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EVENING SESSION

UNITED STATES OF AMERICA

NUCLEAR REGULATORY COMMISSION

ADVISORY COMMITTEE ON

REACTOR SAFEGUARDS

243rd MEETING

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

Thursday, July 10, 1980

The 243rd meeting of the Advisory Committee was convened, pursuant to notice, at 8:30 a.m.

Present:

MILTON S. PLESSET, Chairman
J. CARSON MARK, Vice-Chairman
RAYMOND F. FRALEY, Designated Federal Employee

JEREMIAH J. RAY
DAVID OKRENT
HAROLD W. LEWIS
JESSE C. EBERSOLE
WILLIAM M. MATHIS
MAX W. CARBON
WILLIAM KERR
DADE W. MOELLER
MYER BENDER
STEPHEN LAWROSKI
CHESTER P. SIESS

MR. MILLS: The other point of concern on the Brunswick event was that the reactor was fired up with the scan discharge volume vent and drain valves closed due to unavailability of repair parts. The vent and drain valves are normally open and should be open.

MR. CARBON:: Was that a tech spec violation?

MR. MILLS: It was not at the time.

MR. CARBON: It is now.

MR. MILLS: Tech specs went out I believe just recently, yesterday or today.

MR. NOVAK: Periodically you are required to test the closure time and it must close after an event. Because the closure time was slower than the tech spec requirement they decided, well, if you have the valve closed certainly that is closing very fast, but it didn't open and remained closed. That was the problem we had, the fact that the drain valve was closed. If you couple the fact that your level instruments were questionable then the concern of filling up that system prompted, I think, the bulletin and truly the answer to Dr. Carbon's question. It was a coupling of the two. There was a coupling there and I think that is what pushed the concern out and it was a valid concern.

MR. EBERSOLE: You are telling me they operated with the vent valves closed, correct?

MR. MILLS: Right.

MR. EBERSOLE: Now, did it successfully scram with the reactor vent valves already closed and not closed on delay function? Did it ever operate properly in that mode?

MR. MILLS: Yes. What happened in the Brunswick event was they had the vent and drain valves closed.

MR. EBERSOLE: Yes.

MR. MILLS: They were using the alarm and the rod block switches as a guide to when to drain the instrument volume. They didn't get any alarms and then they finally scrammed by high level in the scram discharge volume.

MR. EBERSOLE: And it scrammed successfully?

MR. MILLS: Yes.

MR. EBERSOLE: Which indicated it was all right to operate with the vent valves closed, right?

MR. MILLS: In that case, yes.

MR. SEISS: Wait, no. It was all right to operate with the water no higher than that top gauge.

MR. MILLS: The scram worked properly in that event.

MR. JORDAN: Could we clear the record on that. It was all right in that the rods were still scrammable and it was demonstrated they did scram, but it is not all right to operate with that vent valve closed, definitely not all right.

MR. NOVAK: One final comment. When we observed that we did ask every operating BWR what was the status of their vent line and drain line and they were all open at the time.

MR. MILLS: When we reviewed that event it did show the lack of tech specs in that area. There were no tech specs, for example, to require operable vent discharge volume vent and drain valves. Even on the closing time, the only one I am aware of is a closing time for an isolation function, but as far as the scram function there was no tech spec.

So required operable scram discharge volume vent and drain valves required the valves to be open during normal operation and a periodic testing of the valves.

Operable rod block and alarm switches were required to provide the maximum information to the operator on the condition of instrument volume. Those were required to be periodically tested.

Also the bulletin will provide failure data on this problem to view the potential for a common cause failure of water level and other common problems.

MR. KERR: Why does one need to require that the alarm and rod block switches be operable?

MR. MILLS: The thought there was to provide the operator with the maximum amount of information that is available or that could be made available to him. They pont out in the tech spec the alarm switch was not included in the tech spec.

Our findings to date with regard to the bulletin, the immediate survey showed no plans for operating with the vent and drain valves closed. They were all open.

The 45-day reports are due July 27th so we haven't gotten any detailed reports yet. However, we have had a report of inoperable rod block and alarm switches at Browns Ferry as a result of the investigations made down there as a follow up to the June 18th report.

That concludes what I had on the Hatch and Brunswick.

Are there more questions?

MR. OKRET: You seem to feel that a water hammer, or some kind of a two-phased system going to a one-phase system or something like that that led to severe forces on the pipe and so forth. Have you arrived at any conclusion as to why this potential is okay or how one might uncover such a potential or are there any kinds of other generic ramifications? Presumably had one anticipated at some earlier time that a water hammer could occur here and incapacitate all the switches or do something else or whatever one would have thought about it. So I am trying to ascertain what the generic ramifications of the water hammer occurring here ar .

MR. MILLS: My thought is that if the vent and drain valves operate as designed the system should not experience this type of water hammer event. By requiring the periodic surveillance and requiring the operability of those valves that decreases the potential for a water hammer.

MR. LEWIS: It is never sufficient to say that if everything operates normally we are okay. We have here obviously the potential for an event which will damage a lot of rod drives. I can't believe that the system hasn't been scrubbed over the years for such potential. That was just a comment and not a question.

MR. EBERSOLE: Will you throw up the diagram again so I can make another comment.

MR. MILLS: I would make one comment on your comment. I have had discussions with the General Electric Company and they have indicated that they see no potential for a water hammer at all in that system.

MR. OKRENT: Have you explained the source of the forces that bent the piping?

MR. MILLS: General Electric Company?

MR. OKENT: Yes.

MR. MILLS: No, we haven't really gotten to that point, to that kind of detail yet in our follow up on this.

MR. SEISS: Why is that a detail? The piping is bent. You said it is a water hammer and GE says it can't be a water hammer. That sounds fairly fundamental to me.

MR. PLESSET: Let me suggest that it may be a little premature or the wrong time to pursue this and I think we will come back to it.

MR. SEISS: I don't think the staff is pursuing the right question.

MR. PLESSET: Well, that may very well be.

MR. SEISS: At Brunswick how long did it take for the water level in the instrument volume to reach the high-high scram level? In other words, how long elapsed between the time they closed the drain valve and the time it scrammed on high-high?

MR. MILLS: I don't know the exact time. I know they started up on November 10th and received the scram on the 11th.

MR. SEISS: Have you any idea how much longer it would have taken for the water level to rise to a point where it would not have scrammed?

MR. MILLS: I can't really make an estimate on that because I don't know.

MR. SIESS: Is it days? Th relative volumes, how much volume is relative?

MR. MILLS: The instrument volume is significantly smaller than the scram discharge volume. The instrument volume goes about a hundred gallons and the scram discharge volume is on the order of seven hundred.

MR. SIESS: You need all of the 700, do you?

MR. MILLS: No. You only need on the order of about 150 at that point.

MR. SIESS: So it might have been five or six more days or something like that?

MR. LEWIS: Well, it might have been one day because we don't know where the high-high is.

MR. SIESS: The water was presumably due to leakage coming through the scram valves and that could have changed.

MR. PLESSET: Well, I am proposing that we have another discussion of this when the staff has had a little more time to be a little clearer in their own minds as to what went on. I think that would help. Otherwise we are spinning our wheels a lot.

Very short, Jessie.

MR. EBERSOLE: Yes, I want to add some substance to what might be a discussion. In view of this horrible design with its commonality will the staff give some consideration of putting an excess pressure relief in that piece of pipe between the rod drive exhaust and the first pneumatic operated valve, that short piece right between -- no, no, the other side, there --at each rod drive put an excess pressure release and thereby destroy the commonality of the dump function. That would dump to the containment. Then if the system didn't work properly it would be a proper punitive consequence to go out and clean up the container.

MR. MILLS: I am sure design changes of various types will be considered on this system especially as a result of the Browns Ferry event.

If there are no more questions on the Hatch and Brunswick event then I will move on to the Browns Ferry event of June 28th.

At approximately 1:30 in the morning the operative manual scram unit lost 30 percent power for a shutdown to the fail feedwater leak. All the rods on the west side were fully inserted. On the east side 13 rods traveled full length and five were already inserted for a total of 18 rods fully inserted on the ease side. Seventy-six rods remained partially inserted after the first scram.

The operator reset the reactor protection system, allowed for a short draining time in the scram discharge volume and initiated another manual scram. This time rods on the east side moved approximately 12 inches further into the core and 34 rods were fully inserted.

They reset the reactor protection system again, had another short drain of the scram discharge volume and initiated another manual scram. Rods on the ease moved approximately seven inches further into the core. Fifty-six rods were fully inserted at that time.

They then reset the reactor protection system, allowed for a longer draining time of the scram discharge volume and moved the scram discharge volume switch from bypass to normal and received an automatic scram because of the still high scram discharge volume Then all rods on the east side were fully inserted.

At this point here the power level on the east side was minimal as observed by local power range monitor readings.

This shows how the control rod drives are dispersed throughout the core electrically by groups for different electrical groups. There was no electrical malfunction determined that could cause an east only scram. An electrical malfunction would result in rods being dispersed throughout the core that were not fully inserted.

This is a functional diagram of the reactor protection system. This point here is just that all four rod groups are contained in each reactor protection system channel. Cannel "A" contains all four rod groups and channel "B" contains all four rod groups. Both channels have to be de-energized in order to get a reactor scram. So again the rods would be expected to be dispersed throughout the core for an electrical malfunction.

The rods are, however, connected hydraulically through the scram discharge volume. The rods on the east side of the core exhaust to the east scram discharge volume and the rods on the west side exhaust to the west scram discharge volume.

Evidence to date indicates that the most likely cause of the Browns Ferry event was water in the east scram discharge volume. While the exact cause of the water is not definite a test has been run by TVA which demonstrates that if the vent is inoperable water will be help in the scram discharge volume and draining will not be complete.

The two most likely causes, the reasons for the water in the east header are an inoperable vent line or valvé for blockaging the system.

MR. LAWROSKI: What are the distances, the real distances?

MR. MILLS: To the east head it is approximately 150 feet of 2-inch pipe.

MR. EBERSOLE: Are those discharge volumes horizontal pipes?

MR. MILLS: Yes.

MR. EBERSOLE: So there is no real head in them?

MR. MILLS: This is a horizontal pipe which sits up approximately 25 feet above the instrument volume.

MR. EBERSOLE: Are they treated as two independent volumes or one total volume?

MR. MILLS: Treated in what sense?

MR. EBERSOLE: With monitoring equipment and vents and drains -- well, no, you have a common drain. What about vents?

MR. MILLS: They have a common drain. Each side has its own vent.

MR. EBERSOLE: Only one vent on each side?

MR. MILLS: There is one vent on each side. Let me put up a little more detailed drawing. There are multiple headers. There is one vent on each side but it is headed for each of the six-inch pipes here. There is commonality through the instrument volume.

MR. OKRENT: These six-inch pipes are vertical pipes or horizontal?

MR. MILLS: This is a horizontal pipe. There is a slight draining slope on it.

MR. LEWIS: I am a little confused by the count because on one of the diagrams it says typical of six. Am I not looking at the scram discharge volume on that diagram. That is Figure 7-1-6 in your handout, the third page of your handout.

MR. MILLS: Where it is on the level switch on the instrument volume?

MR. LEWIS: Oh, there are six level switches.

Thank you. Got you.

MR. MILLS: Investigation into the cause of the event at Browns Ferry including a complete hydraulic control valve alignment. All the valves on the hydraulic system on the control rod drive were vertified to be in a correct position. Short after the event, I think that was completed that morning by 5 o'clock. The east main vent valve was verified to be operable.

The only anomaly found with the vent at the time was after the vent valve was found to be operable and was disassembled. A vacuum pump was hooked up to draw a vacuum in the vent line and it proceeded to vent better, in other words, away from the scram discharge volume. A vacuum was observed of about nine inches of mercury and then it dropped off to approximately two inches, which was really to zero on the scale. So there was about seven inches of mercury vacuum. No debris could be found after that test and there is no conclusiv evidence found as a result of that test.

Thirty-five rods were friction tested almost immediately. The calibration was begun for the 3, 25 and 50 gallon level switches. The 3 to 25 were found to be sticky and operated after being tapped. All the scram switches were operable. Radiation surveys were done. The drain sump was sampled. The reactor coolant was sampled. All gas radiation levels sampled. No anomolies were found. There were visual and mechanical inspections of the vents and drains on the scram discharge volume. It showed no anomolies. No maintenance or modification had been performed that could affect the control rod drives. The scram history was reviewed for any previous occurences. No relevant occurrences were found. Various tests were performed and a flow and draining of the scram discharge volume.

Evaluations and inspections were performed to assure electrical separation and diversity. The General Electric Company performed extensive evaluations and inspections. Scram actuators were tested to ensure that they de-energized properly. The two-inch drain line that we saw before, the 150 feet line was cut at several places and inspected. No blockage was foun. in that line. The scram discharge instrument volume was inspected with a Boroscope. No debris was found in there. The drain tank was inspected and nothing was found there either.

The potential of electric malfunctions to be the cause was evaluated. Response times for de-energizing the scram polots were found acceptable. The scram groups were found to be as we discussed before, not separated east and west but dispersed around the core. Scram valves for each control rod as operated as verified by blue lights indicated in the control room, the operator got the blue lights which come off of limit switches and the scram valves, the inlet and the exhause valve, which indicated that those valves had opened and that the electrical function had been completed. Immediate inspection of the scram group fuse cabinets was completed. That is a point of commonality which could be postulated that the power supply could be inadvertently connected. Nothing was found there. No adnormality.

Based on this the logical conclusion is that electrical malfunctions could not have created the West only scram.

Unit 3 is undergoing extensive testing of the scram discharge volume in the control rod drive system and the drive performance. Verification testing, first of all, in the UT method to determine if there is water in the scram discharge volume independently of the level switches. The vacuum hose test showed that if the vent path were blocked that the vent valve would close and water would be held up and draining would not be complete. The drain test demonstrated that it would drain properly if the system were in normal alignment. Friction tests had been completed on the drive. No abnormalities have been found. The scram testing under various conditions will be performed for each of the drives on the east side.

MR. PLESSET: How much longer do you need?

MR. MILLS: I only have two more slides after this.

MR. PLESSET: Can you make it real short?

MR. MILLS: Yes. Browns Ferry has implemented a UT check in the scram discharge volume piping to inspect for water following each scram. The shift crews have been inspected on how to respond to an event of the type that occurred there. They have increased their surveillance of the scram discharge volume level switches. They have checked the valve alignment on the control rod drive system once a shift. Unit 3 will remain shut down until the NRC concurs in the restart.

MR. OKRENT: I don't understand everything and how it is connected on that previous viewgraph. Could you put it on for a minute?

If we had water which didn't drain because the vent valve was closed would you expect to find anything on those float type instruments?

MR. MILLS: No. If the water were held up above in the discharge volume then you would not expect to see any.

MR. OKRENT: Now, could you have water in that discharge volume if the scram had not occurred due to leakage, for example? Could it be held up having gotten in with the vent valve not functioning properly? Is the question clear?

MR. MILLS: Water couldn't have gotten in there from leakage. If the vent valve weren't functioning properly from the last scram water could have remained in there and not drained out from the previous scram.

MR. OKRENT: No. 1 item says UT check of scram discharge volume piping for water after each scram. My question is can we not get water in for that scram discharge volume without a scram and could it be held up?

MR. MILLS: The sources of water would be, for example, the leakage through the vent exhaust valve which I mentioned. That one would not be expected to be held up because of the level and the leakage rate would be very low and should trickle through the system. Another source of water could possibly be back up through the vent. If somehow you were in a closed system and it was siphoning water back through the vent water could enter that way. Another source of water would be back up through the drain and that one you would expect to detect from the level switches. The only other source of water I can think of would be the flush lines that are connected onto the header.

MR. EBERSOLE: What do you mean by item two?

MR. MILLS: In essence they have been instructions on how to respond if they had to

MR. EBERSOLE: Does that include instruction to avoid wash out of boron?

MR. MILLS: That specific question I can't answer from the procedures.

MR. EBERSOLE: It is important.

MR. MILLS: My understanding is that that has been definitely considered, and if they haven't overreaction to this event it wouldn't initiate standby liquid control prematurely.

MR. EBERSOLE: By having done so they would keep it in the reactor.

MR. LEWIS: I am a slow learner. Could you remind me why setting the scram discharge volume to normal fixed everything. I lost track. What does that do.

MR. MILLS: What I meant to say at that point was that moving the scram discharge volume switch and causing automatic scram in no way is viewed to play the part different than a manual scram. It really was just another scram. The part that is probably more significant is that you waited for the scram discharge volume to drain longer because drain time before that scram was over four minutes. After previous ones it was like 53 seconds, a minute and half and things of those types.

MR. KERR: I was curious because the times you had listed indicated six minutes between scrams. What do those times mean then?

MR. MILLS: The six minutes is the time between manual scrams. In order to drain you have to reset the scram that is already in there. In the six minutes you resets the scram and then the scram instrument volume drain and vent valves open and you can drain that system, but you can't drain the system until the scram is reset. Then the other times shown is when you initiated the second manual scram. The total time between scrams is made up of a reset time plus a draining time. The total time was six minutes, let's say, in the first case. Of that six minutes four and a half minutes were prior to the reset and a minute and a half were after after the reset when the draining function could be effective.

MR. KERR: Thank you.

MR. LEWIS: Still, you know, I am a slow learner. What does normal mean for the scram discharge volume switch?

MR. MILLS: When you get a reactor scram it fills up. Normal means that that scram function is in effect. In order to reset the scram you have to bypass that scram. So the operator takes that switch and goes from normal to bypass and the bypasses the scram and the scram discharce volume high level.

MR. LEWIS: Then it says he resets it to normal. I am trying to understand. I am just being ignorant.

MR. MILLS: After he had given it a four-minute drain time he, and I am guessing, maybe he thought it was already drained so he went from normal to bypass. In any event, that is what he did. He just took that switch from normal and put it into bypass which then put that scram signal back into effect.

MR. LEWIS: You said he turned the switch from normal to bypass. I think you meant to say bypass to normal.

MR. PLESSET: I know the members want to clear things up instantly. I am going to propose that we come back to this later on. We will have one of our ACRS fellows describe to us at an early date in terms that I think we will understand. So if you don't mind we will terminate this presentation.

MR. OKRENT: I only have one question. Did we hear what it was that prevented the rods from going in the first time? Did you tell us?

MR. MILLS: Evidence points to water in the east header of the scram discharge volume.

MR. OKRENT: You didn't tell us why that water was held up there, did you?

MR. MILLS: The reason why it is held up has not been shown definitely.

MR. LEWIS: Did you overstate the case that evidence indicates that or that lack of any other cause suggests that?

MR. PLESSET: Well, let me again say that I think we will come back to this. We are going to really dig into it. It is not a trivial matter and we all very much concerned. We are going to have a rather lucid presentation I promise.

MR. LEWIS: Tomorrow.

MR. PLESSET: No, not tomorrow, at the next meeting. Let me go now, if that is agreeable, because I think otherwise you are going to get very poor return on your mining efforts.

SPEAKER: And a long night.

MR. PLESSET: Yes, and a long night. We are not at all losing one whit of our concern in this whole matter, but we do want to understand it thoroughly.

Mr. Gridley of GE wants five minutes, and it is five minutes and not six. So will you come forward.

MR. GRIDLEY: My name is Dick Gridley. I am Manager of Fuel and Licensing Services for the General Electric Nuclear Energy Business Group.

I would like to summarize the actions which GE has taken with the TVA people to help determine the cause of the scram incident at Browns Ferry on June 28th and to describe our actions to prevent future occurrences.

I will cut my remarks and be as brief as I can recognizing the time and certainly would be very interested in coming back again at the next meeting. Bill Mills has describe quite well the facts that we learned at the site. I would like to just state that TVA notified General

Electric of the partial insertion of the east bank rods the same day that it occurred. The GE operations engineer was already on site and we had direct telephone conversations and consultation underway that day.

Following the notification of TVA on the 28th GE set up and initiated in fact direct telephone consultation with the site. In addition, we established a management and engineering task force in San Jose and at the Browns Ferry site to assist TVA in the evaluations and the tests and the analysis that followed.

I was going to describe some detail as to GE's and TVA's efforts in determining the cause but Bill has quite readily concluded that the mechanism of the scram failure was water in the discharge volume. Why the water was there we still have not placed a firm convincing handle on it. We know that the most likely cause was either the vent system or blockage or restriction in that long two-inch header.

As a result of our evaluations guidelines were sent to each operating utility on July 7th which reinforced existing procedures to the operators should such an incident occur at their plant in the future.

We have also recommended interim UT monitoring techniques as a more positive means of verifying absence in the scram discharge volume. Also we are checking to be sure that the instrumentation associated with the system does function properly.

We believe that the monitoring techniques and the operator guidelines are adequate to ensure that the incident does not occur in the near future. We base this confidence on the fact that we have had over 300 reactor years of operating experience with complete scrams during that period.

The results of thousands of scrams at San Jose test facility also gives us confidence that there are no fundamental problems with the basic design of the control rod drive system itself.

I would like to just take one more minute and summarize what we see in the future. We are currently working on a design of the system for a continuous monitoring of that scram discharge volume. This system will provide an alarm which will signal the need for operator action if the level reaches a predetermined value.

Currently we are considering either an ultrasonic or a conductivity probe as an installed sensor in this scram discharge volume.

In addition, GE is evaluating the design requirements for venting and draining of the volume. We expect to have recommendations for our customers in a timely manner.

With that brief statement I will stop and take any questions if we have time.

MR. PLESSET: Let's just take a few.

MR. MARK: Have you tried in some test facility to see if putting a monitor in that long place you can get similar effects as this?

MR. GRIDLEY: Yes, we have. We conducted in control rod drive test facility in San Jose in a configuration that similated Browns Ferry scramming a production drive with varying volumes and we got exactly the same condition.

MR. BENDER: What is meant by the operator action following the sonic signal?

MR. GRIDLEY: We are trying to determine by that method whether there is water present in the scram discharge volume. If there is water in that volume then, you know, he needs to take action to shut the plant down. I might add that in scramming versus, you know, controlled shutdown, the impact on the system is completely different.

MR. BENDER: The term "shut the plant down" doesn't convey quite the message I wanted.

MR. GRIDLEY: I guess maybe I need some help on this. The procedure that we have indicated for the operator to evaluate is if he has presence of water in the scram discharge volume he would immediately start inserting rods, but I think now I am on shaky grounds because I am not sure that we have looked at the procedure other than following normal shutdown.

MR. BENDER: We don't need to know now. Thank you.

MR. OKRENT: Normal shutdown is not easy and is not fast. You can do it by putting in one rod at a time and so forth, but I don't know whether you have that kind of time if you don't know how the water is getting in and at what rate.

MR. GRIDLEY: That is a good question. I really don't see any problem with proceeding with a normal shutdown, but I think we need to evaluate that and decide whether or not there is a need for more expedient action.

MR. LEWIS: I can't resist a probabilistic comment. Sure you want higher reliability for the scram system than you can justify on the basis of operating experience so far. So that is not a good argument.

MR. PLESSET: It is so different from other numbers we have heard in the past, but we don't need to belabor the point. I think it is pretty clear.

Mr. Lellouche isn't here to revise his numbers.

(Laughter)

So thank you, Mr. Gridley. We are going to pursue this and you will be in touch with us and vice versa.

MR. GRIDLEY: Thank you.

MR. PLESSET: I think that I am not going to let you have a break until we finish the discussion of the St.

Lucie Unit 1.

MR. KERR: Mr. Chairman, I don't think we should give the wrong impression. This reactor was shut down.

MR. PLESSET: Oh, yes, I agree.

MR. KERR: When the button was pushed half the rods went in. The incident is certainly serious.

MR. PLESSET: Yes. That is all I meant, that it was a serious incident and one in which we are continuing to be concerned and we want to understand it quite fully.

Let's go then to this St. Lucie Unit 1 item.

MR. JORDAN: Ed Blackwood is going to give you a presentation on the St. Lucie event. There are other NRC staff here to back up the presentation. So, Ed, why don't you proceed.

MR. BLACKWOOD: Edward Blackwood. This is an agenda of the items I would like to discuss briefly with you this afternoon.

First of all, site description and event description we will spend probably a little bit of time on and I will be glad to answer any questions you may have. The areas of specific interest dealt with the reactor coolant pump seal performance, steam void indications in the reactor vessel head and anomalous solid plant indications.

Now, following this Brian Sheron of the staff will discuss the safety impact and the future actions regarding steam voiding the reactor vessel head during natural circulation cool down.

This is self explanatory. It is a brief description of the St. Lucie site and the type of reactor and some other details. The criticality of this cycle was May 7th, 1980, and following the loss of component cooling water they restarted on June 30th and achieved 100 percent power on July 1st.

This is a summary of the sequence of events which I believe are significant to the three areas of interest which we have.

At time 0226 on June 11th valve 14-6, which is one of the series return valves from the component cooling water coming back from all four reactor coolant pumps failed to shut. It failed to shut as a result of a short in a terminal board that was associated with the solenoid air operated valve which in turn operates the component cooling water valve.

This is a rather busy print but the area of interest is the component cooling water which cuts in this way and penetrates the containment and goes through all four reactor coolant pumps which are in parallel and then a common return line coming back. Valve 14-6 is this air operated valve right here, one of the two series isolation valves in the return line. This the one that failed to shut. The air operated solenoid valve is here and the power to this valve is what failed due to a short in a terminal box that was located approximately two feet away from it.

After a brief attempt to restore component cooling water at time 0233 the reactor was tripped manually from 94 percent power. Within two minutes all four reactor coolant pumps were secured and a minute or so later 1-B reactor coolant pump was restarted and run for approximately one minute in order to enhance natural circulation.

At time 0300 the natural circulation cooldown was commenced.

At time 0350 the failed component cooling water valve was reopened by jumpering an airline around the solenoid valve who power supply had failed.

The cooldown continued uneventfully until around 0600 or slightly thereafter. At 0600 they depressurized, or started the depressurization from 1,140 pounds down to 690 pounds charging ia he a ilia a kr'ssurdz'r.

Since reactor coolant pumps were not operating there was pump induced spray because there was essentially no differential pressure across the core. That is why they have an auxiliary spray line.

MR. LEWIS: Is it a normal procedure by the way to start a pump to enhance natural circulation and to run it for a minute like that?

MR. BLACKWOOD: I don't know. They wanted to make sure they didn't set up a reverse flow. It was that type of a situation.

Between 0600 and 0630 they depressurized, and around 0615 they noted variations in pressurizer level that were a little bit off normal.

Now, between time 0630 and 1230 they alternated charging to the auxiliary spray line to cool the pressurizer down and allow them to depressurize and to the reactor coolant loops the rest of the time to make up for contraction in the system due to cooldown.

Between 7 o'clock and 7:30 they had initial indications that there may be voiding in the reactor coolant system somewhere other than the pressurizer. At this time the subcooling, that is, saturation temperature for pressurizer pressure minus hot leg temperature ranged between, it says 200 here, it was actually between 220 degrees at 0600 and about 150 degrees around 0730. So at all times they had adequate subcooling regarding the bulk coolant that was circulating via natural circulation through the core, the loops and the steam generators.

At time 1051 pressure and temperature were down far enough to start a low pressure safety injection pump in the shutdown cooling mode.

From 7:30 until right around 12:15 they experienced rather large variations in pressurizer level. These were not uncontrolled oscillations. They were controlled by whether they chose to charge into the pressurizer via the auxiliary spray line or charge to the cold legs.

MR. OKRENT: When they started the LPSI were they adding water to the primary system?

MR. BLACKWOOD: No, they started it in shutdown cooling.

MR. OKRENT: The recirculation mode?

MR. BLACKWOOD. The shutdown cooling mode.

Now, this is a good place to look at the trace of pressurizer level. It is in two parts. You will notice the reactor trip at time 0233. The solid line across here is programmed pressurizer level.

MR. LAWROSKI: Excuse me.

MR. BLACKWOOD: Yes.

MR. LAWROSKI: Could you use the pointer on the table there.

MR. BLACKWOOD: The solid line is the programmed pressurizer level and, as indicated, this is one channel of the hot calibrated pressurizer level which they had selected for the recorder.

From time 0600 to 0630 they depressurized as indicated, and around 7 o'clock they noted a rapidly increasing pressurizer level at a much faster rate than the charging rate.

Now, further on in the morning they did a couple of tests and determined that the rise in pressurizer level was approximately a factor of 10 greater than the charging rate. Throughout most of the cooldown they were charging with two coolant charging pumps at a rate of 88 gallons a minute.

Around 7 o'clock to 7:30 they had pretty good indications that there was a void in the system somewhere other than the pressurizer.

There were a number of things that happened in here during this dip in pressurizer level. They recovered it and essentially continued the pressurizer cooldown and the natural circulation cooldown.

MR. EBERSOLE: This occurred after they were on shutdown cooling, right?

MR. BLACKWOOD: No.

MR. EBERSOLE: Before?

MR. BLACKWOOD: Shutdown cooling occurs at time 1051.

MR. EBERSOLE: Got it.

MR. BLACKWOOD: Right about here.

MR. KERR: What was the system pressure at that point?

MR. BLACKWOOD: At the point they went on shutdown cooling? I would say 200 or 250 pounds, something like that. There is an administrative requirement that it be less than 300 or 350.

MR. MOELLER: What was the explanation on the previous chart of a drop in the pressurizer water level?

MR. BLACKWOOD: I will explain that.

Throughout the morning during the pressurizer cooldown the level did this, basically it sawtoothed. The explanation is that during the charging into the pressurizer via the auxiliary spray line they saw these very rapid rises in the pressurizer level and that is attributed to collapsing the steam bubble in the pressurizer due to charging in relatively cool water from the auxiliary spray line.

Now, during most of the morning letdown was secured and that would have caused the charging water into the auxiliary spray line to be roughly the same as volume control tank temperature water which was I would say roughly 120 degrees or something like that. So it was relatively cool water. They were able to collapse the bubble in the pressurizer very rapidly and the resultant insurge that caused this rise in pressurizer level was expansion of the steam void in the reactor head.

Now, during the down ramps they were charging via the cold legs and we don't attribute that charging to having very much to do with the decay in level. The explanation for the decay off in level is that spraying into the pressurizer steam volume is really a transient effect in the cooldown in the shell of the pressurizer. You don't completely cool down all of the water in the bottom half of the pressurizer either such that when they weren't spraying down the steam bubble in the pressurizer was experiencing some amount of reheat which was enough to cause it to expand against the void in the reactor vessel head. As a result there was an insurge back through the surge line into the reactor coolant system.

Down in this area the surges get pretty violent and they were concerned right around noon that they may reach a condition where they would have saturation in the loops. They had roughly 50 degree subcooling at a little after noon, let's say, 12:10 or something like that. They were in a rather difficult position because if they charged into the loops, and they had pressurizer heaters out by this time. They had pressurizer heaters and they were trying to recover the pressure. They were at about 110 pounds or so, right around here at time 1215 with 50 degrees subcooling.

As they charged into the loops they would see the rapid decrease in pressurizer level which they could not keep up with the charging pumps. They had isolated letdown and they were worried about uncovering the pressurizer heaters which would not enable them to use the heaters to try to regain pressure control.

The only alternative was to charge via the auxiliary spray line, or in this case charge for short periods of time via the auxiliary spray line in order to keep the pressurizer level on scale.

Now essentially what they were doing here was maintaining the steam void in the reactor vessel in order to keep the pressurizer level on scale in order to run the pressurizer heaters. So it was somewhat of an untenable situation. That is why at time 1226 they started the one alpha low pressure safety injection pump in the injection mode takin the suction from the refueling water storage tank and discharging into a common header. We will come back to this one a little bit later.

MR. OKRENT: Is there a drawing of what the level in the vessel was at this time?

MR. BLACKWOOD: No, that is not indicated.

MR. MOELLER: At that time at 1226 or whatever it was then the pressurizer is solid?

MR. BLACKWOOD: Well, they thought it was solid and I am getting to that.

At time 1227 they started the pump in the injection mode and by time 1230 the pressurizer level trace you have here is a hot calibrated level. They also have a cold calibrated channel, that is calibrated at ambient temperatures, for water in the pressurizer at ambient temperatures.

Now, at this point water in the pressurizer was at approximately 350 degrees and they did not have any sort of density conversion such that they could correct that cold calibrated level indicator. Now, that level indicator went to about 64 percent and remained constant right around time 1230. They were charnging water at approximately 88 gallons a minute. The pressurizer level at hot leg was pegged high which they expected. The cold leg was steady at 64 percent. They knew that that was not an accurate reading, but since it wasn't moving they thought that the pressurizer at that point was solid.

Now, the anomaly here was that if the plant was solid and they were charging at 88 gallons a minute they should have seen a pressure increase, although they didn't see a pressure increase. So this was cause for concern. They investigated possible leaks. They did valve line-up checks on the shutdown cooling system, the low-pressure safety injection system. They looked at containment levels and other auxiliary tank levels and everything trying to do an inventory balance to see if they could find out where this 88 gallons of water was going.

Now, at around 1300 they found the miniflow isolation valve on the 1B low pressure safety injection pump had just cracked open. At that time that valve was shut.

They continued injecting from the refueling water storage tank the LPSI pump 1A until time 1357 at which time they noted a slight increase, the width of a pen essentially, in the refueling water tank level. Now, the width of a pen at 15,000 gallons a foot in the refueling water tank amounts to about 5,000 gallons of water that somehow or other ended up in their refueling water tank that wasn't there before.

So at that time they secured the 1A pump which was in the injection mode. They shut the miniflow line motor operated valves and they also noted a slight rise in pressurizer level and a slight rise in pressurizer pressure. The pressure went from 200 pounds which it had been pretty much constant during the injection time frame, and from there it went to roughly 260 pounds. So they regained some normal indication of charging at 88 gallons a minute.

They maintained pressurizer heaters on throughout this time. By time 1500 they had drawn a bubble in the pressurizer and drained back to the indicating range, and by time 1600 they had moved back to the pressurizer level trace. By time roughly 1600 or so with charging greater than letdown in this area they had regained normal indication or normal plant response for charging with two pumps at a rate greater than the letdown flow.

Now into the areas of specific interest. Reactor coolant pump seal performance is the first one I would like to discuss.

MR. OKRENT: Excuse me. Was the Incident Center notified of this during this time period?

MR. BLACKWOOD: Yes. I was called at 3:15 in the morning. After a couple of failed attempts to get a confernce call going I just decided to go in and I got there about a quarter to four and I stayed from then through 4 in the afternoon. So I was there pretty much the whole time.

Now, I think around 8:30 or so I had made all the notifications. The operations center did not have knowledge of the variations in pressurizer level at that time. I left instructions with the plant to call me if they had problems and in any case when they got on shutdown cooling, which they did. I was notified about 11:15 that they were on shutdown cooling.

Now, at 11:39 after watching the pressurizer level and by that time, going back to this picture, you will note that the swings were becoming a little bit more severe than they had been earlier in the morning. At time 1139 the licensee called the operations center back and then I went back in there and stayed until about 4 o'clock or so. It was at time about 1139 that they called and said they thought they had indications of a steam void some place other than the pressurizer. It was about that time that they were becoming concerned over their ability to stay above loop saturation, which I have already discussed.

MR. MOLLER: What triggered their call to the incident center? In other words, at which particular point does it trigger them to call?

MR. BLACKWOOD: Well, the first call was pursuant to 50.72 because they had an unscheduled reactor trip.

MR. MOLLER: Well, that was several hours before they called.

MR. BLACKWOOD: No, they called at time 0233 and they called the operations center either a little before 3 or right around 3.

MR. MOLLER: Oh, I am sorry. I was thinking it occurred earlier. Well, then, what would have triggered you to initiate action at the incident response center in terms of having the chairman out and so forth? How far would this have had to have gone before that was done?

MR. BLACKWOOD: Ed, would you care to answer that?

MR. JORDON: Certainly if those diversion oscillations had continued any further that would have been basis for activating the operations center. In terms of the licensee's response, we have already conveyed to the licensee his lack of advising us of this I would say unstable performance in terms of the charging flow and the change in pressure and change in level which indicated a void in the reactor vessel. That is something we should have been notified of immediately.

MR. MOELLER: So if you had been notified of that earlier you might have activated the center?

MR. JORDAN: We would have been manning the center during that particular phase and understanding it and been ready to activate. We had manned up until 8:30 or so in the morning and then people went back to normal duty stations with the duty officer still in the operations center.

I would like to make a plea at this point in terms of the nuclear data link. This would be, I think, one of the best examples we have had where the nuclear data link would have provided the operations center with the right information as opposed to erroneous information.

MR. MOELLER: Then you would have had this plot?

MR. JORDAN: That parameter would be plotted, yes.

MR. MOELLER: Thank you.

MR. KERR: At what point did you man the emergency response center with 50 or 60 people?

MR. JORDAN: We did not activate the operations center. I will differentiate. Activate means that we have called in the chairman and the directors. We manned it which is a convenience for placing proper staff there to monitor particular questions.

MR. KERR: How many people were there, the duty officers?

MR. JORDAN: The manning was like three people.

MR. BLACKWOOD: It was two or three in the morning.

MR. KERR: Had you had this information would you have called in the full force at some point?

MR. JORDAN: I don't believe with the occurrence as it was going on had we had the information we would have activated the center. We would have continued to man it.

MR. KERR: All right. So with the nuclear data link what would you have done differently than what you did?

MR. JORDAN: I believe we would have been able to advise the licensee that he had indeed a void and to repressurize.

MR. BLACKWOOD: I believe the licensee knew they had a void but they were still very concerned about the integrity of the reactor coolant pump seals. They had been without cooling water for approximately an hour and a half. They were run for about eight minutes. The vendor's recommendation was don't run them without component cooling water for more than seven minutes due to motor considerations and ten minutes due to seal considerations. So they were still very concerned about the integrity of the seals even though they had re-established component cooling water flow about 4 o'clock. As a result they wanted to cool down and depressurize as rapidly as possible. They maintained between 65 and 70 degrees per hour cooldown rate.

MR. KERR: What would you have told them to do differently than they did?

MR. JORDON: I believe that our instructions would have been to repressurize rather than to play with that.

MR. KERR: So you would have taken over control of the reactor?

MR. JORDAN: Not without activating the center clearly. We would have been in an advising mode.

MR. KERR: I thought you said you wouldn't have activated the center with that information.

MR. JORDAN: Yes. I will try again. We would be in an advising mode and we would be recommending to them to repressurize.

MR. KERR: Let's not play games. Would you have told them to repressurize or not?

MR. JORDON: I would not have ordered them to repressurize at that point.

MR. KERR: You would have said, I think that is the thing to do, but you wouldn't have ordered them?

MR. JORDAN: We would have asked them to consider it at that point. That is correct.

MR. BLACKWOOD: I think I would have addressed the pump seal integrity. They had re-established cooling water flow to the pumps and chances are there was really no great need to depressurize at that rapid a rate. In other words, if it slowed the thing down, then either ambient losses or heat conduction through the upper head down into the other reactor internals would have ---

MR. KERR: Did they have a shift technical advisers?

MR. JORDAN: Yes, they did.

MR. BLACKWOOD: Yes. They had about six shift technical advisers.

MR. KERR: Those guys would have apparently reached different conclusions than you would have, I gather, because in retrospect you would have told them not to depressurize.

MR. BLACKWOOD: No. I would have explored whether or not their concern for the integrity of the reactor coolant pump seals was great enough for them to continue to depressurize at this rapid a rate.

MR. KERR: Well, clearly it was because that is what they did.

MR. JORDAN: Let me go back to the seals then.

The seals had had cooling water re-established. The pumps were not running.

MR. KERR: I am not trying to judge which group of people would have made the better judgment. It seems to me from what went on that they had a shift technical adviser and other advice. They reached a conclusion. What I seem to be hearing is that you gentlemen would have reached a different conclusion with the same data. Am I missing something?

MR. JORDAN: I think we would have reached it perhaps sooner and would not have wanted to continue toying with a bubble in the reactor.

MR. LEWIS: You are dealing with a very important question here if you decide that they ought to depressurize. You started out by saying you would recommend it and then backed off to saying that you would recommend that they consider it and those are two different things.

I know that in the aviation business the game is played that everything that FAA tower controller says to me is purely advisory. He never gives me orders. But if I disobey his advice they will lift my license and not for disobeying the orders but for operating the airplane recklessly.

When you give advice to an operator at a plant which is in trouble he is going to have this kind of thing running through his mind and I think he is not going to be dealing with the legalisms of whether you say to him is advisory or mandatory until these things are really unscrambled which may be years. So this is a test case for a very important issue.

MR. JORDAN: I understand, but I wouldn't want to disrupt the discussion of St. Lucie for it. I would be willing to go into it in much more detail if you wish.

MR. BENDER: How much interviewing and discussing of the event is being carried on with the operators now? I am more concerned with the matter of just the communications problem that arises at a plant like this since you now have the shift technical advisers. It is a pretty good test case of how effectively the internal manning arrangement is.

MR. JORDAN: In terms of this event how much interviewing we have done?

MR. BENDER: Yes, just to see whether the new arrangement is doing things. Who is making the decisions? The fact that there were six technical advisers there, was that better or worse than having none, among other things.

MR. BLACKWOOD: We asked the licensee during a meeting on June 20th that specific question and they said, yes, the presence of six technical advisers, in fact they cancelled classes that day so there were six of them, six shift technical advisers and about seven other people who were once they realized that there might be a valve line-up problem were doing valve line-up checks.

MR. BENDER: If that event had occurred instead of at early in the morning and in time for the morning crew to come on but instead it occurred say about midnight what would have been the manning capability? What would they have had?

MR. BLACKWOOD: Whatever the plant manager deemed necessary. He was there very early in the morning. I don't know the exact time.

MR. BENDER: I am talking about at midnight. I am not talking about early in the morning. If the same event had occurred at midnight so that it was just about shift change time and the plant manager wasn't going to be there, and there was just the shift supervisor and the shift technical adviser what would be the manning action? Would they just stay with what they have got to sort it out?

MR. BLACKWOOD: I guess you misunderstood me. The plant manager arrives I think before five in the morning and the operations supervisor was there at that time, too, which is significantly before their normal work day. So I would expect that at any time of the day or night their response would have been same and it would have been his decision as to how many extra people he needed.

MR. BENDER: I guess I was sort of leaning to the fact that sometimes the plant manager is out on the town, for example, and when that happens -- well, I don't want to go further.

MR. MATHIS: I have got a question. What would have happened if you had time to analyze what would have happened if the reactor coolant pumps hadn't been tripped?

MR. BLACKWOOD: Eventually the seals would have failed, but their operating procedures limit the time that a reactor will function and be operated without flowing cooling water for ten minutes.

MR. MATHIS: I am well aware that they could be tripped but I don't know that it is tied to seal water.

MR. OKRENT: They trip to their instructions and not NRC instructions.

MR. MATHIS: They trip to save the seals.

MR. OKRENT: Yes.

MR. EBERSOLE: This is a CE plant. It doesn't have PRVs and block valves, doesn't it on the pressurizer.

MR. OKRENT: Yes. It has a PRV and one block valve.

MR. EBERSOLE: Was it possibly contemplated that they were close to the edge of repressurizing on the charging pumps and going ahead and making it water solid at 2200 to fill it and collapse the bubble?

MR. BLACKWOOD: At 2200 pounds?

MR. EBERSOLE: Yes.

MR. BLACKWOOD: They didn't even form the bubble until they passed below approximately 900 pounds.

MR. EBERSOLE: I know. What happened is you cooled the plant. You bought it down in temperature and that is when the bubble started, right?

MR. BLACKWOOD: Yes.

MR. EBERSOLE: Had they stayed up at natural convection would they have had this bubble?

MR. BLACKWOOD: No.

MR. EBERSOLE: Could they have gone back?

MR. BLACKWOOD: You mean maintain pressure?

MR. EBERSOLE: Yes. The pump seals would have leaked?

MR. BLACKWOOD: Pardon me?

MR. EBERSOLE: Would the pump seals have been ruined at static, without cooling on them if the shaft was static? If the shafts were not turning but pressure was on them would they have been bothered?

MR. BLACKWOOD: They proved that they weren't bothered for an hour and a half.

MR. EBERSOLE: Yes.

MR. BLACKWOOD: They basically maintained temperature at 540 degrees or so initially until commencing the natural circulation cooldown at 3 o'clock. So during that period of time the seals were without cooling water and there was what they believe to be possibly some steam and two-phase flowing in the control feed-off line back to the line control. So they did experience some high temperatures.

MR. EBERSOLE: Thank you.

MR. BLACKWOOD: They were very concerned in depressuring as fast as they could to get pressure off of it.

MR. LAWROSKI: Was there a resident inspector there?

MR. BLACKWOOD: Yes.

MR. LAWROSKI: What was his role?

MR. BLACKWOOD: He was there at approximaterly 5 a.m.

MR. LAWROSKI: What kind of role did he play in that?

MR. BLACKWOOD: He followed the licensee's action and I believe that he was out of the control room for an hour to an hour and a half or so in the morning about the time that I left the operations center because it was basically a natural circulation cooldown and they were expected to got on shutdown cooling by 8 o'clock in the morning. Then he came back in a little bit later in the morning and also became concerned over the pressurizer level trace. About 11:30, close to the same time as the licensee elected to call the operations center, he asked them exactly the same question, don't you think that maybe you should call the operations center on this and the licensee said, yes, we are in the process of doing that right now.

MR. MOELLER: Was the cooldown always within tech specs?

MR. BLACKWOOD: Yes, it was.

Let's talk briefly about reactor coolant pump seal performance. Starting down here with the Byron Jackson pumps, they have a controlled bleedoff to volume control tank or approximately 1 to 1.1 gallons per minute. There is no seal injection and it is a three-stage seal plus a vapor seal. There is a picture of that about three slides back.

Let's talk about the component cooling first and then we will get into the seal designs. As I said, they saw some erratic indications in the control bleedoff line to the volume control tank which caused them to believe that they probably had steam in the seals.

Now, it was approximately 25 minutes after they had lost seal water that they received the high temperature alarm in the first stage seal cavity which is set at 250 degrees. The vendor's recommendation is that we get that alarm and inspect the seals for damage due to thermal transient.

There was no leakage through the vapor seal into the containment other than the 50 ounces per hour or whatever the design number is. In other wor , the leakage up through the seals during the component cooling water outage was back to the volume control tank which is the normal flow pattern.

After they shut down and depressurized and got the seals out, they inspected all the seals and found no damage on any of the seals. However, there was quite amount of heat checking noted on the carbon rings where the running contacted the carbon ring.

MR. KERR: What does heat checking mean?

MR. BLACKWOOD: Well, in this case based on observations by a person in AEOD who was down at the site Monday and Tuesday, it is a series of radial lines that cross the small band where the running contacts the carbon face.

MR. KERR: Thank you.

MR. BLACKWOOD: The vendor said that this is something that they would probably expect to see after the seal had been running for some period of time. So it is not really attributed to passing steam through them. The indications were basically just a reflection. You could see these lines visually, but to run your hand around the sealing surface you couldn't feel any cracking or anything like that. There were no grooves, no scoring or anything of that nature. They did replace all the seals.

MR. EBERSOLE: May I ask you something. What seems to be developing here is that they overrun and natural convection cooling functions. You haven't mentioned what they were doing to the secondary. Were they driving that pressure down to maintain a good high differential from primary to secondary as they brought primary pressure down to keep a coupling between primary and secondary before they got on shutdown cooling?

MR. BLACKWOOD: Well, they initially steamed the generators down to about 20 percent early in the morning.

MR. EBERSOLE: How many psi? I mean that is what gives you the differential from primary to secondary is what the psi difference is.

MR. BLACKWOOD: Yes. Well, they were bypassing the condenser until they broke back and then after that they used atmospheric steam belts.

MR. EBERSOLE: What was the pressure on the secondary side? Did they not overrun the natural convection system?

MR. BLACKWOOD: What do you mean "overrun it"?

MR. EBERSOLE: Well, they didn't cool the primary fast enough consistent with the pressure reduction.

MR. BLACKWOOD: No, they cooled it.

MR. EBERSOLE: They didn't cool it fast enough. They reduced the pressure.

MR. BLACKWOOD: No. They cooled it too fast.

MR. EBERSOLE: Well, I am talking about consistent with the temperature.

MR. NOVAK: The problem is you may have had some hot water up in the upper head. I think we have a brief presentation. There is a stratification of hot water. The question then is how quickly does that hot water cool down as you depressurize.

MR. EBERSOLE: Well, you get the temperature down by passing it to the secondary before you go to shutdown cooling.

MR. NOVAK: Yes, but that water in the upper head is not moving.

MR. EBERSOLE: Yes, unless it is just diffusion mixed. There must be some programmed rate to do this which must have been overrun.

MR. JORDAN: That is the problem. There was not a programmed rate for natural circulation.

MR. EBERSOLE: Now there will be, right?

MR. JORDAN: That is right.

MR. EBERSOLE: That is what I am after.

MR. JORDAN: They were following and saying subcool for force circulation and they were keeping their subcool margin, you know. They were seeing this and seeing a void.

MR. EBERSOLE: It is surprising to hear there wasn't a programmed shutdown rate like this.

MR. JORDAN: I agree.

MR. EBERSOLE: Is it everywhere like that?

MR. NOVAK: One point. This is the second time that that plant has cooled down on natural circulation. It is my recollection that it has occurred once before, and it is also my recollection that that is the only plant that has ever cooled down on natural circulation.

MR. EBERSOLE: Is that so.

MR. JORDAN: Let me tell you the other bad part of the story though. We resurrected the charts from the previous cooldown and had the same sawteeth in it.

MR. BLACKWOOD: I have them in about three slides.

Here is the reactor coolant pump. There is either this picture or if you want to refer to the next one it is in a little bit more detail. Here is the seal cartridge, here is the integral seal cooler and the thermal barrier area is down here in a water jacket that is in the pump cover assembly.

Now let's home in on that just a little bit. The pump cooling water injection is here. It splits and part of it goes through the concentric tube heat exchanger here which is the seal cartridge or seal cooler. The other part passes down into this water jacket into what is called the thermal barrier. Now, the function of this jacket here is to cool the reactor coolant as it leaks up the shaft prior to the coolant being picked up auxiliary impeller. The auxiliary impeller right here circulates the coolant that is passing up through the seals back through the tube second of this concentric tube heat exchanger and cools it. So there is a closed cooling path right here and this is reactor coolant that is passing through there. Then that control bleedoff that is coming up through the termal barrier comes up right here and this is approximately 1.1 or so gallons per minute for all four seals with all three seal stages in tact.

Component cooling water is what they lost. Once they re-established it they got cooling back to this water jacket area and cooling back here, although the pump was secure so there was no reactor coolant flow in the concentric heat exchanger. They had to start flowing through the thermal barrier which is actually where it cooled the seals down because there was a continuous bleed rate of approximately one gallon per minute.

This is the type of seal on this particular variety, the Byron Jackson pump. This is the seal runner. Its face is I think titanium carbide and the seal ring is a hard carbon material. This is the first stage. The auxiliary impeller is here. This is the first stage seal, the second stage seal and the third stage seal. The controlled bleedoff coming off this way, and up here is another seal called a vapor seal with a lead off of 50 Ox's per hour. The vapor seal was not damaged.

MR. EBERSOLE: Does that direct water?

MR. BLACKWOOD: Yes, it directs it.

MR. EBERSOLE: They don't have a seal injection?

MR. BLACKWOOD: Yes, that is right, there is no seal injection for this plant

Questions on seal performance?

(No response.)

Very briefly let's talk about steam voiding indications. As I said variations in pressurizer level were up to ten times the charging flow rate. The ramp up during auxiliary spray was due to collapsing the steam bubble in the pressurizer allowing the void to form in the reactor vessel and to expand in the reactor vessel. The pressurizer level decayed back down again due to reheat of the steam bubble in the pressurizer.

Right around 6:15, that is when they first noted an anomolous pressurizer level indication, and that was as they passed through a pressure of about 900 pounds. Now the saturation temperature for 900 pounds or so is roughly around 500 degrees I believe. No, excuse me. It is about 536 or 537 degrees. By this time at 6:16 the reactor coolant system bulk temperature was down about 200 degrees cooler. It was maybe 350 or 346 or something like that.

By seeing the first indication of a void in the vessel at 900 pounds suggested that there was probably 200 degrees that had built up as a result of cooling down the natural circulation at a rate of 65 to 70 degrees Fahrenheit per hour.

Now, based on the amplitude of the swings in pressurizer level we estimate that the void in the reactor vessel could have been as large as approximately half of the pressurizer volume which is 700 cubic feet or so. That would have taken the reactor vessel water level down to possibly slightly below the vessel plan. So it was still I would say 12 feet or more above the top of the core, but based on that volume estimate that is about where the water level would have been.

The pressurizer level variations were controlled. They were not uncontrolled oscillations because the licensee realized they were probably causing them by shifting his charging pump discharge into auxiliary spray the cold ice.

There was a previous cooldown on the 15th of April in '77, due to a loss of controlled air which did exactly the same thing to the component cooling water as to the reactor coolant pumps.

MR. KERR: At what point did the operator recognize what was probably occurring?

MR. BLACKWOOD: Between 7 and 7:30 they had a pretty good feel.

MR. KERR: So in some sense they had this thing under control?

MR. BLACKWOOD: Yes, and to cool down and depressurize, that is really the only option that they had was to alternate charging back and forth and generate the sawtooth level.

MR. MOELLER: Did they ever in the sequence actually have a leak then, I mean a significant leak of coolant? When you mentioned earlier about the raw water storage tank ---

MR. BLACKWOOD: Yes, that is the next thing after the anomalous solid plant indications.

MR. EBERSOLE: When he put it on shutdown cooling what was the pressure in the secondary?

MR. BLACKWOOD: Well, let's see.

MR. EBERSOLE: Was it still a heat sink or was it a source?

MR. BLACKWOOD: I have the data sheets back in my briefcase.

MR. EBERSOLE: I would think it should still be a sink; that is, you should lead on the secondary.

MR. BLACKWOOD: Well, let's see, by 12:15 they were down at about 250 to 260 degrees.

MR. EBERSOLE: On the primary.

MR. BLACKWOOD: On the primary.

MR. EBERSOLE: Well, the secondary ought to be down, you know, like -- well, for that matter why wasn't it subatmospheric?

MR. BLACKWOOD: Well, for 260 degrees, what do you have, 12 pounds, something like that, not very much. Not really enough to drive very much steam.

MR. EBERSOLE: Right, it wouldn't have mattered much.

MR. BLACKWOOD: That is why they steamed the steam generators down early in the morning so that when they got close to shutdown cooling they could go ahead and fill the steam generators at the high of the indicating range which gives them that extra one shot of cooling even though they had low steam pressures to allow them to get on shutdown cooling.

MR. EBERSOLE: Well, it wasn't subatmospheric, was it?

MR. BLACKWOOD: No. They had broken vacuum at 5:30, something like 5:30 in the morning.

MR. LAWROSKI: May I ask a question.

MR. BLACKWOOD: Yes.

MR. LAWROSKI: At the event that you looked at that occurred some time ago, do you think there was a steam bubble there, too?

MR. BLACKWOOD: Well, that is this slide right here. The top traces the 4:15 event. You don't see it here, but it is indicated on your handout. The top one is the June 11th event. This one is April 15th, 1977. Down in this region towards the end of the cooldown, and this cooldown, I believe it was delayed for about three hours in getting started and then -- I am not sure about the cooldown rates. I think they were slightly less than what they had up here. Down towards the end of this cooldown you see again the characteristic rapid rises in pressurizer levels and you cannot charge the plant that fast. That is, I don't know, a factor of 10, something like that.

MR. LAWROSKI: How big might have been the bubble then?

MR. BLACKWOOD: A rough estimate would be if the amplitude of these swings would indicate the amount by which the void in the reactor vessel had to expand to cause the water to surge into the pressurizer. Some of these were about 50 percent of pressurizer level. This is maybe 25.

MR. KERR: I think that is as much of an answer as you want, isn't it?

MR. LAWROSKI: Yes. Thank you.

MR. BLACKWOOD: There is prior indication of this happening.

Now, I mentioned that they did see anomalous solid plant indications there after they turned the LPSI pump on at time 1227 although they had constant pressurizer level in the cold calibrated and hot calibrated level instrument.

There are many postulations, if you will, on why the plant responded this way, and this is a little bit of background on the miniflow and recirculation valves associated with the low-pressure pumps. Miniflow values were opened at 6:30 in the morning for a system warm-up. The 1B miniflow line was shut when that pump was put on shutdown cooling about time 1051. At time 1500 they found that they could get another half turn to a turn in the shut direction on that miniflow valve.

MR. OKRENT: What is that, an annual?

MR. BLACKWOOD: Yes, that is an annual valve.

The next slide I think is a good illustration. It is simplified, but it is a good illustration of these things. There is a common recirculation line for the two low-pressure pumps and the three high-pressure pumps. That is indicated on the system diagram. There are two series isolation valves in that miniflow recirculation line that are locked open so that under no conditions would the safety injection pumps be without the capabilty of having recirculation back to the refueling water storage tank in an injection phase.

Now, at time 1227 they got into what I would consider an off-normal system lineup in that one pump was taking suction on the refueling water tank and the other pump was taking suction on the reactor hot leg in the shutdown cooling mode. Both of these were discharging into a common discharge header back to the reactor cold leg. The miniflow line on the 1A pump was open because they thought that that pump was basically -- well, that pump was basically deadheaded. It was running very close to the shutoff head condition.

Now this, as I said, is one postulation of how the water got back into the refueling water tank. The concern here is that reactor coolant getting into the refueling water tank represents an unmonitored release path particularly for the nobel gases and dissolved gases that would come out of solution and go out the atmospheric path. The vent under refueling water tank is not monitored. The tank is outside.

There are other possible flow paths back to the refueling water tank. We are not sure right now and neither is the licensee on how the water got back there. The volume of water in the refueling water tank increased by approximately 5,000 gallons, four inches or so, up until the time when they turned off the pump on recirculation and shut the motor operated isolation valves. They would be up here. I haven't put them in, but they would be up in this area.

MR. KERR: You got that information from a level chart or something?

MR. BLACKWOOD: Yes. It is basically one pen width.

MR. MOELLER: You say an unmonitored release path, but did they detect any nobel gases airborne?

MR. BLACKWOOD: No.

MR. MOELLER: Is there a monitor?

MR. BLACKWOOD: No, there is no monitor. It is a 12-inch pipe with a hooded vent. The tank is located outside. The tank at the time had a little over 500,000 of borated water in it, but it is outside.

MR. BENDER: There have been a number of discussions about level indications. In there any level indicator that has been proposed so far that would tell you about the existence of that steam bubble?

MR. BLACKWOOD: Yes, that has been proposed.

MR. BENDER: No, I say are the ones that have been proposed capable of telling you what was happening in that event?

MR. BLACKWOOD: I would think so.

MR. JORDAN: That is exactly what they are proposed for.

MR. BENDER: I know that is what they are proposed for. I want to know whether the level indicators that have been proposed can tell what is happening in that particular vent. Most of them are based on some static condition and I would like to know whether any of them are useful in this dynamic circumstance.

MR. JORDAN: This was very slow dynamics though.

MR. BENDER: Well, maybe.

MR. KERR: How many inches rise in level does that 5,000 gallons represent roughly. Do you know?

MR. BLACKWOOD: Four inches in the refueling water tank, 50,000 gallons per foot. If a differential pressure type of an instrument is used the trace in pressurizer level shows that it is certainly capable of responding fast enough to these transient conditions to give you an indication.

MR. KERR: Fine. Thank you very much.

MR. OKRENT: This water presumably came from the power system or where?

MR. BLACKWOOD: They were charging at 88 gallons a minute. They saw no increase in pressurizer level and they were seeing no increase in pressure. Some of this water may have been going into collapsing the void in the reactor vessel. We are not sure when the void in the reactor vessel had collapsed, but there was 5,000 gallons more in the refueling water tank when they got done than there was when they started.

MR. OKRENT: My question was where was there 5,000 gallons less?

MR. BLACKWOOD: Well, if you track it all the way back, the volume control tank was on automatic make-up so I expect that they saw a reduction in whatever pure water tank went on service.

MR. OKRENT: Did somebody check that?

MR. BLACKWOOD: I don't have confirmation of that.

MR. EBERSOLE: Isn't there a spray inside the vessel head?

MR. BLACKWOOD: No, no overhead injection.

This is a simplified diagram of the low-pressure safety injuction system. Pump 1B was taking a suction from the hot leg, loop B, through the pump. The miniflow valve was shut when they on. This the valve that they found had cracked open and was shut further around 1 o'clock. This valve was open and basically throttled so that the flow reactor coolant is in through the pump up this way into the the shutdown cooling heat exchanges which are in the core spray lines back around this flow control valve and into the cold legs in both loops.

Now, concurrently with that 1A pump was running taking the suction from the refueling water storage tank again into this common discharge header. The path from hre into the system is the same, part of it going through this valve that was opened or throttled and the rest of it going through one of the auxiliary shutdown cooling heat exchangers. The miniflow valve was open because they had intended basically to deadhead this pump on the system in order to take water from the refueling water storage tank and get it into the reactor cooling system and get the pressurizer full of water as soon as they could. They could do that because of the high flow rates that are available with these low-pressure safety injection pumps.

Now, as I said, this is a common miniflow recirculation line. There are 53 hidden pumps, miniflows that are down here and the two low-pressure safety injection pumps are in there. Of course, spray recirculation also goes back to the refueling water storage tank.

There are some other theories about leaking check valves letting water back this way since this pump was deadheaded back into the tank. Another alternative would be I believe these two valves were shut when they started this pump and recirculation. If these two valves were not shut or weren't fully shut this pump would have been taking a common suction on the refueling water tank at elevation head pressure and the reactor coolant system in this situation at roughly 200 pounds.

MR. OKRENT: If you didn't happen to have changing pumps available then would this have been a way of emptying the primary system?

MR. BLACKWOOD: If you didn't have charger pumps you couldn't pump it out.

MR. OKRENT: Let me say we got down to the low pressure and then we had this line up and we lost the charging pumps. Could we then have been in a position of unknowingly at least pumping water from the primary system back into the refueling water storage tank, if I understand correctly?

MR. BLACKWOOD: That probably would not happen. As long as this pump is running and taking suction there and keeping this header at 200 pounds or something like that I think the primary system would stay full. Now, that would be a situation where the primary system would stay full at 300 pounds and whatever water, there would just be a transfer of reactor coolant back into the refueling water storage with a corresponding suction of the same amount to keep the primary system full. The reason that you saw an increase in the refueling water tank level I think is because we were charging and there was an excess of water that had to go some place.

MR. OKRENT: You can only charge is there is an empty spot.

MR. BLACKWOOD: Not with a positive displacement charging pump.

MR. OKRENT: You would have opened a safety relief valve. So in other words, there was an empty spot in the primary system.

MR. BLACKWOOD: Yes.

MR. MOELLER: Is someone checking all of this out, the licensee?

MR. BLACKWOOD: They are not satisfied with the explanation of the licensee as given as such.

MR. MOELLER: So you are asking for better?

MR. BLACKWOOD: Yes, we are.

MR. MOELLER: What is the status now of the plant?

MR. BLACKWOOD: The plant, as I said, started up on June 30th and achieved a hundred percent power on July 1st and has remained at 100 percent power.

MR. BLACKWOOD: That concludes what I had to say.

Brian.

MR. SHERON: I am just briefly going to tell you what we are doing with regard to the upper head voiding question.

The upper head voiding can occur during transients and accidents which would depressurize the primary system. The concern that I guess we would raise over it is is it being properly accounted for in the models as they calculate intransients and accidents say with Chapter 15 analysis. Some of the models, the vendor models don't account properly for the upper head region and also they may not account for the structure on the upper head region which could be a source of heat which would tend to hold the upper head fluid at a hotter temperature.

Just quickly, this is a combustion vessel and you can see this region up here, this upper head plate here. During pump force conduction flow there is a circulation pattern up here which would tend to put the fluid into the core in some reasonable communication with this fluid up here.

During natural circulation flow, however, the momentum of the fluid into the core would not probably be enough to penetrate all the way up to this region and this region up here would be relatively stagnant with respect to the fluid down here.

We took a brief look at this upper head voiding and we did not see any direct safety problems with regard to combustion plants or PWRs in general. By no direct safety problems what I mean is that nothing stuck out and glared right in our face that if this happened during some event it would obviously cause an unacceptable situation.

Some of the things though that we did see were that the unexpected voiding which did occur produced an anomolous plant behavior which initially confused the operator which is not a desirable situation. We also said there may be other transients or accidents lurking around which this voiding may affect in some fashion which we just don't know yet.

What we believe was necessary to resolve the problem was to form a systematic detailed evaluation assessing the impact of voiding on all postulated events and modes of operation of the plant.

MR. LEWIS: What is meant by postulated events?

MR. SHERON: Transients and accidents.

MR. LEWIS: All possible ones?

MR. SHERON: All the ones that we postulate, for example, in Chapter 15.

MR. EBERSOLE: Let me pick one. Take a B&W reactor, depressurize the second side and admit that the full feedwater flow continues to run on. That is a good one.

MR. SHERON: A rapid depressuration.

MR. EBERSOLE: That is the worst.

MR. SHERON: Like I say, we haven't done the analysis.

MR. PLESSET: Can't hear you, Jessie.

MR. EBERSOLE: If you fill it full of cold water it will do a great job of depressurizing the primary.

MR. SHERON: Well, you could postulate the steam line accident.

MR. EBERSOLE: I just did that but I compounded it by putting cold water in where there was hot water on the second said.

MR. SHERON: The effect of voiding in the upper heading again is something that has to be examined.

One of the things that I think was pointed out previously in Ed presentation was that the plant control, in other words, how does one depressurize these plants during natural circulation cooldown, to preclude this voiding needs to be identified. This should be done and also it should be properly accounted for in operating procedures and operator training, including training the operators so that they can identify this if and when it occurs and not be baffled by it but actually know what it is and what action to take.

The licensee, which is Florida Power and Light, has been directed to perform the above items. This is being done through a series of requests for additional information.

MR. KERR: Is the voiding looked on as a serious problem because it could interfer with natural circulation cooling or because it could lead to core uncovery or just because it might lead to anomolous behavior?

MR. SHERON: Well, we asked ourselves that question and the answer was that because the thermocouples at the core exit indicated a high degree of subcooling even though there was a void forming in the upper head one could say that if this void started to expand down towards the hot legs as it expanded it would encounter a cooler region of fluid and condense. So then you take a step further and say, gee whiz, what if it didn't condense, what if it expanded down and got into the hot legs. Well, you would postulate then that any steam that got into the hot legs would travel into the steam generators and condense.

So from the standpoint of natural circulation we didn't identify any situation where it could interrupt it. There are events, like I said. One might be the way one depressurizes following a steam generator tube rupture which may be affected by this, and I don't know in what direction or how. We have directed the licensee to examine this. Basically we said go back and look at Chapter 15 in light of this phenomena and tell us which transients or accidents might be affected and in what manner. In other words, are your results still valid?

MR. KERR: But in your thinking so far you haven't identified anything specific, just a general unease that here is a situation that has not been looked at in detail. Is that right?

MR. SHERON: Yes, because it was not previously identified, the operator did not expect it and he did not recognize it immediately when it did occur.

MR. EBERSOLE: Isn't it generic to all PWRs? Why did you just tell one licensee?

MR. SHERON: Yes, it is.

MR. EBERSOLE: You just told one licensee.

MR. KERR: Excuse me. I had gotten the impression that the upper head configuration of this reactor was somewhat more conducive to this behavior.

MR. JORDAN: That is correct with regards to upper head flow. It is more conducive.

MR. SHERON: We have thought about this, you know, should it be a generic concern, and I think it is. Before we go off half cocked, I guess, and request all licensees to do calculations and analyses what we felt the best way to approach it would be would be to let the licensee, Florida Power and Light, perform the analyses, the information we requested and to get that back to analyze it and digest it to determine if there is a generic problem or generic concern which should be expanded to the industry at large.

We have requested the coming up of a cooldown rate and putting an upper head model and so forth in your transient calculations. That probably would calculate this. That information I believe we requested for 30 days upon receipt of the letter and the remaining information 60 days at which time we would get back the responses, evaluate them and determine whether further action was needed on a generic basis.

MR. OKRENT: Well, my question is really for Dr. Budnitz. My crude estimate is that we do about three experiments a year and it costs $45 million. Have you considered giving them $15 million for having run one of your experiments?

(Laughter)

MR. MOELLER: I had a question. Was the April 15th, 1977, event, was that reported as an LER?

MR. SHERON: I would ask Ed.

MR. JORDAN: Yes, the event was reported, but the details such as the strip chart records were not included in the report.

MR. MOELLER: Well, I guess that leads to two questions. One is, has anyone searched back through LERs to see how many other similar events may be there? Two, I guess you send out an all-points bulletin and you ask every plant to report if they have had anything like this in the past as well as you alert them to this problem.

MR. JORDON: Right. We sent out a circular on this particular problem advising them of this event and giving them recommendations as to how to change their procedures. Then we have our inspectors following up on the follow-up actions at the plant.

MR. MOELLER: Have you asked them to remind you of any similar events that may have occurred at other plants in the past?

MR. JORDAN: The circular doesn't require a written response from the licensees. I would elaborate and say that there were several NRC staff members post-TMI that had concerns with regards to voids forming in the upper head for this particular reason. So we had done some reviews and Brian Sheron was involved in those reviews earlier. So it was this particular episode that magnified it and I think brought it to the point that it is now.

MR. PLESSET: Bob Budnitz wants to make a comment.

MR. BUDNITZ: From this discussion it is clear that there were weaknesses in the licensee's or the vendor's code that weren't able to treat this phenomenon. I gather that from your statement.

MR. SHERON: Well, it was my understanding that combustion engineering's model that is used to predict these type of transients is SEESECK. That code as I understand does not have an upper head region modeled in it?

MR. PLESSET: They don't note it separately, do they?

MR. SHERON: I beg your pardon?

MR. PLESSET: They don't note that separately, do they?

MR. SHERON: No, they don't.

MR. PLESSET: So how could they do it?

MR. BUDNITZ: I understand that. Secondly, I gather we don't have a code within NRC that is capable of doing that right now either.

MR. PLESSET: That is right.

MR. SHERON: I think a code like RELAP where you can model that region separately would be appropriate with the approprite flow paths.

MR. PLESSET: A one dimensional RELAP, that could do it, yes, but I don't think they have ever done that.

MR. SHERON: We have never really used RELAP extensively for transients as what I would consider as mild as a cool down on natural circulation which does carry out over hours.

MR. BUDNITZ: These incidents seem to point up one after that we just have a general situation codes. There is a lot that could be done and hasn't yet been done either by the industry or by us.

MR. PLESSET: I was going to point out, Bob, that TRACK flunked physics one. It doesn't conserve mass.

MR. BUDNITZ: No, I didn't know that. I thought TRACK concerned all the relevant points.

MR. PLESSET: No, Bob, it doesn't.

(Laughter.)

MR. OKRENT: A code that follows a transient for five hours or so forth. We need a different concept in fact.

MR. PLESSET: TRACK gains mass, Dave, so that the longer you follow it the more inventory you have got.

MR. BUDNITZ: Well, that is great.

(Laughter.)

MR. PLESSET: Let Brian finish.

MR. SHERON: That was basically my presentation. I just wanted to point out that we are looking into the possibilty of running an experiment in future semiscale at a Mod. 2-A facility. I am not too sure since it is the head upper region of the vessel or modeled after Westinghouse's UHI plant and the communication paths may be atypical with respect to a combustion plant.

MR. KERR: Are you going to try and find out if a bubble can form in the upper head or how you can lose 5,000 gallons of water?

(Laughter.)

MR. SHERON: Whether a bubble can form in the upper head. I know many ways to lose 5,000 gallons of water.

MR. OKRENT: By the way, with regard to 5,000 gallons of water, Mr. Chairman, I would like to understand how that really happens and whether it could occur in a situation when you didn't have charging. Not tonight but either from I&E or from an ACRS file or both.

MR. PLESSET: I think they have made note of that, Dave. I believe that I&E now owes you further discussion on the GE drives, the Browns Ferry event and now this matter.

MR. KERR: Well, I don't know if it is going to be I&E but we are going to get more discussion.

MR. SEISS: Be sure we note both of those requests.

MR. PLESSET: Are you finished, Brian?

MR. SHERON: Yes, I am.

MR. PLESSET: Thanks very much.

I am going to take the liberty of recessing until tomorrow at 8:30.

(Whereupon, at 7:50 p.m., the meeting recessed, to reconvene at 8:30 a.m., Friday, July 11, 1980.)

* * *

NUCLEAR REGULATORY COMMISSION

This is to certify that the attached proceedings before the

____

in the matter of: ACRS - 243rd Meeting

Date of Proceeding: July 10, 1980

Docket Number: ________________

Place of Proceeding: Washington, D. C.

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

Mary C. Simons

Official Reporter (Typed)

Mary C Simons

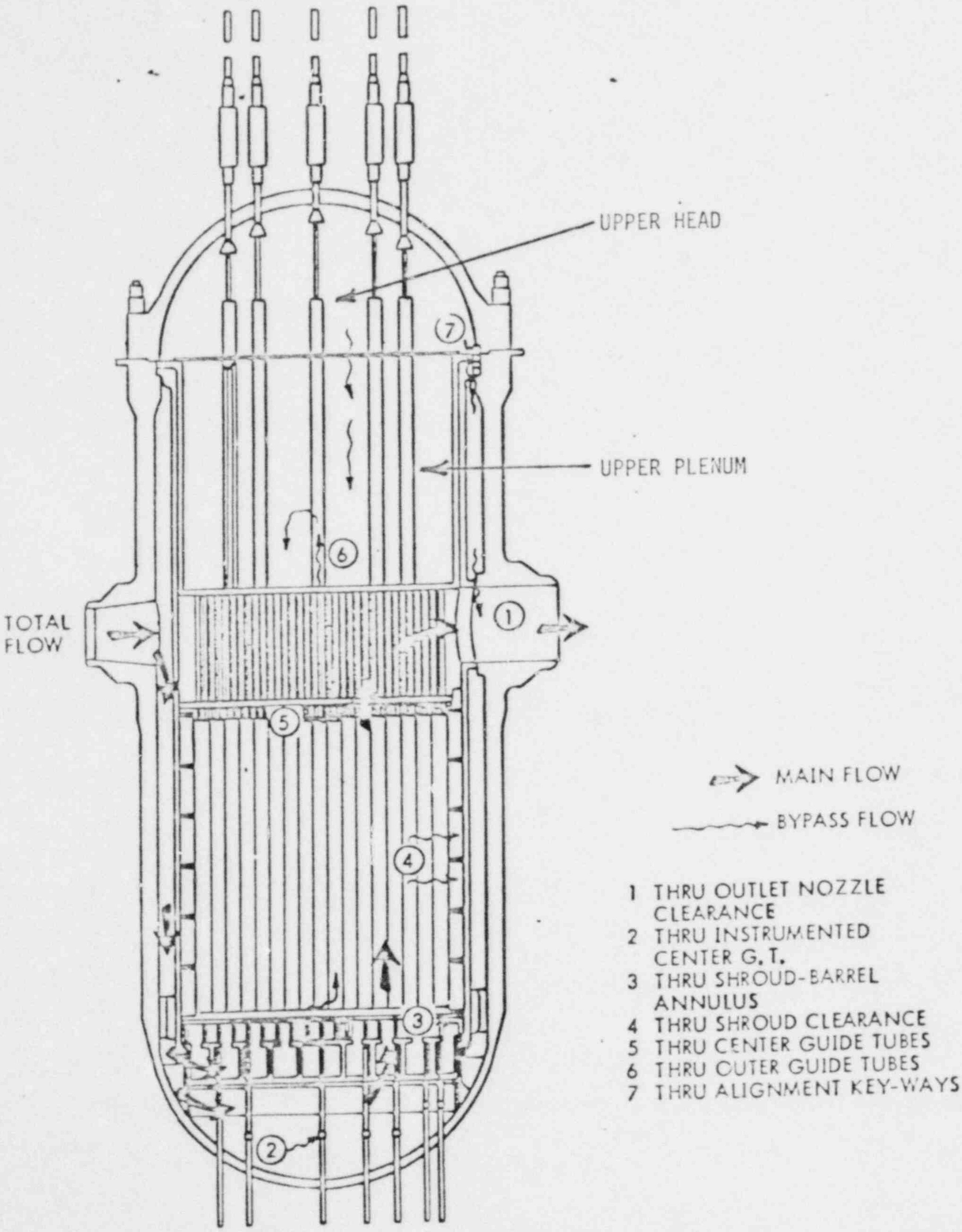
Official Reporter (Signature)

IMPLICATIONS OF UPPER HEAD VOIDING

- POTENTIAL FOR UPPER HEAD VOIDING OCCURS DURING TRANSIENTS AND ACCIDENTS WHICH DEPRESSURIZE PRIMARY SYSTEM (E.G., LOCAs, OVERCOOLING EVENTS ON SECONDARY SIDE)

- SOME VENDOR ANALYSIS MODELS MAY NOT PROPERLY ACCOUNT FOR WEAK HYDRAULIC COUPLING BETWEEN VESSEL UPPER HEAD REGION AND THE REST OF THE VESSEL UNDER LOW-FLOW CONDITIONS

- SOME VENDOR ANALYSIS MODELS MAY ALSO NOT PROPERLY ACCOUNT FOR STORED HEAT WHICH EXISTS IN METAL STRUCTURE IN THE UPPER HEAD REGION.



REACTOR VESSEL FLOW PATHS

- NO DIRECT SAFETY PROBLEMS HAVE BEEN IDENTIFIED
- UNEXPECTED VOIDING WILL PRODUCE ANOMALOUS PLANT BEHAVIOR WHICH COULD PRECIPITATE INCORRECT OPERATOR ACTIONS

TO PROPERLY RESOLVE PROBLEM

- A SYSTEMATIC, DETAILED EVALUATION IS NEEDED, ASSESSING THE IMPACT OF VOIDING ON ALL POSTULATED EVENTS AND MODES OF OPERATION
- OPTIMUM PLANT CONTROL (E.G., COOLDOWN RATE) NEEDS TO BE IDENTIFIED WHICH MINIMIZES OR ELIMINATES POTENTIAL FOR VOIDING DURING COOLDOWN (ON NATURAL CIRCULATION OR OTHERWISE)
- THE UPPER HEAD VOIDING PHENOMENON NEEDS TO BE PROPERLY ACCOUNTED FOR IN OPERATING PROCEDURES AND OPERATOR TRAINING, INCLUDING THE PLANT SIMULATOR.
- THE LICENSEE IS BEING DIRECTED TO PERFORM THE ABOVE ITEMS. BASED ON RESULTS OF ABOVE EVALUATION STAFF WILL DETERMINE IF VESSEL VOIDING IS GENERIC CONCERN FOR ALL PWR's.

<u>ST. LUCIE TRIP AND COOLDOWN (6/11/80)</u>

I. SITE DESCRIPTION

II. EVENT DESCRIPTION

III. REACTOR COOLANT PUMP SEAL PERFORMANCE

IV. STEAM VOID INDICATIONS

V. ANOMALOUS SOLID PLANT INDICATIONS

ST. LUCIE UNIT NO. 1

LICENSEE: FLORIDA POWER AND LIGHT COMPANY

SITE: TWO NUCLEAR UNITS

1. OPERATING
2. UNDER CONSTRUCTION (36%, FLD 10/82)

LOCATION: 12 MILES SE OF FT. PIERCE, FLORIDA

REACTOR: COMBUSTION ENGINEERING PWR

2560 MWT 802 MWE

INITIAL CRITICALITY: APRIL 22, 1976

COMMERCIAL OPERATION: DECEMBER 21, 1976

CURRENT CYCLE: CYCLE #4 (16-MONTH OPERATING CYCLE)

CRITICALITY THIS CYCLE: MAY 7, 1980

RESTARTED: JUNE 30, 1980
AT 100% JULY 1, 1980

CONDENSER COOLING: ONCE-THROUGH

HEAT SINK: ATLANTIC OCEAN

EVENT DESCRIPTION

INITIAL CONDITION: FULL POWER

TIME	EVENT/ACTION
0226	HCV-14-6 FAILED SHUT SHORTED SOLENOID TERMINAL BOARD LOST CCW FLOW TO ALL RCPS
0233	MANUAL REACTOR TRIP
0235	STOP ALL RCPS
0238	START 1B1 RCP TO ENCHANCE NATURAL CIRCULATION
0239	STOP 1B1 RCP
0300	START NC COOLDOWN CDR: 60-70F/HR
0350	OPEN HCV-14-6 AIR LINE JUMPER
0600-0630	DEPRESSURIZE 1140 PSIG TO 690 PSIG CHARGE VIA PZR AUX SPRAY LINE
0615	PZR LEVEL VARIATIONS NOTED
0630 ~ 1230	ALTERNATE CHARGING FLOW BETWEEN PZR AUX SPRAY AND LOOPS

TIME	EVENT/ACTION
0700-0730	INDICATIONS OF VOIDING OTHER THAN IN PZR (SUBCOOLING 200-150F)
1051	START LPSI 1B IN SHUTDOWN COOLING MODE
1227	START LPSI 1A IN INJECTION MODE TO GO SOLID
1230	PZR LEVEL (HOT PEGGED HIGH) (COLD STEADY AT 64%) NOTED ANOMALOUS SOLID PLANT RESPONSE (PRESSURE CONSTANT WHILE CHARGING AT 88 GPM)
~1300	SHUT LPSI 1B MINIFLOW ISOLATION VALVE (FOUND CRACKED OPEN)
1357	NOTED SLIGHT RISE (RAMP) IN RWT LEVEL STOP LPSI 1A SHUT MINIFLOW LINE MOVS SLIGHT RISE IN PZR LEVEL (COLD) AND PZR PRESSURE
1500	DRAW STEAM BUBBLE IN PZR, DRAIN TO INDICATING RANGE
1600	NORMAL RESPONSE TO CHARGING AND LETDOWN VARIATIONS

REACTOR COOLANT PUMP

SEAL PERFORMANCE

- ERRATIC CONTROLLED BLEEDOFF FLOW INDICATION
- NO VAPOR SEAL LEAK INTO CONTAINMENT
- VISUAL INSPECTION RESULTS

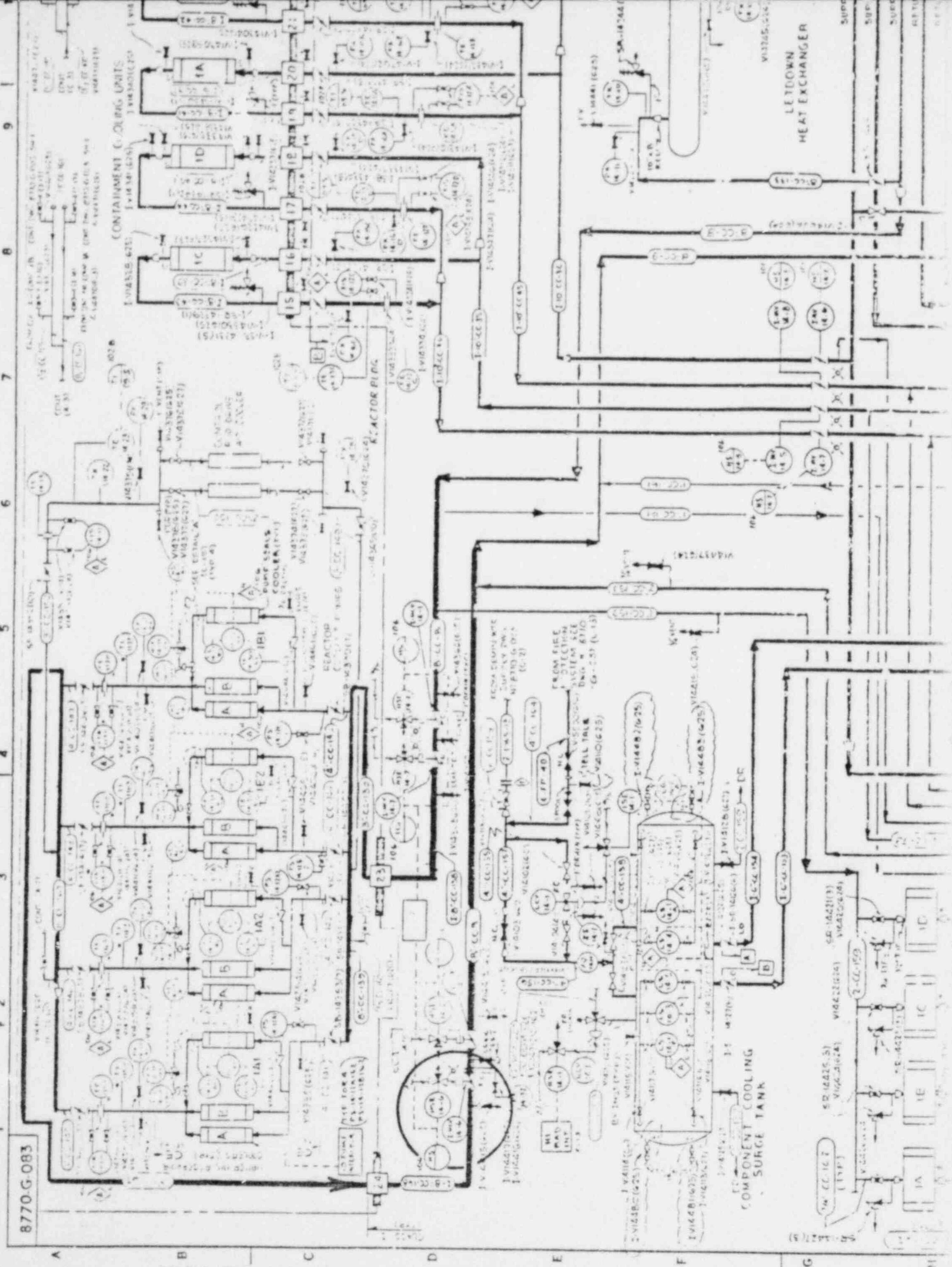
  NO DAMAGE
  SLIGHT HEAT CHECKING

- ALL SEALS REPLACED
- SEAL INFORMATION

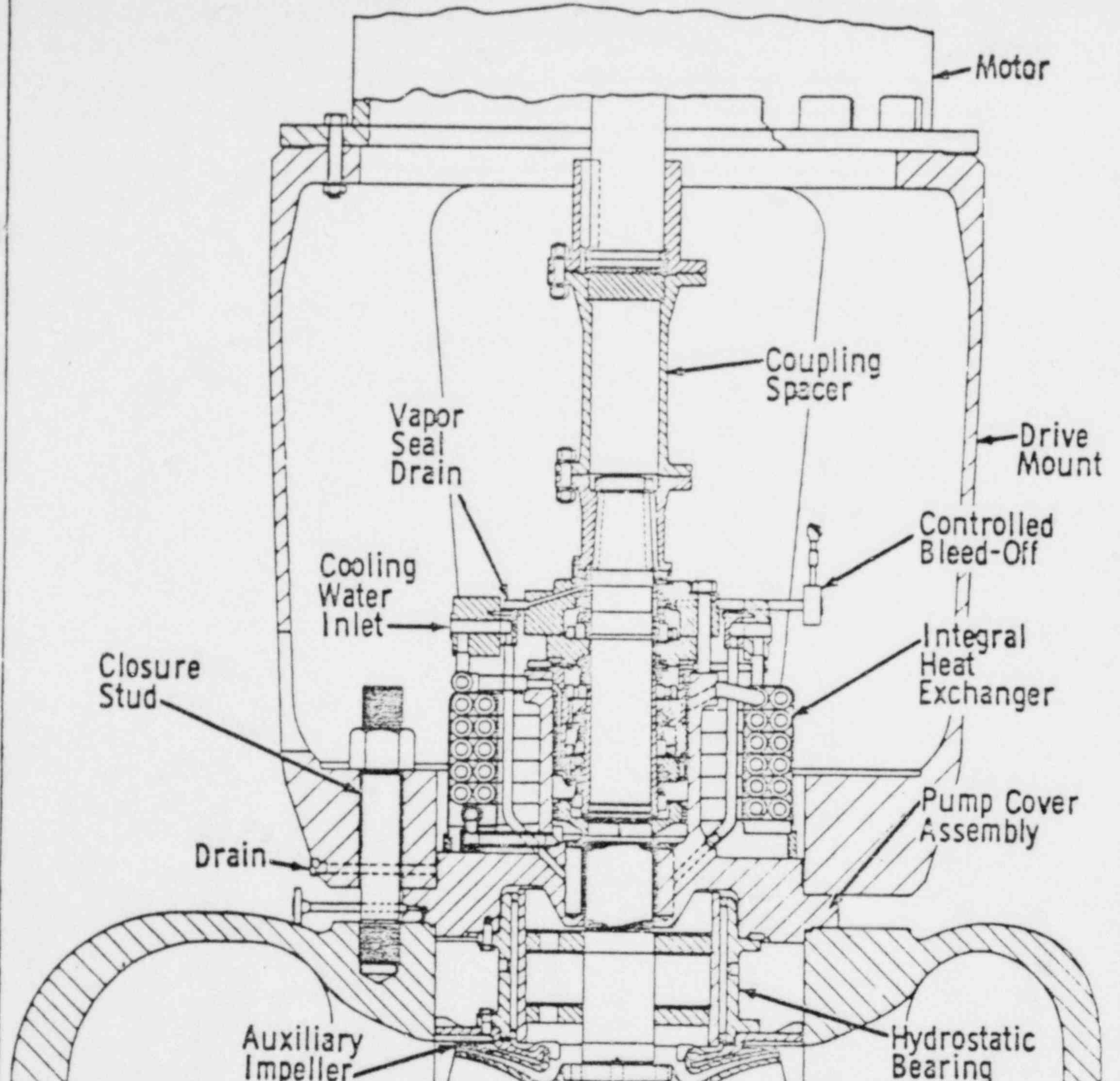
  BYRON JACKSON
  CONTROLLED BLEEDOFF TO VCT
  3-STAGE SEAL PLUS VAPOR SEAL

- SEAL REPLACEMENT:

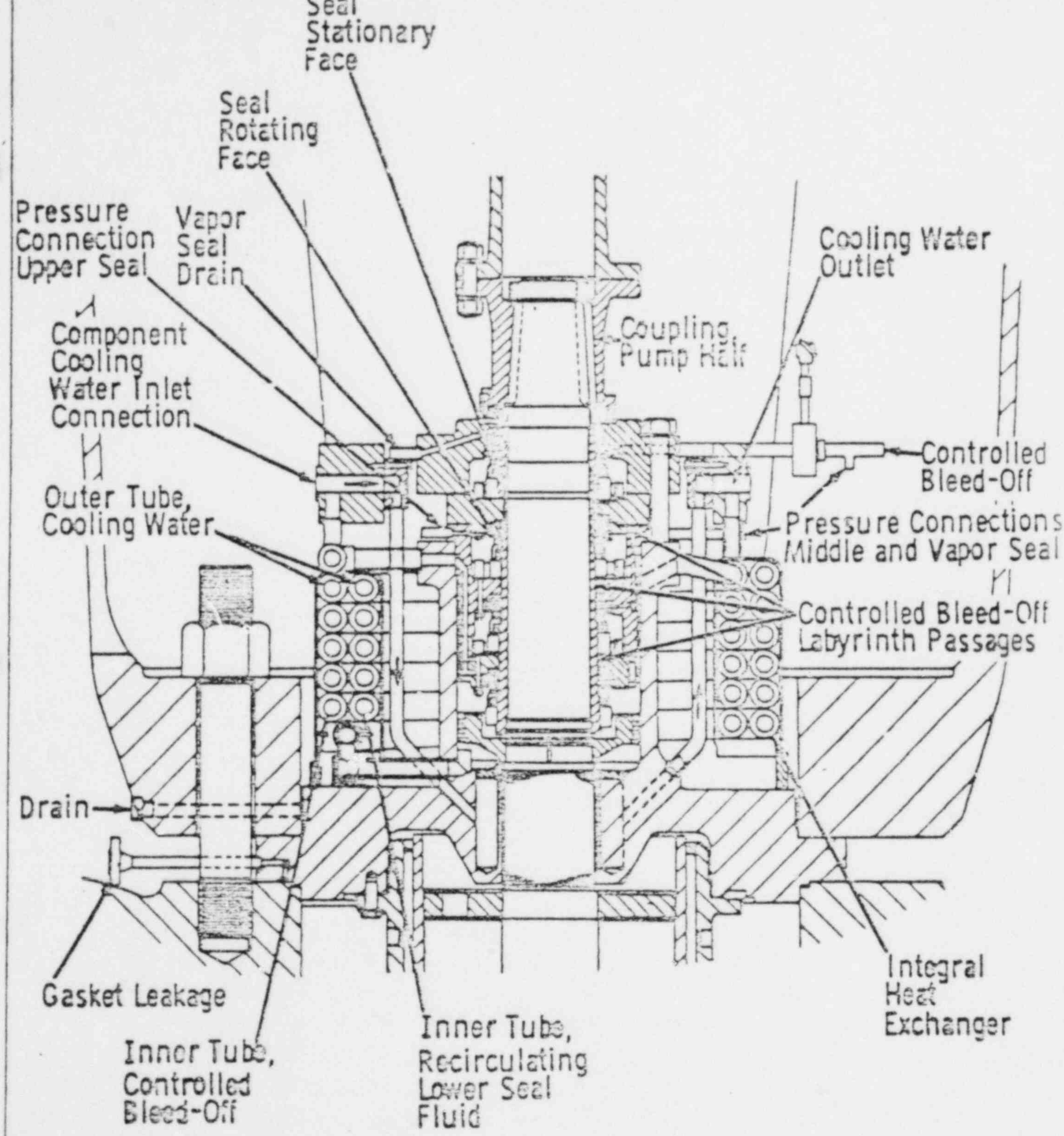
RCP 1A1	APRIL 1977 (LOSS OF CCW)
RCP 1A2	APRIL 1977 (LOSS OF CCW)
RCP 1B1	NOVEMBER 1978 (SUSPECTED CAUSE OF MOTOR PROBLEMS)
RCP 1B2	OCTOBER 1979 (PLANNED MAINTENANCE)



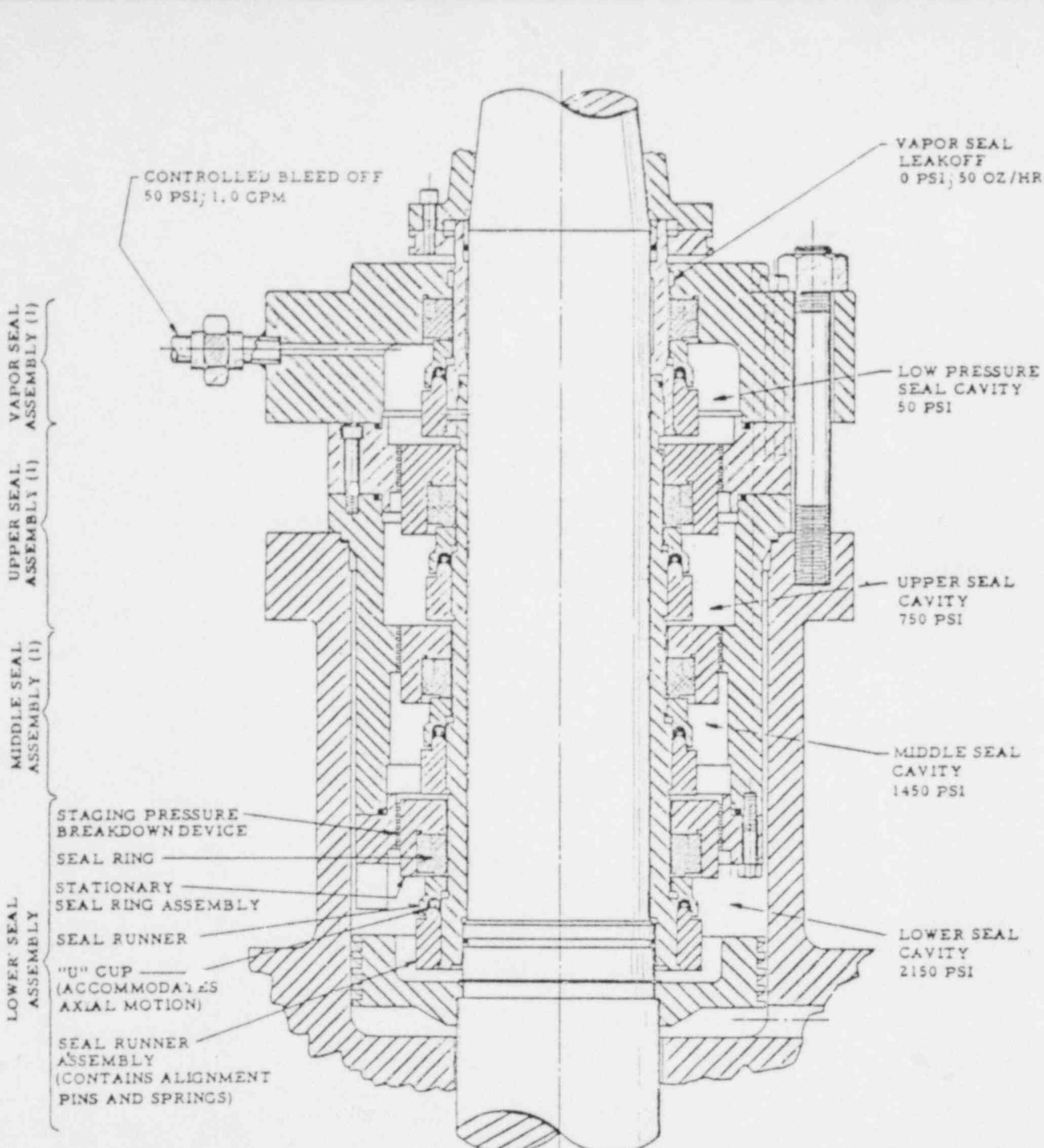
COMPONENT COOLING WATER TO REACTOR COOLANT PUMPS



FLORIDA POWER & LIGHT CO. St. Lucie Plant	Reactor Coolant Pump	Figure 5.5-6



FLORIDA POWER & LIGHT CO. St. Lucie Plant	Reactor Coolant Pump Seal Area	Figure 5.5-8



NOTES:

1. SEE LOWER SEAL ASSEMBLY FOR COMPONENT IDENTIFICATION.
2. ONLY THREE SEALS NORMALLY BREAK DOWN THE PRESSURE. THE FOURTH SEAL SERVES AS A VAPOR SEAL AND AS A BACKUP. THE BACKUP SEAL IS PRESSURIZED ONLY WHEN THE CONTROLLED BLEEDOFF DISCHARGE IS VALVED SHUT.

BYRON JACKSON MECHANICAL SEAL CARTRIDGE

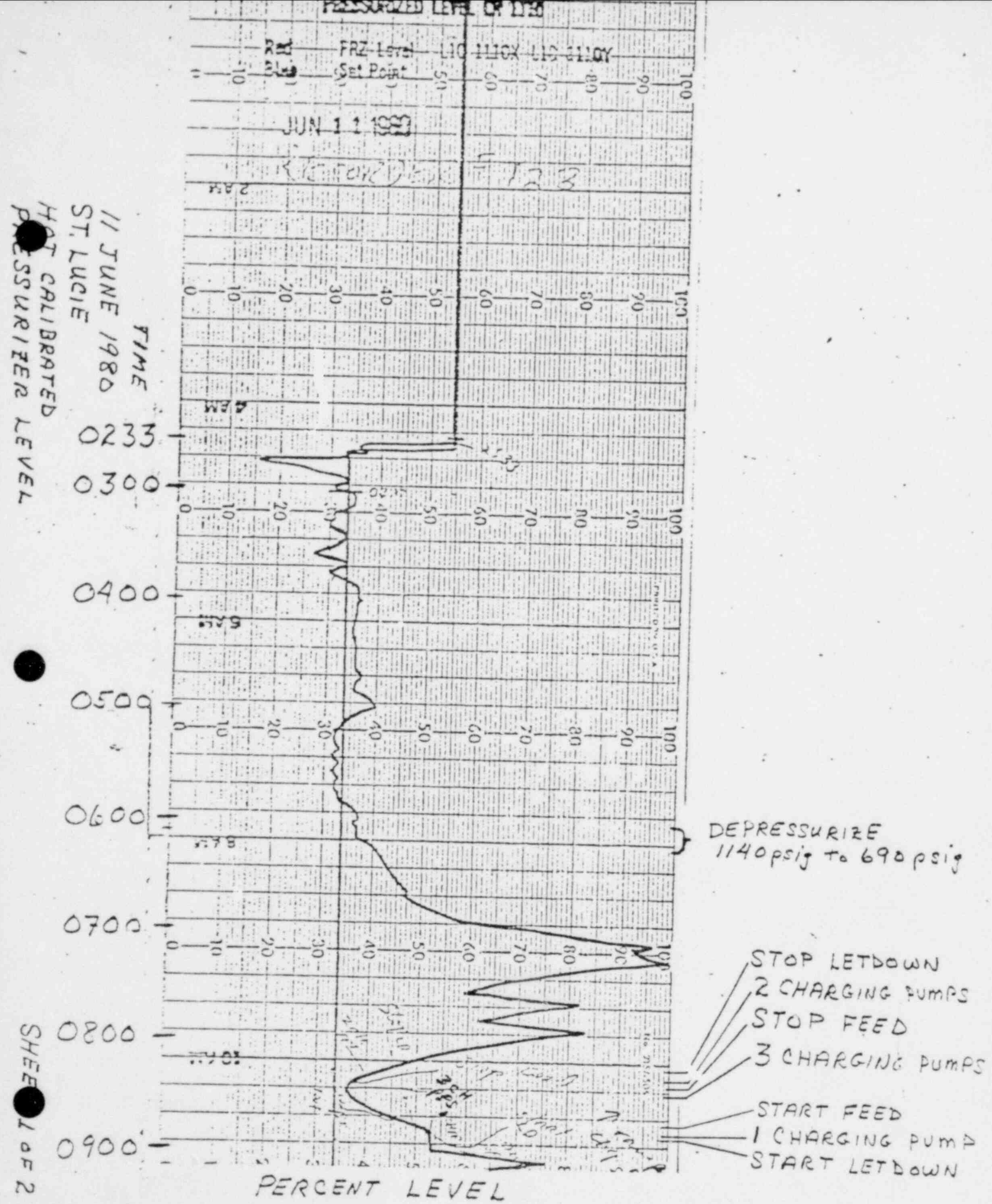
4 SEAL UNIT FOR PWR APPLICATIONS

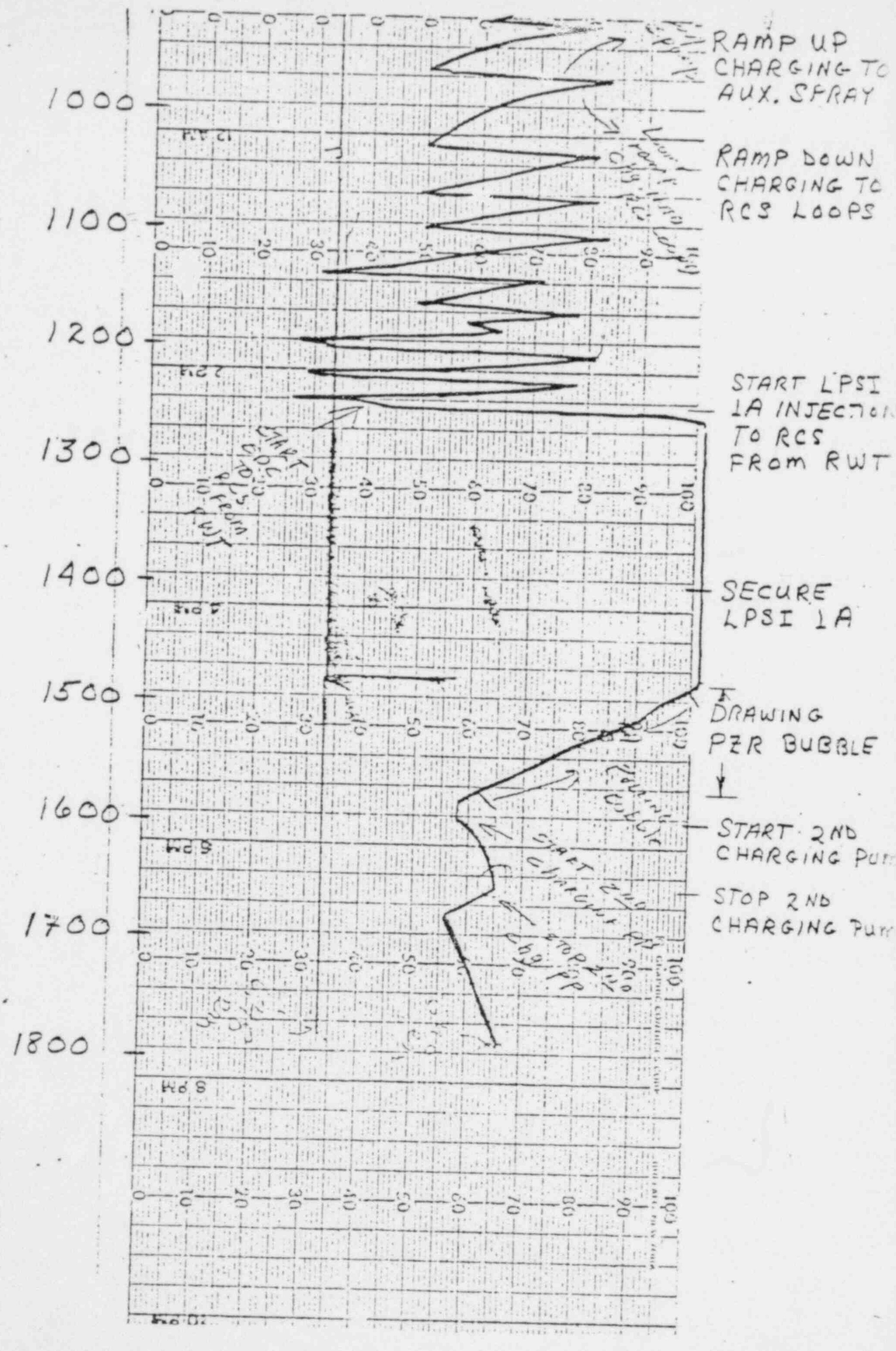
(COURTESY OF BYRON JACKSON)

FIGURE III-6

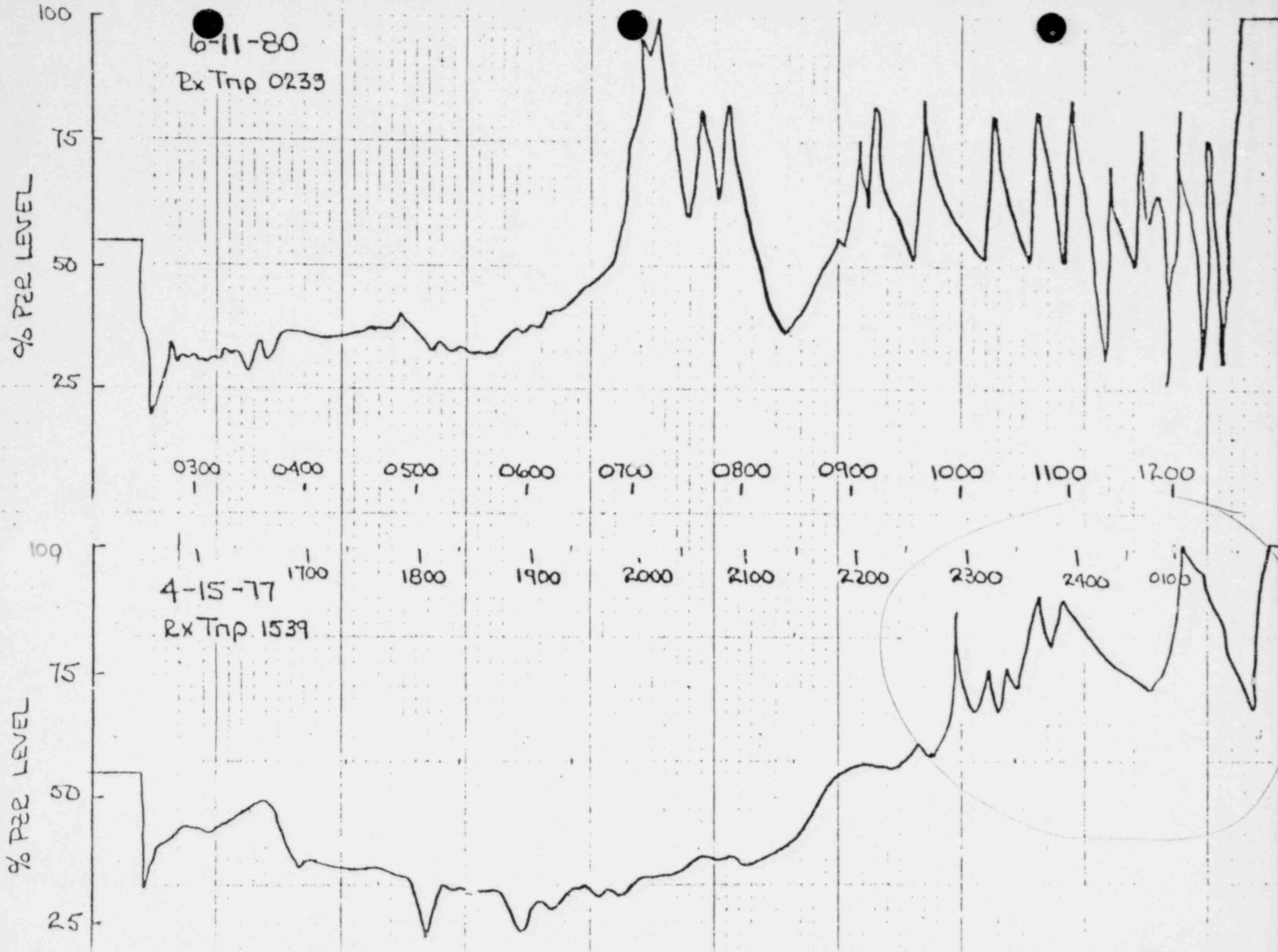
STEAM VOID INDICATIONS

- VARIATIONS IN PZR LEVEL UP TO TEN TIMES CHARGING FLOWRATE
- PZR LEVEL RAMP UP DURING AUX SPRAY (COLLAPSED PZR BUBBLE)
- PZR LEVEL DECAY DOWN WHILE CHARGING TO LOOPS (PZR BUBBLE REHEAT)
- REACTOR VESSEL HEAD TEMPERATURE LAG DURING NC COOLDOWN (ESTIMATED 200F ΔT AT FIRST INDICATION ~900 PSIG)
- VOID SIZE ESTIMATED UP TO 750 CU. FT. LOWEST RV LEVEL IN AREA OF VESSEL FLANGE
- PZR LEVEL VARIATIONS CONTROLLED
- PREVIOUS NC COOLDOWN (4/15/77) POSSIBLE VOID INDICATIONS


PRESSURIZER LEVEL
FRZ Level
Set Point
JUN 1 1 1980
TIME
11 JUNE 1980
ST. LUCIE
HOT CALIBRATED
PRESSURIZER LEVEL
0233
0300
0400
0500
0600
0700
0800
0900
DEPRESSURIZE
1140 psig to 690 psig
STOP LETDOWN
2 CHARGING PUMPS
STOP FEED
3 CHARGING PUMPS
START FEED
1 CHARGING PUMP
START LETDOWN
PERCENT LEVEL
SHEET 1 OF 2


RAMP UP CHARGING TO AUX. SPRAY
RAMP DOWN CHARGING TO RCS LOOPS
START LPSI 1A INJECTION TO RCS FROM RWT
SECURE LPSI 1A
DRAWING PZR BUBBLE
START 2ND CHARGING PUMP
STOP 2ND CHARGING PUMP
1000
1100
1200
1300
1400
1500
1600
1700
1800

SHEET 2 OF 2

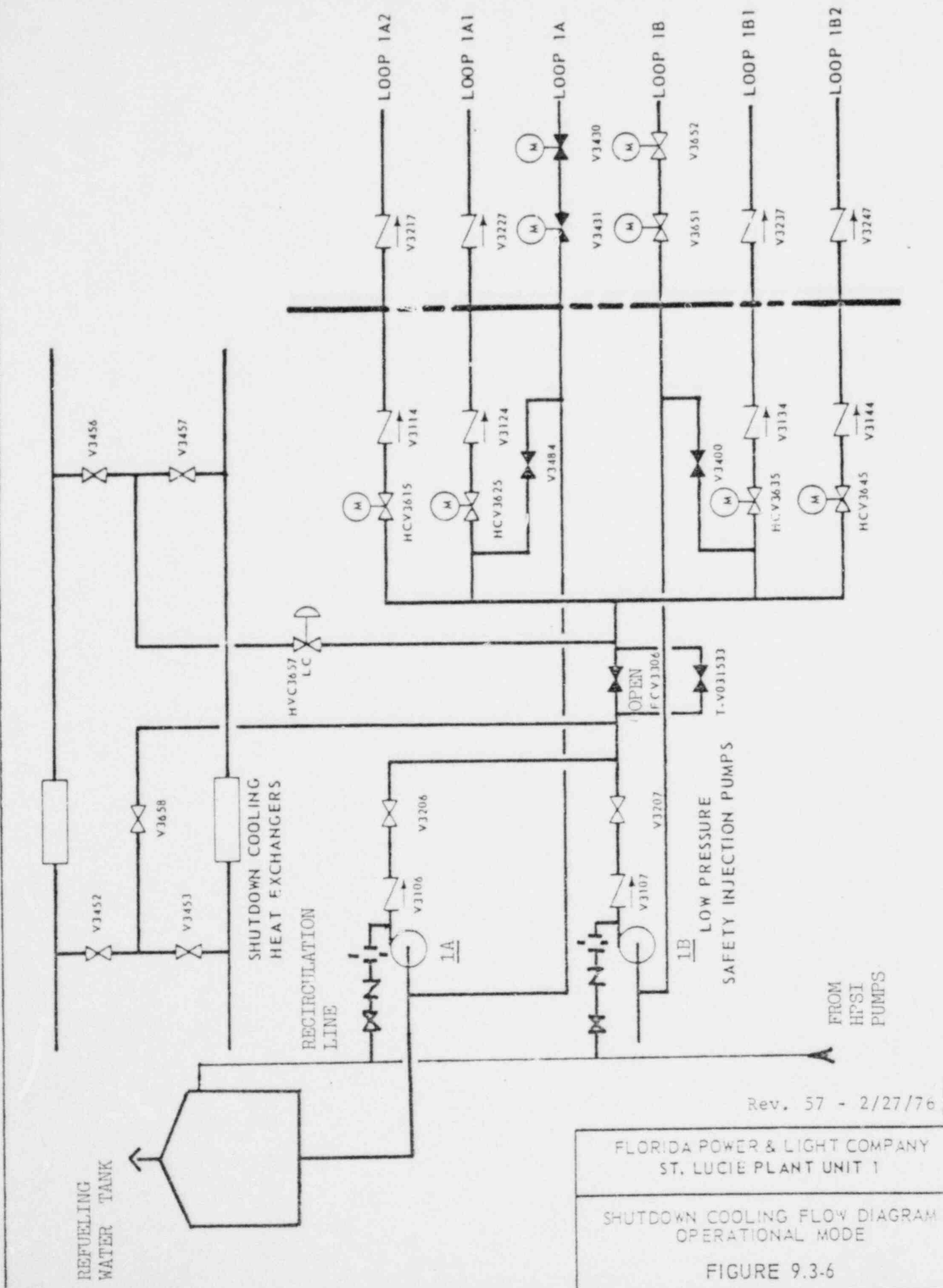

6-11-80
Rx Trip 0233
% PZR LEVEL
100
75
50
25
0300
0400
0500
0600
0700
0800
0900
1000
1100
1200
4-15-77
Rx Trip 1539
% PZR LEVEL
100
75
50
25
1700
1800
1900
2000
2100
2200
2300
2400
0100

ANOMALOUS SOLID PLANT INDICATIONS

- LPSI MINIFLOW OPEN FOR SYSTEM WARMUP
- LPSI 1B MINIFLOW SHUT GOING ON SHUTDOWN COOLING
- LPSI 1B MINIFLOW FOUND CRACKED OPEN
- COMMON RECIRCULATION LINE FOR 2 LPSI AND 3 HPSI PUMPS
- COMMON LINE ISOLATION MOVS LOCKED OPEN POWER REMOVED PER TECH SPECS
- OFF NORMAL SYSTEM LINEUP

    LPSI 1A ON INJECTION
    LPSI 1B ON SDC
    BOTH THROUGH COMMON DISCHARGE HEADER TO RCS

- UNMONITORED RELEASE PATH
- OTHER POSSIBLE FLOW PATHS TO RWT MAY EXIST



Rev. 57 - 2/27/76

FLORIDA POWER & LIGHT COMPANY
ST. LUCIE PLANT UNIT 1

SHUTDOWN COOLING FLOW DIAGRAM
OPERATIONAL MODE

FIGURE 9.3-6