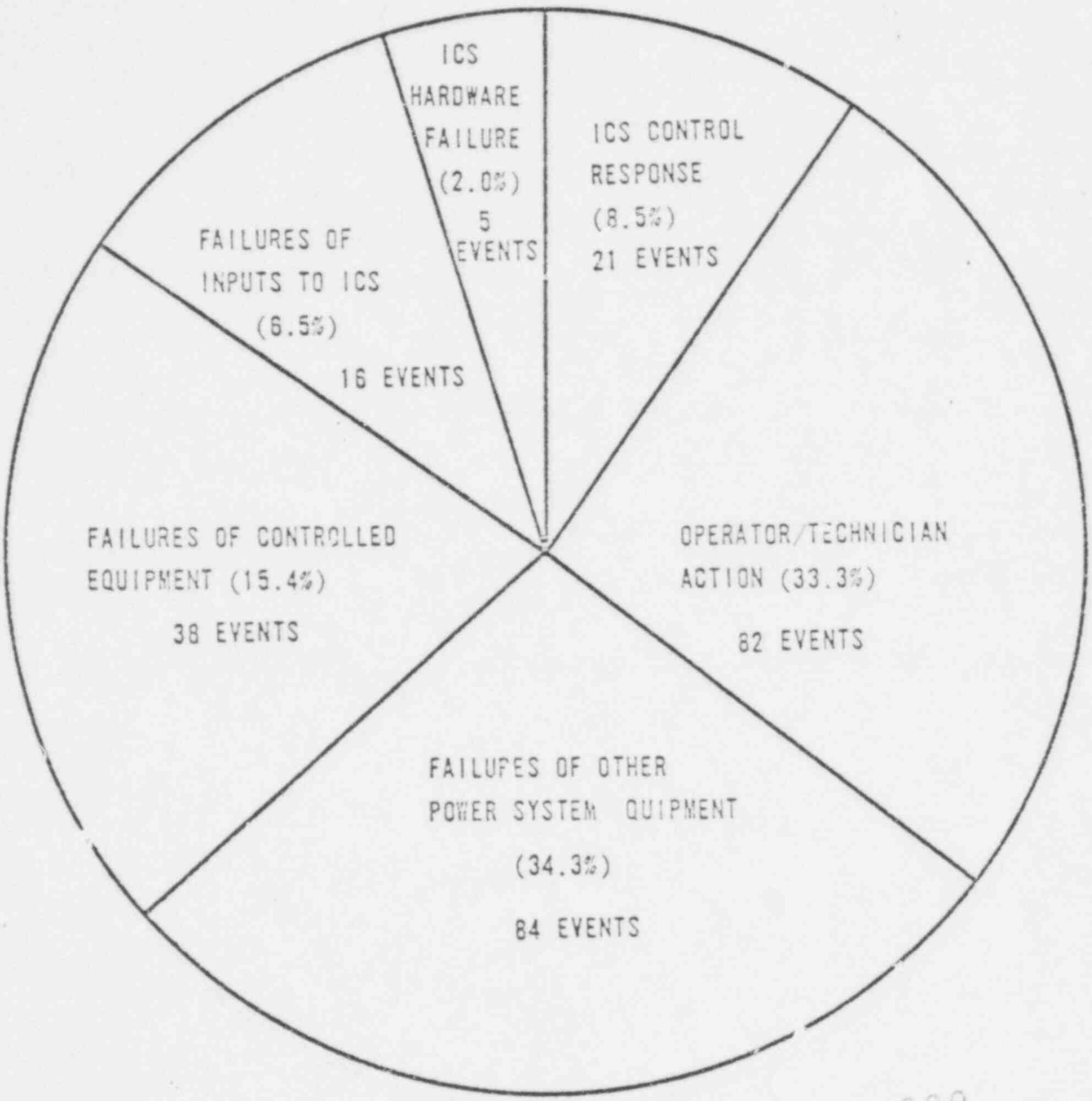
ICS HARDWARE FAILURES

5 EVENTS



538 007

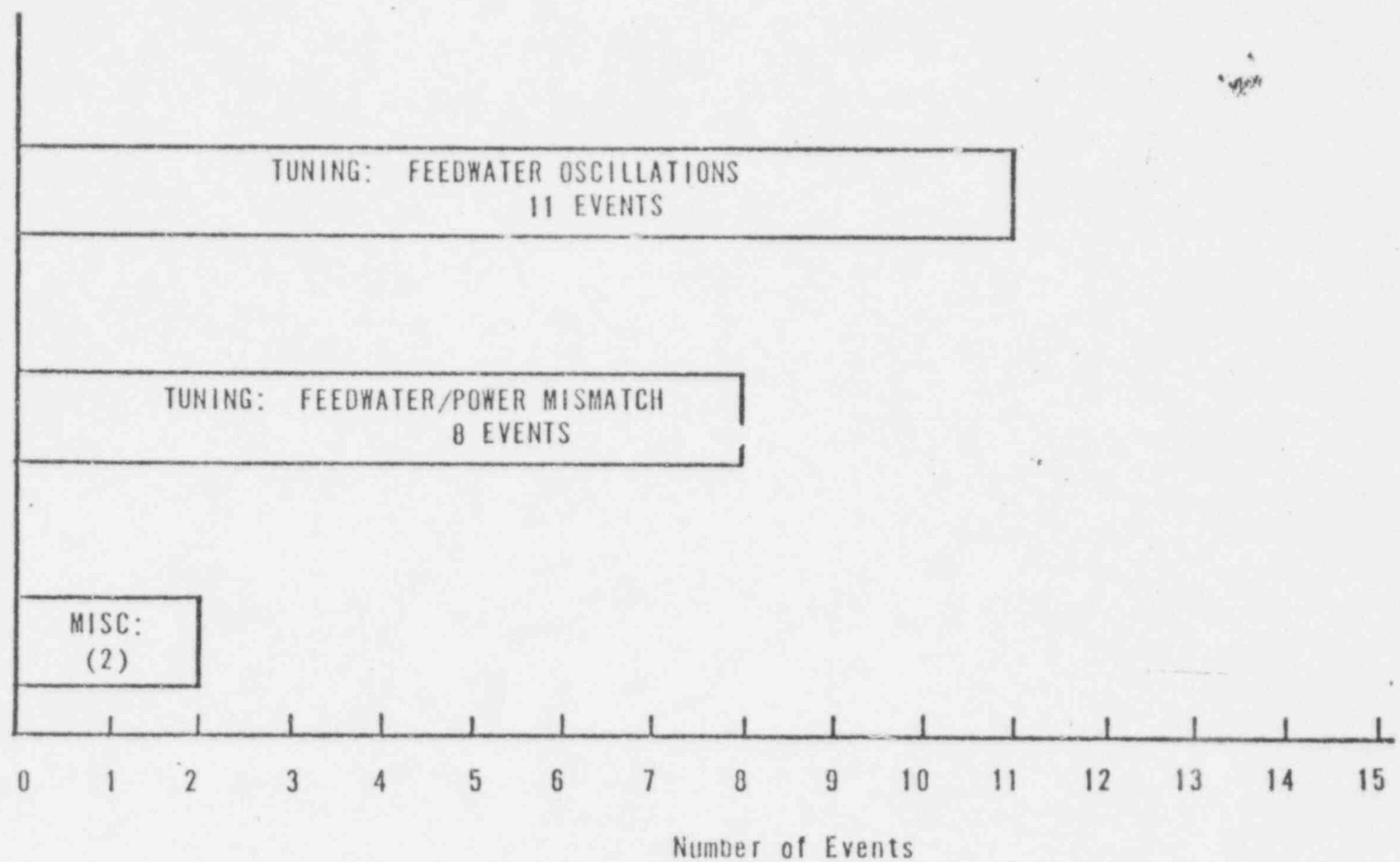
ANALYSIS OF 246 REACTOR TRIPS



538 008

ICS CONTROL RESPONSE

21 EVENTS



538 009

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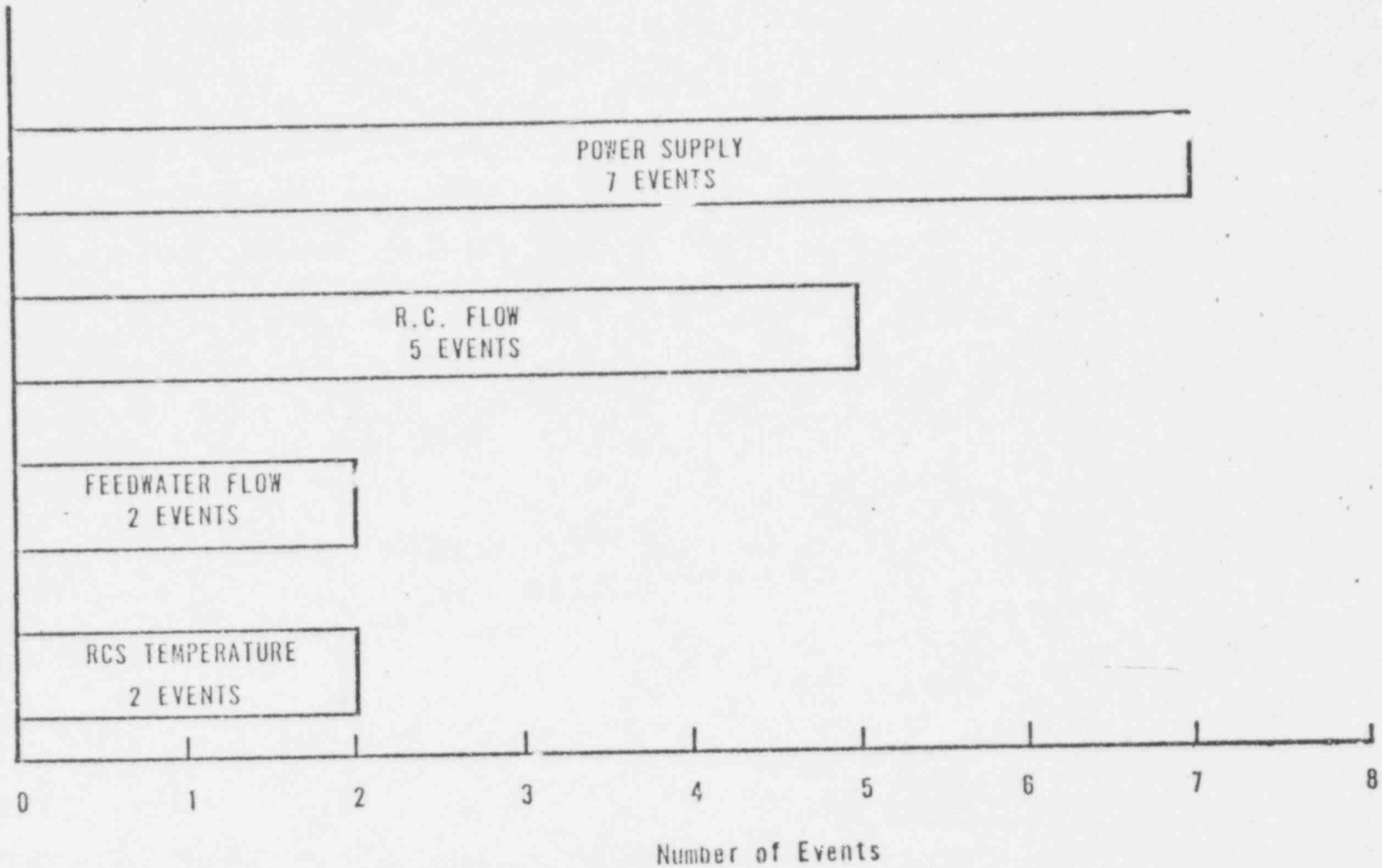
FAILURES OF INPUTS TO ICS

16 EVENTS



538 010

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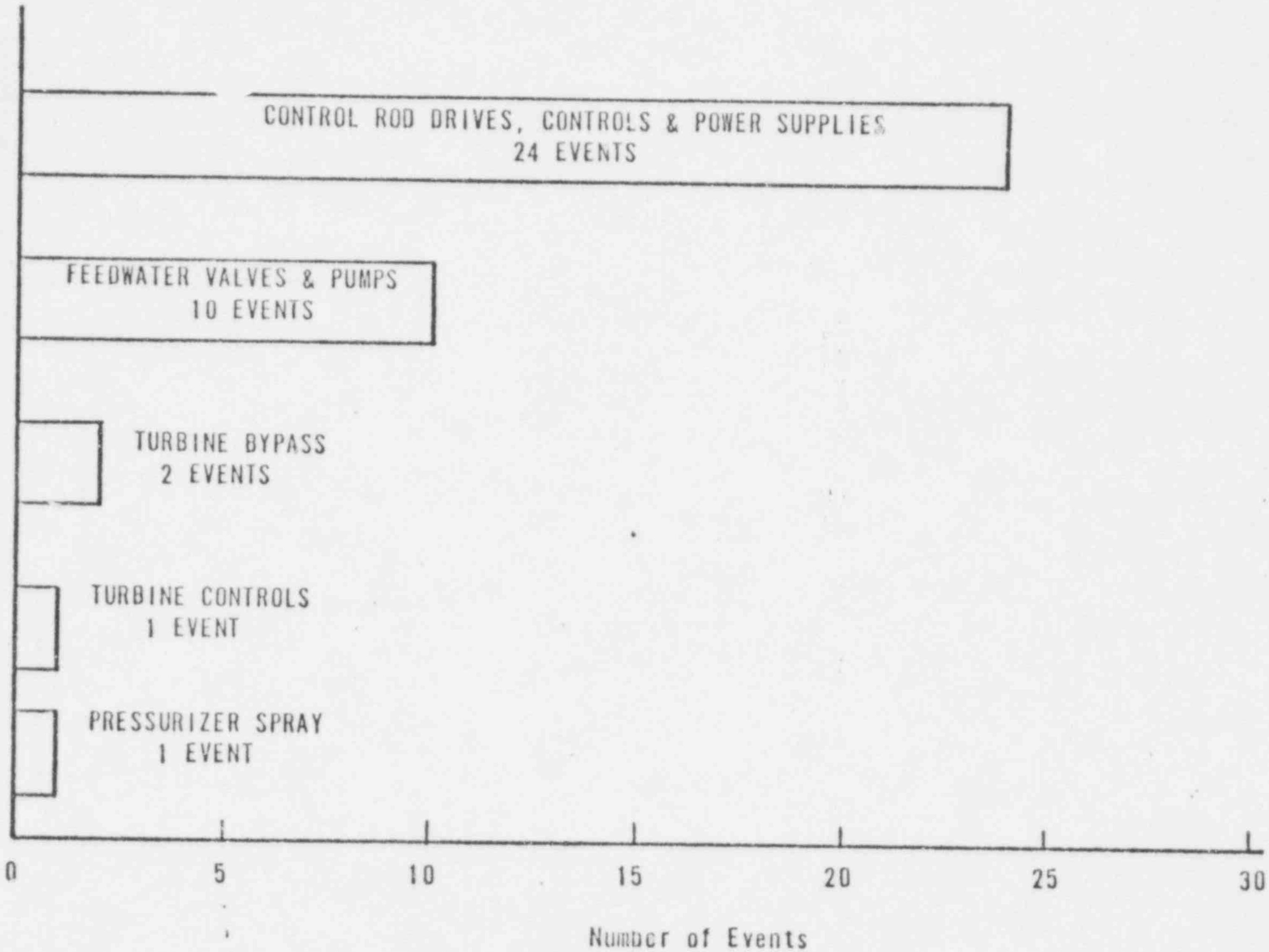
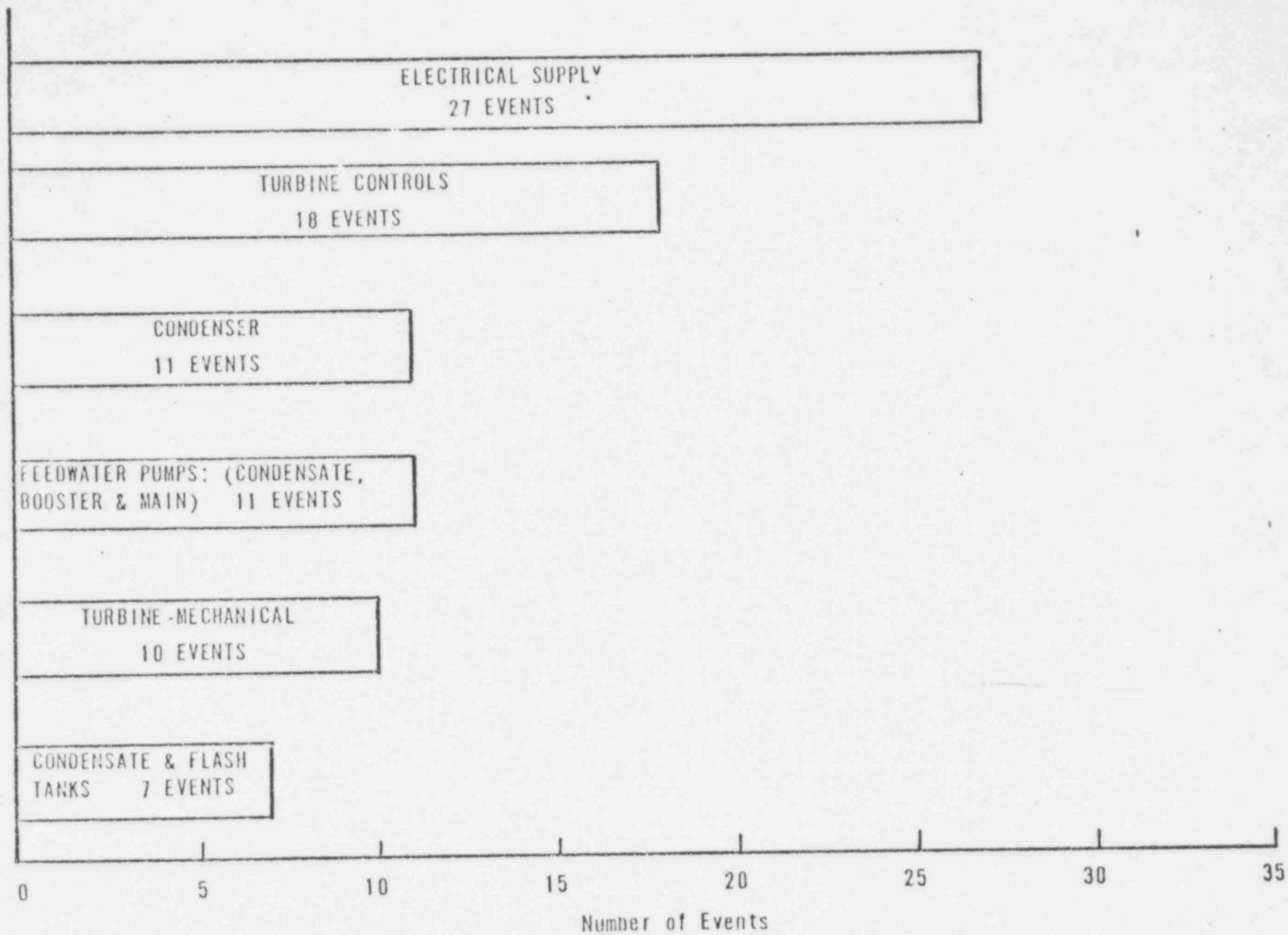
FAILURES OF CONTROLLED EQUIPMENT

38 EVENTS



538 011

FAILURES OF BOP EQUIPMENT
84 EVENTS



538 012

SMALL BREAK

OPERATIONAL GUIDELINES

538 013

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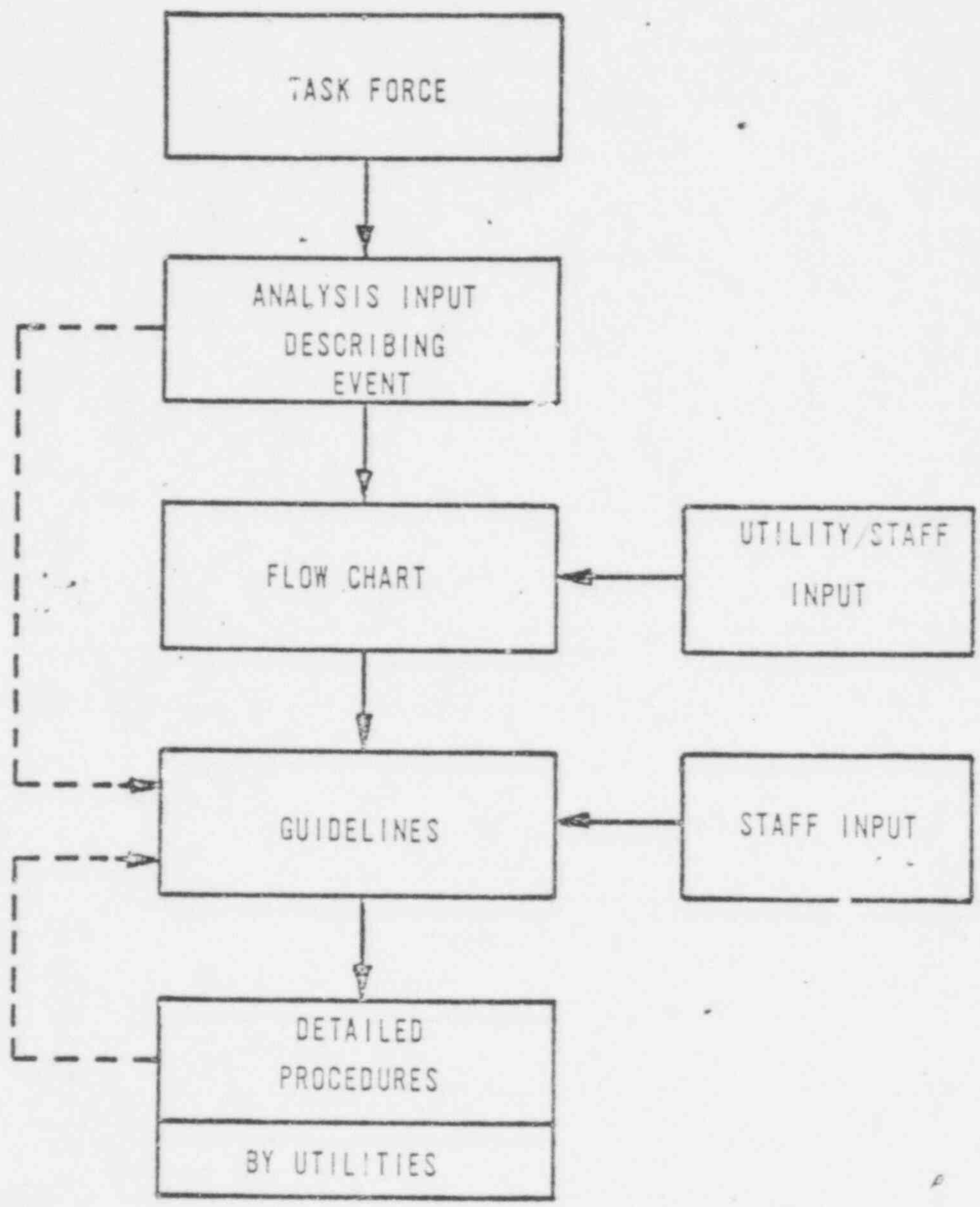
Small break guideline development



538 014

Organizational input to guidelines

B&W task force

- Engineering
- B&W training
- B&W customer service

Utility operators

NRC staff

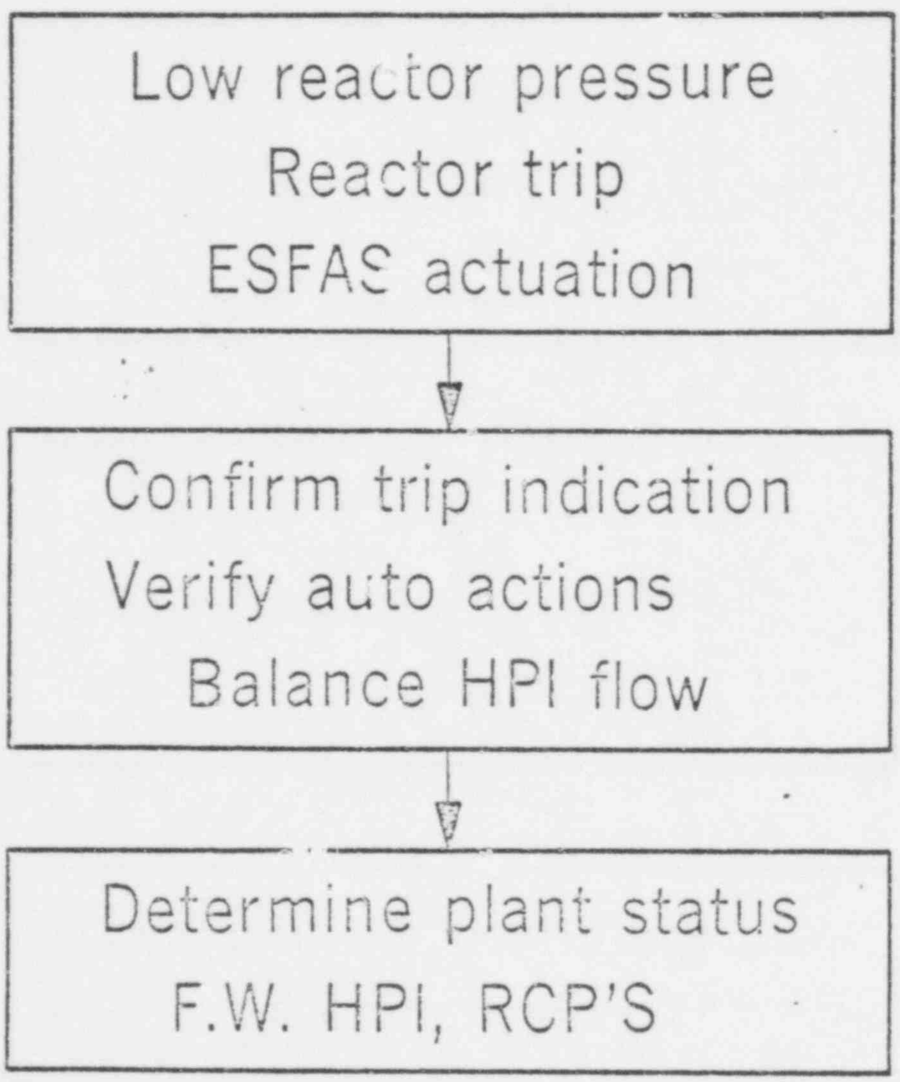
Operational guidelines for small breaks

Guidelines

- Symptoms
- Immediate action
- Precautions
- Follow-up actions

Supplementary information

- Small break phenomena


Low reactor pressure
Reactor trip
ESFAS actuation
Confirm trip indication
Verify auto actions
Balance HPI flow
Determine plant status
F.W. HPI, RCP'S

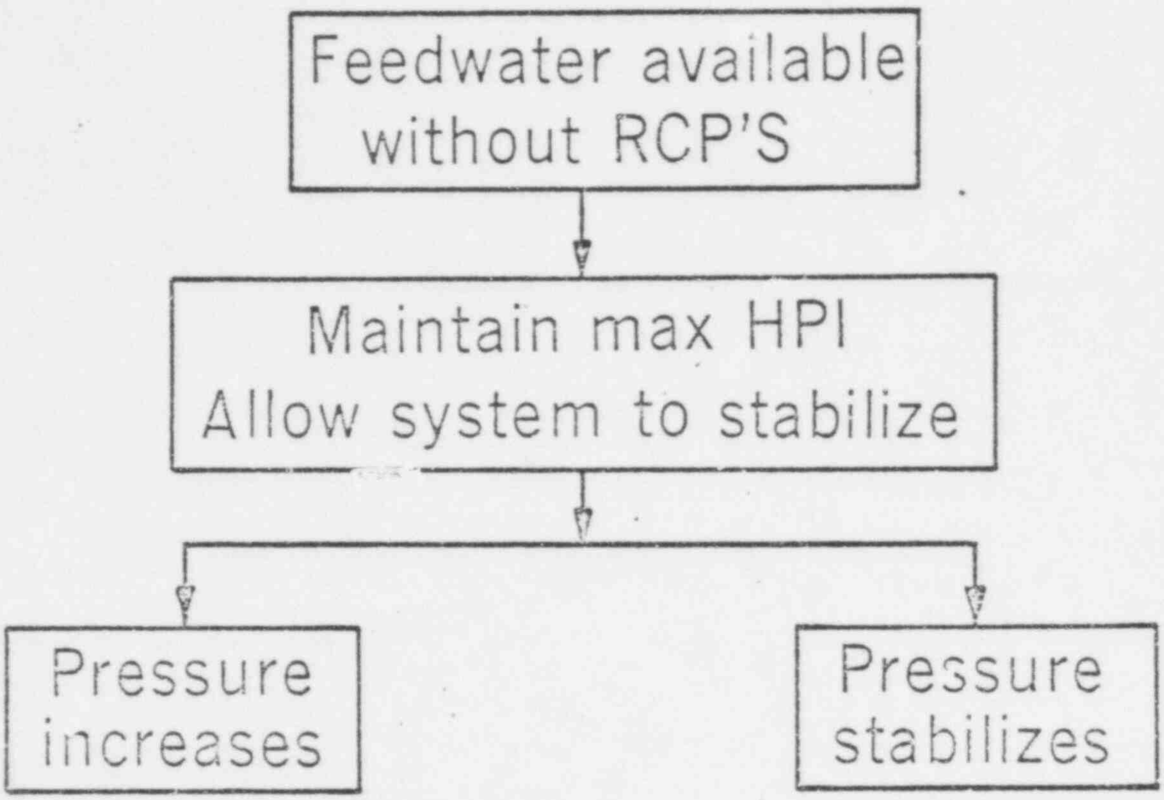
538 017

Feedwater available
RCP'S available

↓

- Maintain max HPI
- Allow system to stabilize
- Begin cooldown
- Cooldown and go to LPI cooling using available equipment

533 018



- If NEC open PORV to keep off safeties
- Wait until steam generator cooling is available or a pump can be started

- Begin cooldown
- Bump/Start a pump to continue cooldown
- Cooldown and go to LPI cooling using available equipment

538 019

Small break guidelines conclusions

Small break system responses vary

Operator responses are basically the same

- Maintain maximum HPI flow
- Obtain feedwater if lost
- Cooldown

65

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55

CATEGORIES FOR FUTURE ACTIONS

I. ACCIDENT PREVENTION - MINIMIZING THE NUMBER OF INCIDENTS OF MODERATE FREQUENCY

II. ACCIDENT MITIGATION - CONTROLLING INCIDENTS OF MODERATE FREQUENCY SO THEY DO NOT DEGRADE TO INFREQUENT INCIDENTS

III. ACCIDENT RECOVERY - LONG TERM CONTROL AND RECOVERY FROM ANY SERIOUS ACCIDENT

533 021

I. ACCIDENT PREVENTION

A. REVIEW OF ITEMS ALREADY COMPLETED:

1. Increased Auxiliary Feedwater Reliability
2. Provided Criteria for Securing Safety System Operation
3. Revised High Pressure Reactor Trip and PORV Setpoints

B. ITEMS PLANNED FOR FUTURE:

1. ICS Reliability Study
2. Improved Auxiliary Feedwater Controls
3. Quantification of Safety Goals
4. ESF Status Monitoring
5. Operating Experience Feedback
6. Review for Changed/Additional R&D Needs

C. CONCLUSION:

You Can't Completely Prevent Incidents - You Can Only Safely Terminate Them When They Occur!

538 022

II. ACCIDENT MITIGATION

A. REVIEW OF ITEMS ALREADY COMPLETED:

1. CONTROL-GRADE TRIPS ON LOMF AND TT HAVE BEEN COMMITTED

2. OPERATING PROCEDURES WERE IMPROVED:

   NATURAL CIRCULATION

   SMALL BREAKS IN THE RCS

B. ITEMS PLANNED OR UNDER CONSIDERATION FOR THE FUTURE:

1. ANTICIPATORY SAFETY-GRADE REACTOR TRIPS ON LOMF AND TT

2. INSTRUMENTATION TO FOLLOW THE ACCIDENT

   T_{SAT} METER (PLUS WIDE RANGE RTDs)

   REACTOR VESSEL LEVEL

   INCORE THERMOCOUPLES

   PORV INDICATION

3. CONTAINMENT ISOLATION CRITERIA

4. PRESSURIZER HEATERS

5. INCREASED OPERATING EXPERIENCE REVIEW

6. IMPROVED DIAGNOSTIC INFORMATION

III. ACCIDENT RECOVERY

A. Review of Items Already Completed:

1. A Task Force to Assist in the TMI-2 Recovery Has Been Established

B. Items Planned for the Future:

1. RCS Remote Venting
2. Emergency Communication Circuits
3. Hardened Decay Heat Removal System
4. TMI-2 Recovery Plan

538 024

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ACRS RECOMMENDATIONS

RECOMMENDATION: ADDITIONAL ANALYSES OF TRANSIENTS OR ACCIDENTS IN PWRs ACCOMPANIED BY A SMALL BREAK

ACTION TAKEN: PREPARED AND SUBMITTED REPORT "EVALUATION OF TRANSIENT BEHAVIOR AND SMALL REACTOR COOLANT SYSTEM BREAKS IN THE 177 FUEL ASSEMBLY PLANT"

B&W POSITION: CONTINUING ANALYSIS OF SMALL BREAKS (EVENT TREES, ADDITIONAL FAILURES, ETC.)

CONTINUE TMI-2 BENCHMARKING

PARTICIPATE IN SMALL BREAK STANDARD PROBLEM PROGRAM

RECOMMEND ADDITIONAL RESEARCH NEEDS

538 025

ACRS RECOMMENDATIONS

RECOMMENDATION: EXPANDED SAFETY RESEARCH - LWR TRANSIENT ANALYSIS, DECONTAMINATION AND RECOVERY, EXPLORATORY VS. CONFIRMATORY

ACTION TAKEN: NONE

B&W POSITION: PLAN IN PREPARATION TO SUPPORT TMI-2 RECOVERY AND INVESTIGATION TASKS

RESEARCH SHOULD EMPHASIZE REALISTIC ANALYSIS OF SYSTEM RESPONSES TO PROBABLE EVENTS

REVIEW OF B&W R&D PLAN UNDERWAY TO ASSESS IMPACT OF TMI-2

538 026

ACRS RECOMMENDATIONS

RECOMMENDATION: OPERATOR TRAINING, QUALIFICATION, AND PROCEDURE REVIEW

ACTION TAKEN: SUPPLEMENTARY TRAINING PROGRAM ON TMI-2 OFFERED 4/9/79

OPERATING GUIDELINES FOR MANAGEMENT OF SMALL BREAKS

B&W POSITION: PLAN FOR EMERGENCY PROCEDURE GUIDELINE PREPARATION UNDERWAY

EXPAND SYSTEM FOR RECEIPT, REVIEW AND DISPOSITION OF SPRs AND LERs

REVIEW EXISTING TRAINING AND REQUALIFICATION PROGRAM REGULATIONS, GUIDELINES, CONTENT FOR TMI-2 IMPACT WITH OWNER-OPERATORS

533 027

ACRS RECOMMENDATIONS

RECOMMENDATION: NATURAL CIRCULATION MODE OF COOLING - ADDITIONAL ANALYSES, PROCEDURE AND VERIFICATION CRITERIA DEVELOPMENT, PRESSURIZER HEATER POWER SUPPLY

ACTION TAKEN:

- ANALYSES OF NATURAL CIRCULATION COOLING WITH AND WITHOUT SMALL BREAK PROVIDED IN REPORT "EVALUATION OF TRANSIENT BEHAVIOR AND SMALL REACTOR COOLANT SYSTEM BREAKS IN THE 177 FUEL ASSEMBLY PLANT"
- OPERATING GUIDELINES SUBMITTED TO OWNER-OPERATORS FOR "CONTROLLED TRANSITION TO NATURAL CIRCULATION"
- NATURAL CIRCULATION IN CONJUNCTION WITH SMALL BREAKS ADDRESSED IN GUIDELINES SUBMITTED TO OWNER-OPERATORS FOR "OPERATING GUIDELINES FOR SMALL BREAKS"

B&W POSITION: PROVIDE OTHER ANALYSES AS REQUIRED

ASSIST IN DEFINING ADDITIONAL NATURAL CIRCULATION SAFETY RESEARCH

538 028

ACRS RECOMMENDATIONS

RECOMMENDATION: INSTRUMENTATION TO DIAGNOSE AND FOLLOW AN ACCIDENT

- REACTOR VESSEL LEVEL MEASUREMENT
- WIDE RANGE T_H INDICATOR
- SATURATED CONDITION MONITOR
- CORE EXIT THERMOCOUPLES

ACTION TAKEN:

- WIDE RANGE T_H INDICATION RECOMMENDATION SUBMITTED TO OWNER-OPERATORS
- PROTOTYPE T_{SAT} - P_{SAT} INDICATOR IN OPERATION
- RECOMMENDATION FOR T_C HOOKUP AND RANGE EXTENSION SUBMITTED TO OWNER-OPERATORS

B&W POSITION: CONTINUING INVESTIGATION OF RV LEVEL MEASUREMENT - WILL MEET WITH OWNER-OPERATORS - NOT NECESSARY FOR SAFETY

RESEARCHING OTHER MEANS TO AID OPERATOR IN DIAGNOSING AND FOLLOWING TRANSIENTS

REACTIMETER INSTALLATION - WILL MEET WITH OWNER-OPERATORS

553 029

ACRS RECOMMENDATIONS

RECOMMENDATION: SAFETY SYSTEM STATUS MONITORING

ACTION TAKEN: EMERGENCY FEEDWATER SYSTEM STATUS ADVISORY TO OWNER-OPERATORS

B&W POSITION: INVESTIGATE AND RECOMMEND MEANS FOR DISPLAY OF STATUS OF KEY SYSTEMS - INCLUDE PHYSICAL CONFIGURATION, SYSTEM PARAMETERS AND SYSTEM CROSS CHECKS - WILL MEET WITH OWNER-OPERATORS

EMPHASIZE READINESS STATUS - ABILITY TO ACHIEVE DESIRED LINEUPS

538 030

ACRS RECOMMENDATIONS

RECOMMENDATION: RCS VENTING

ACTION TAKEN: NONE

B&W POSITION: UNDER INVESTIGATION - CANDIDATE METHODS FOR VENTING IDENTIFIED - WILL MEET WITH OWNER-OPERATORS - NOT NECESSARY FOR SAFETY

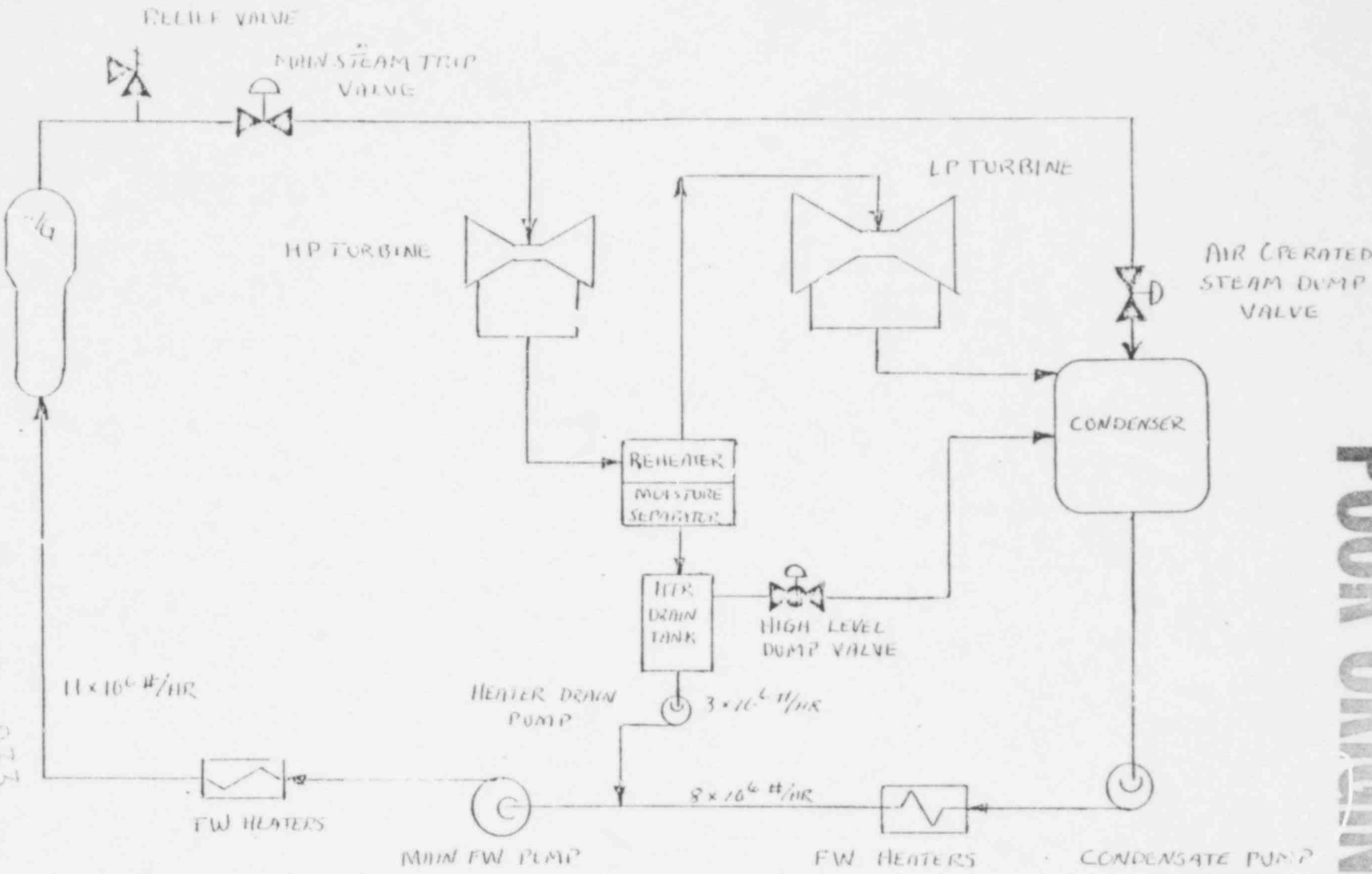
533 031

ACRS RECOMMENDATIONS

- ITEMS NOT YET ADDRESSED -

- RELIABILITY OF AC/DC POWER SUPPLIES
- STATION BLACKOUT
- WATER HAMMER POTENTIAL
- NRC CAPABILITIES
- FILTERED, VENTED CONTAINMENT
- QUANTIFY SAFETY GOALS

533 032



SECONDARY PLANT SCHEMATIC

SEQUENCE OF EVENTS

T = 0	HEATER DRAIN PUMP TRIPS AT 92% POWER
<1 MIN	OPERATOR RAPIDLY REDUCES GENERATOR LOAD BY 100 MWE. POWER STABILIZING AT ABOUT 80% FOR 2-4 MINUTES.
3:31 MIN	CONDENSER STEAM DUMP VALVES BEGIN OPERATION CAUSING A 22% STEP INCREASE IN STEAM FLOW.
4:13 MIN	CONTINUED OPERATION OF CONDENSER STEAM DUMP VALVES RESULTS IN LOW STEAM PRESSURE COINCIDENT WITH HIGH STEAM FLOW.
	REACTOR TRIPS ECCS SYSTEMS ACTUATE - HIGH HEAD SI INJECTS MOTOR DRIVEN AUXILIARY FEED PUMPS INJECT MAIN FEEDWATER ISOLATION OCCURS EMERGENCY DIESEL GENERATORS START CONTAINMENT ISOLATION (PHASE A) OCCURS STEAM DUMP VALVES SHUT
APPROX 5 MIN	OPERATOR MANUALLY SHUTS MAIN STEAM LINE TRIP VALVES.
APPROX 7 MIN	OPERATOR RESETS SAFETY INJECTION AND CONTAINMENT ISOLATION SIGNALS.
	LHSI PUMPS ARE SECURED.
	ONE OF TWO OPERATING AUXILIARY FEED PUMPS SECURED.
APPROX 10 + MIN	PRESSURIZER PRESSURE AND LEVEL CONTINUE RISING. OPERATOR SECURES ONE OF TWO HIGH HEAD SAFETY INJECTION PUMPS.
	PRESSURIZER POWER OPERATED RELIEF ACTUATION OCCURS.
APPROX 15 MIN	OPERATOR SECURES ONE OF THREE OPERATING REACTOR COOLANT PUMPS TO LIMIT PLANT HEATUP. STEAM GENERATOR PILOT OPERATED ATMOSPHERIC RELIEF VALVES INTERMITTENTLY ACTUATING TO MAINTAIN STEAM GENERATOR PRESSURE.
NEXT SEVERAL HOURS	OPERATORS RESTORE PLANT TO NORMAL HOT SHUTDOWN CONDITION.

538 034

PROBLEMS

HEATER DRAIN PUMP TRIP

-- HEATER DRAIN TANK HIGH LEVEL DUMP VALVE AND ACTUATOR APPEAR UNDERSIZED FOR PROPER CLOSURE AT OPERATING FLOWS AND D/P'S.

STEAM DUMP VALVE RESPONSE

-- VALVES APPEAR TO HAVE ACTUATED EITHER SLUGGISHLY OR WITH A TIME LAG IN OPERATION WHICH RESULTED IN OVER-RESPONSE.

-- VALVE SLUGGISHNESS POSSIBLY CAUSED BY ICE IN AIR OPERATING LINES DUE TO SUBFREEZING BUILDING TEMPERATURES AND WATER ENTRAINMENT IN INSTRUMENT AIR SYSTEM.

-- DELAYED ACTUATION POSSIBLY CAUSED BY CONTROL ROD MOTION NOT SUFFICIENTLY COMPENSATING FOR INCREASING PLANT TEMPERATURES DUE TO ROD CONTROL CIRCUIT CHARACTERISTICS.

MAIN STEAM TRIP VALVE CLOSURE

-- VALVES DID NOT AUTOMATICALLY TRIP SHUT ON MOMENTARY, 20 MILLI-SECOND SIGNAL.

-- NO LATCH IN FEATURE FOR VALVE CIRCUITRY.

533 035

CORRECTIVE ACTIONS

BUILDING FREEZING CONDITIONS

-- NEW ADMINISTRATIVE CONTROLS FOR CONTROL OF TURBINE BUILDING VENTILATION DURING WINTER OPERATION

-- ACCESS TO VENTILATION SYSTEM CONTROLS RESTRICTED BY PLEXIGLASS ENCLOSURES

INSTRUMENT AIR SYSTEM WATER CONTAMINATION

-- MODIFICATION TO INSTRUMENT AIR DRYERS TO IMPROVE RELIABILITY AND AVAILABILITY

STEAM DUMP CONTROL RESPONSE

-- CONTROL CIRCUIT GAIN INCREASED TO PROVIDE FASTER, MORE DEFINITE RESPONSE

-- COMPLETE CONTROL SYSTEM CIRCUIT CHECK AND CALIBRATION NOW IN PROGRESS. WILL BE COMPLETE PRIOR TO RESTART.

HEATER DRAIN SYSTEM RELIABILITY/STABILITY

-- HEATER DRAIN TANK HIGH LEVEL DUMP VALVE HAS BEEN DISABLED TO PREVENT SIMILAR CLOSURE FAILURES. OPERATION ACTION IS NOW REQUIRED TO CORRECT HIGH TANK LEVEL CONDITION.

-- A NEW VALVE AND ACTUATOR ARE BEING SOUGHT FOR INSTALLATION DURING THE FALL 1979 OUTAGE

-- PLANT POWER LEVELS HAVE BEEN LIMITED BY MANAGEMENT TO VALUES LOW ENOUGH TO PERMIT AVOIDANCE OF A PLANT TRIP OR ECCS ACTUATION ON HEATER DRAIN SYSTEM MALFUNCTIONS.

MAIN STEAM LINE TRIP VALVES

-- NO CORRECTIVE ACTION CONSIDERED NECESSARY BASED ON EXISTING SAFETY ANALYSIS CRITERIA.

-- VALVES OPERATE CORRECTLY WITH 200-500 MILLISECOND TRIP SIGNAL DURATION.

538 036