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COMMITTEE ON INTERIOR AND INSULAR AFFAIRS

TASK FORCE ON

THREE MILE ISLAND ACCIDENT

Washington, D. C.

FRIDAY, MAY 11, 1979

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U. S. House of Representatives,

Committee on Interior and Insular Affairs,

Washington, D. C.

The committee met at 10:10 a.m. in room 1324, Longworth House Office Building, the Honorable James Weaver presiding.

Present: Representatives Weaver, Carr, Markey, Vento, and Cheney.

Staff present: Messrs. Reis, Meyers, Scoville, Thurber, Burnham, and Terrell.

Also present: Edward Frederick, Craig Faust, William Zewe, Gary Miller, and Frederick Scheimann.

Representative Weaver. The Task Force will come to order, and we continue our inquiry into the facts as to what happened at Three Mile Island beginning on March 28th, 1979. And we are very pleased to have two very fine people with us today. And would you please identify yourselves. And you've got a recorder here. We will take it down. Don't let that worry you. But we want some record of the questions and answers.

So if you would, just identify yourselves, who you are, where you work, and what you were doing on -- as I say, it sounds like Perry Mason -- what were you doing on the night of March 28th?

Would you please start?

Mr. Frederick. My name is Ed Frederick. I am a control room operator for Metropolitan Edison Company at Three Mile Island Unit 2. I was the control room operator on duty when the accident occurred.

Representative Weaver. What is a control room operator?

Mr. Frederick. A control room operator is a licensed person, licensed by the NRC, who is designated to operate the controls of a nuclear power plant, for which he is qualified, and no one else is allowed to touch the controls unless he is licensed.

Representative Weaver. Turn those knobs?

Mr. Frederick. Touch the switches or in any way manipulate the contols that could in some way affect the state of the reactor.

Representative Weaver. On one shift how many control room operators are there?

Mr. Frederick. On our shift there are two control room operators licensed with reactor operator licenses. There is a foreman and a supervisor, each with senior reactor operator licenses. So four licenses total, plus seven operators that are not licensed, that operate the auxiliary equipment in the other buildings.

Representative Weaver. I see.

Would you identify yourself, sir?

Mr. Faust. My name is Craig Faust. I too work for Metropolitan Edison Company. I am licensed on Unit 2. I am also a control room operator.

Representative Weaver. Would you begin by just simply telling us what happened. I mean, you were standing around having a cup of coffee or watching the gauges. What was the first thing that happened?

By the way, how many times have you been interviewed now so far on this?

Mr. Frederick. Several: The NRC, the General Public Utility, Metropolitan Edison.

Mr. Faust. Just people we know.

Mr. Frederick. The President's Commission yesterday. Mostly with the NRC. I think we have had several individual interviews with them.

Representative Weaver. How long did the interview with the NRC take?

Mr. Frederick. They last anywhere between one and three hours.

Representative Weaver. Now, would you mind just starting out. Just tell us, if you can remember, what you were doing.

Mr. Faust. Well, first of all, we just have to set up that we were just doing routine things at that time as far as operation of the plant goes. I myself am known as the switching and tagging CRO that night. What it amounts to is I take the readings that are involved throughout the shift during the night, and also perform any surveillance, surveillances that are needed to be done on the plant, as well as, if there is tagging orders that are to be written up by people needing to work on pieces of equipment that are taken out of service, in other words, tagged out by isolating components and hanging tags, depending upon the nature of what they're doing, to perform the job and protect them from having any damage to equipment or themselves by inadvertently operating the equipment.

I was at that time, just a little bit before 4:00, I was finishing up on readings on our main turbine generator and returning to the desk that I normally operate from in this capacity.

Representative Weaver. This desk is right in the control room?

Mr. Faust. It is right in the control room. My desk faces -- I should say, the desk faces the control panel. And I was just turning, I was saying something to Ed. I can't remember what it was. But as I was turning around, I caught a set of lights coming on on the ICS panel. These are alarm lights that are above.

If you are picturing the control room like you could picture the desk you're sitting at right here, the lights would be up in the upper right-hand corner. At the same time, I pointed to Ed and said something like, something is wrong in the plant, or something's going wrong, or we have troubles. I can't even remember exactly what I said there to him.

At the same time, I caught other alarm lights coming on on our electrical board, which things that were flashing. In my mind, I just drew the position of the alarms that were coming in. I could not read them from that distance, but where they are located is significant to me. It was that we were into a runback on the reactor, and that the turbine generator had tripped due to the generator breakers being open and the position of these lights on the panel.

I proceeded to go around the desk, and I was getting ready to take initial actions on our EPs, emergency procedures, which designate verification of a lot of things coming up, as well as some manual manipulations of the switches up there on the panels. As I was coming around the desk and heading over, my course changed a little bit, because I noticed rod bottom lights coming on in the reactor, which told me further that we had a reactor trip trip.

Representative Weaver. The scram?

Mr. Faust. The scram.

My course of action then changed in my mind from what I was going to do initially, which took me to what is known as our makeup system, which would be the letdown, where I shut a valve first which is known as NEV-376.

Representative Weaver. You were going to, after you saw the scram, you were going to shut this valve?

Mr. Faust. I did shut this valve. That is what I'm trying to say, I changed. In our EPs, the direction of the course I was going to take involved doing this.

The next thing I did was try to get another makeup pump on, which I didn't succeed in doing. I tried two times. The first time I did not hold. We have what is known as an interlock or a time delay on the switch that allows a lube oil pump to come on first to pre-lube the pump. I let go of that switch too soon. It was like a second time delay, and it was a matter of turning on the switch and let it go. And I went immediately back on the switch and held it over longer.

I got a run indication on the pump as far as light. When

I left off on the switch again, the pump tripped off for some reason. I don't know yet.

Ed at that time was moving across the panel -- turn ng, I should say, across the panel o: moving across. And he saw the pump was still off, and reached down and grabbed a hold of the switch. And I left at that time. I was heading to another station.

Representative Weaver. What was this valve you were going to open?

Mr. Faust. It is the NEV-376, and the idea behind this is to limit the amount of water coming out of the reactor, the primary system, because what you want to do is keep your water inventory in there.

Right now, what normally happens is you go into a cooldown plant. Your water is going to contract on you. So you want to minimize the amount of water you're letting down. The system is normally on the purification system, so you shut it off. That is one of the first courses you do.

The next thing is, if you need it, you want another pump on, so that you can provide more water, if you need it, into the reactor.

Representative Weaver. And that pump is what?

Mr. Faust. That is the makeup pump. It is one of three we had at the time, one running, which is MUP-1B, which is normally running.

Representative Weaver. We've heard of the high-pressure --

Mr. Faust. These are high-pressure injection pumps. When we're talking about these pumps, these are, all three pumps are high-pressure injection pumps.

Representative Weaver. A, B, and C, and you've got B running?

Mr. Faust. Right.

Representative Weaver. It was running to adjust pressure on a normal basis and you were going to put on A, then, is that right?

Mr. Faust. Right.

These pumps are part of a volume control system, and also supplying water to ou ctor cooling pumps for sealing the shafts. So that is why B would normally be running on our pump. The other two are backups for ES actuation and they were in that capacity at that time.

We have a capacity, of course, to be able to start them whenever we want to, and that is part of our procedure, put another one on. The A is normally picked because it is lined up to our makeup tank. This gives it an immediate source of water right off that we can put it on and we don't have to draw from any other tank at that moment.

So that was my initial action. As I said, after Ed started the pump, I was moving across the panel to what is known as our feed station.

Representative Weaver. We are 13 seconds in now.

Mr. Frederick. Are we pretty clear on the sequence he just gave you as to what he did?

Representative Weaver. Yes, I think I've got it.

Mr. Frederick. There is an awful lot that happened in the first seven or eight seconds.

Representative Weaver. You're talking about in the plant itself?

Mr. Frederick. Yes.

Representative Weaver. Yes, we've been going over that for a number of days.

Representative Cheney. Had you ever been through this thing before?

Mr. Faust. Yes, a reactor trip and turbine trip, we have.

Mr. Frederick. Up to this point it is fairly routine.

Representative Cheney. It happens what, once a month or once a year?

Mr. Frederick. It happened several times on our shift in the past year, maybe two times.

Representative Weaver. Which plant, because obviously not Unit 2?

Mr. Frederick. Yes, Unit 2. Unit 2 had been in operation for a year.

Representative Weaver. I see. You hadn't been actually licensed to operate it, but you had been testing it for a year?

Mr. Frederick. We were licensed, we were testing, and we were generating power for seven or eight months. However, we were not receiving a commercial rate. The accounting thing had changed on December 30th. In other words, they declared themselves a commercial plant, reliable for providing so many megawatts of electricity every day. It was just a declaration of, from now on we will give you so much power.

Representative Weaver. So you fellows had been operating this Unit 2 for almost a year?

Mr. Frederick. Yes.

Representative Weaver. And how many times had we actually experienced a transient in Unit 2 up to this point?

Mr. Faust. A transient?

Mr. Frederick. During the testing procedure, we initiate these transients intentionally.

Representative Weaver. Intentionally?

Mr. Frederick. Yes, to verify that the proper response is taking place. In other words, the safety systems have to be tested under actual operating conditions before the plant can be licensed to progress through the power escalation from zero percent to 100 percent.

Representative Weaver. Had you initiated a transient comparable to the one that started off at this Three Mile Island accident?

Mr. Frederick. We had not simulated this transient with the emergency feed isolated and a leaky relief valve.

Representative Weaver. I see.

Mr. Frederick. During the testing procedure you test things as they are designed to respond. You don't intentionally try to make it break and go into what we had. That is not the general idea.

Representative Weaver. How many unintentional -- I don't know the difference between a transient and an incident and an accident.

Mr. Frederick. We may have pointed that out, because there's a difference between a runback and a trip and a power reduction. These are different. There are all kinds of different terms that come in.

A reactor trip is initiated whenever a reactor protection system, which is an automatic system which monitors parameters in the reactor coolant system, decides we are approaching an unstable condition, as undesirable. As an automatic trip, that will be initiated, and that has happened, I would have to guess, maybe five times in the last year.

Representative Weaver. We've been calling it a scram, a scram, meaning a reactor trip.

Mr. Frederick. An unplanned reactor trip. I would anticipate maybe five times. You could get that off the record. There is an accounting and a report given to the NRC each time that happens.

Representative Weaver. So you had five scrams in Unit 2's lifetime up to this point?

Mr. Faust. I was just going to say, he's trying to indicate that you can get the actual number.

Mr. Frederick. From the NRC. They have that.

Like I say, we went through many of these trips and these transients intentionally. And it would be hard right now to figure out which ones were intentional and which ones were not. You could count them on your fingers and say there were five.

Representative Weaver. Five unintentional?

Mr. Frederick. Yes, there were probably five, about.

Representative Weaver. And nothing untoward happened in those?

Mr. Frederick. Well, each time that it was unintentional, of course, an investigation starts to find out what initiated it and what can be done to prevent it. And each time it was either a string of events started, like we did have some trips from the pumps before. I believe there were two of them, but not from the same reason. It was loss of suction pressure or something like that.

And we had an emergency safeguards actuation in which this relief valve stuck open once before. And all this stuff is on record somewhere, I'm sure. I know it is in my log.

Representative Cheney. When the valve stuck open once before, was that planned or accidental?

Mr. Frederick. That was unplanned. It was not because of the trip, but it was one of the things that happened during the transient.

Representative Weaver. But did you know it stuck open that time?

Mr. Frederick. No, we had the same problem with valve indication, that there was nowhere on the panel that indicates that the valve was open. We still don't have that. They made an attempt at providing valve indication for it by monitoring the initiation signal that goes to the valve and give a red light on the panel whenever there's a signal calling for that valve to be open.

However, once that signal to open the valve goes away the light goes out, and it does not indicate the actual position of the valve. In other words, it says it is supposed to be open. There is no way of verifying whether it is or is not.

Representative Cheney. And when the valve stuck open once before, was there then some kind of inspection to find out why it stuck open?

Mr. Frederick. Yes, it was worked on and repaired, and the indication that we have now was installed in order to preclude this from happening again.

Representative Cheney. I'm sorry, I did not catch that.

Mr. Frederick. I say, they repaired the valve and then they installed this new indication, this new valve indication, hoping that in the future, if it was stuck open, we would be able to tell.

Representative Cheney. Do you recall why it was that it stuck open that time?

Mr. Frederick. No.

Representative Cheney. We had testimony previously involving another valve in a different reactor, where it stuck open at one point and they found out that there was a missing light of some kind.

Representative Weaver. Why don't you just go on and tell us what you did then, what happened?

Mr. Frederick. I will just give you up to where Craig is right now, I will tell you what I was doing in the meantime. When Craig pointed at the panel, I was facing away from the alarms that were coming in. I had turned to see what was going on, and I read a few of the alarms as I was turning.

The first ones I read were condensate pump trip and turbine trip. Now, that in my mind initiates the emergency procedure for turbine trip, which calls for verifying that the runback, reactor runback has taken place.

I monitored the ICS system, the integrated control system, for a runback. You have to study the gauges to see if they are moving from 100 percent down to 15 percent for demand sequence. As I started to do that, Bill Zewe came out of his office and came up on my left, and he was also scanning the panel, and he said: You just lost the reactor. In other words, he was indicating that we had a reactor trip while I was looking down at the panel.

So that initiated a different emergency procedure. We moved from turbine trip to reactor trip. And the verifications there are different. So I verified that all of the rods had been dropped into the core. The individual rod positions are straight ahead on the panel, and so I verified that and the neutron power indication coming down.

And my first manual action other than verification of all this going on was to place the pressurizer, the pressure control systems, in automatic, which had previously been in manual.

We were doing some water inventory control several weeks before this and it was necessary to have the pressurizer instruments in manual. But it is undesirable to have them in manual during the transient, so I threw them in automatic almost immediately.

And, as Craig said, I moved to the left. He was already at the makeup system. I saw he was having trouble with the pump. I started it and he left.

At this point, the way we run the drill on a simulator and at the plant, one of us should take charge of the reactor cooling system and one take charge of the secondary plant, and try and communicate with each other on what is happening. So

I took the primary and he took the secondary. It was my job to maintain the water inventory in the reactor cooling system by adding water through the makeup system and monitor the pressure, the pressurizer level and the system temperature, to assure that a normal cooldown was going to take place. That is what I was doing when he went to the emergency feed station.

Representative Cheney. How far along are we now at this point?

Mr. Frederick. We're still within the first minute or minute and a half.

Mr. Faust. Then I picked up and ran behind or moved across behind Ed. I came in across. The first place I wanted to look at was the steam generator levels. The first thing I saw was that the operating range had several indicators up there of steam generator level. The operating range was off on the bottom.

The next area I looked at was our startup range of indication, which was approximately midway. It was coming down on scale.

The next thing I did was I looked over at the main feed pumps. Both had been tripped off. So I verified that our emergency feed pumps were on. There were three of them. They were all indicating operation at that time.

Another thing I looked for was the EFE-11A and B valves, which are automatic emergency feed valves that throttle to control level in the generators if you lose normal feed. The signals should have been generated at this time to go on what is known as low-level limits. It was 30 inches, approximately, in the steam generators.

Representative Cheney. I just wonder on this -- we're all novices in technology. We've got a chart. It wouldn't be possible for you to just show us the pieces of equipment in the plant?

Mr. Frederick. On these pictures, you mean?

This is the area of the plant that we were in. Looking at the level for the steam generator, which was right here. The emergency feed valves we were trying to operate are these black boxes right here.

Mr. Faust. The emergency feed valves I'm trying to operate at this time are up here, these two boxes here. I was monitoring them, just looking at them. The light indication I was looking at were the traveler valves set up here.

Mr. Reis. Could we just arrange this so the members could get seated and see what's going on here?

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Mr. Frederick. We're told that by the time the reactor tripped we had only been in emergency three seconds.

Representative Weaver. Three seconds when the scram occurred?

Mr. Frederick. From the time the condensate pump tripped to the reactor trip, the total time was seven seconds. So all this that we talked about so far happened in seven seconds.

Mr. Reis. Although we're sitting across the table, this may has got to hear. So speak up a little.

Representative Carr. And before you get into the details, setting the stage, when did you come on duty?

Mr. Frederick. We'd been there about four hours out of an eight-hour shift. We'd been there about half the time. Actually, it was five hours.

Representative Carr. Okay, go ahead.

This is Mr. Faust and Mr. Frederick.

Mr. Faust. The place I was looking at, like I said, when I was monitoring the steam generator level in the startup range, which would be these two indicators here. The first ones I looked at were operating range, and they were on the bottom, indicating that -- in other words, you have to picture where these operating ranges were monitoring on the steam generator.

The operating range covers a level something like 96 to 300.

Representative Weaver. What is that?

Mr. Faust. Inches of water in the steam generator. The startup range goes from zero to 250 inches. So I was already down in the midrange and on the startup range. As far as I could see at that time, the operating range had bottomed out. Levels were coming down, which I expected them to do. I was looking for that.

I look at EFV-11 valve here, which indicated -- the first thing I looked at were these controllers here, which were indicating a demand signal calling for the valves to open. The other thing I noticed were these lights up here were red and green. In other words, that was indicating that the valves were traveling from what I supposed to be a closed to open position or in between there.

Representative Cheney. Which valves were these?

Mr. Faust. These are the emergency feed valves.

Representative Cheney. On the secondary system?

Mr. Faust. Right.

Mr. Frederick. There is an automatic valve in there.

Mr. Faust. The next thing I did was I looked over -- at this time I wasn't aware of actually the status on the secondary plant as far as our feed goes. I looked over and I caught -- if I can show you the lights, it is up in this corner here. You see these two top switches here. There are lights, indications up there that are indicating to me that both our feed pumps had tripped, the normal feed pumps.

Okay. The next thing I did was immediately -- I guess you should realize the position of me against the panel right now. I'm up against the panel, right in this corner right here. So that I looked down under me and over to the side, which would be over in here, starting over in here, to verify that our steam-driven and electric-driven steam pumps had picked up, which they had. I had a discharge pressure indication on the gauges above, which are essentially these three gauges. If you just want a location on the panel, they are right across the top.

So I felt we were going down to low-level limits. I was going to leave that station and go further over on the panel, over to our turbine generator and also to monitor the output breakers on the generator itself. These are parts of our EP that we follow up on.

Representative Carr. "EP" meaning?

Mr. Faust. Emergency procedures.

So the first thing I came across was I saw one valve, the throttle valve -- I can't identify now which one it is. I would be guessing to say. The indicator on one throttle valve was hanging up. All the governor valves were shut. In others, there are four valves, eight valves we're talking about here.

Mr. Frederick. The valves he's talking about are the steam valves that make the turbine turn. At this time they should all be shut and he noticed that one was open.

Mr. Faust. The indication was that it was hanging up. I pushed the trip button on the turbine at that time just to ensure that the trip signal was indeed into everything. It drops out the hydraulics on it, too.

So I didn't pay much more attention to that at that time, except to note in my mind for later reference. I had four other valves fully shut to isolate steam to the turbine. The idea here is you don't want to drag steam off, too much steam off the turbine generator, the reactor right now or the steam generators, because you will subcool yourself and you will shrink out of the pressurizer. In other words, you will lose your level.

So the idea is you want to stabilize the plant out right now and hold pressure and temperature at about 547. That's an average temperature across the timer. And also, 2155, which is the normal pressure that we operate at, you want to hold there and cool from there, just to remove decay heat, at this time.

So I hit the turbine button, the turbine trip button. The indication was that it still had hung up, but I had indication that the others were down.

Part of our verification is to ensure that the extraction steam valves going to our feedwater heaters are shut or go shut. I verified movement on them going from -- there was dual indication at the time that they were going shut.

Another thing I did was I took the turbine generator breakers and the field breakers for the generator and put them in a polar lock to ensure that they were open. All the indications at this time were normal that they were open, except for the one indication on the throttle valve hanging up on the turbine. We found out later that was just the valve shut so fast that it ripped an indicating arm off. The valve was actually shut.

I came back across the secondary panel. I made a decision during that time that I had time to ignore part of our EP until a later date. In other words, this involves just putting turning gears, switches for turning gears in automatic, so that when the turbines coast down they don't come to a dead stop with a large hot rotor there. That could cause distortion of the rotor. These things spin for a while, so I had time to leave that go for this point.

I came back over to the emergency feed station. The first thing, again, that I looked at was the startup level. They were indicating 10 inches on the startup range. It was at that time that I announced that the generators are dry.

I started looking. I took control of EFV-11A and B, these Bailey stations, right here. I took them into manual and went to full open on the demands, and it indicated once again that the valves were traveling from shut to open. At this time they should have been open. Something was abnormal. I had to wait.

It turns out that time is the big thing here in the way we're thinking. I actually ended up waiting, apparently, overall 8 minutes before I actually got the feed reestablished to the generator. But during that time --

Representative Weaver. And is this this valve you're talking about?

Mr. Faust. No, it's EFV-11.

Representative Vento. The indicator valves that you saw were open and closed? Where are the valves in the system?

Mr. Frederick. It's the one I drew, just there. That is an automatic valve that should be full open at this time.

Representative Vento. And it's indicating it's still moving?

Mr. Frederick. Yes, it's indicating it's still moving.

Representative Vento. And these were the generators, and you took control. When you took manual control, they indicated that they were dry.

Mr. Faust. Yes.

Representative Vento. Both?

Mr. Faust. You're talking about the steam generators? Yes, on the secondary side.

Mr. Frederick. It's undesirable not to have water in the steam generator.

Representative Vento. Oh, yes.

Mr. Frederick. The steam level showed just at the bottom of the generator. He said he had 10 inches of water.

Mr. Faust. The indicators did not move any lower or any higher at the time. In other words, they stayed at 10 inches.

From past experience, we come up with that whenever, I believe, we set 10 inches to consider whether it is or it is not that the generators are dry and to treat it as such. In other words, we start looking for trouble and correct it.

So my first actions were to, like I said, take manual control and go to full demand on them, raising the full demand.

Representative Carr. [illegible] these, again, go to these valves here?

Mr. Faust. Right, the controls for those valves.

Once again, I had to wait.

One other thing that I looked at was T-Ave at this time. T-Ave was up from 570 degrees. It should have been lower. At this point in the game, I should have been down around 4 or 547.

Representative Carr. Where do you find that?

Mr. Faust. It's right here, a digital display. It was 575 and it should have been 547.

Representative Vento. Now where do they go to? Is that within the system?

Mr. Faust. These temperature indicators are indicating at loop temperatures. In other words --

Representative Vento. They are not directly on the reactor, not the reactor core?

Mr. Faust. It would be a temperature indicator off here, this point in the primary loop, and also coming out of the bottom of the steam generators. It would be TC and TH. The average of those is what I'm looking at at this time.

Representative Vento. So one or more may be hotter or colder at this point, you don't know? Or are they about the same?

Mr. Faust. I'm looking at one indication right now. These are all averaged together in one.

Representative Vento. And there are how many points on there that test for that in this type of generator, do you know?

Mr. Faust. We've got two in each loop as far as TH that are going to this purpose right now, and we have two legs coming out of each generator that go to the pumps. So that makes four TC indicators or sensing points for the purpose of displaying T-Ave, of which we select -- these are averaged, so we will select averages of these TCs and feed them together for loop T-Ave.

And we feed also from both loops, then, and get an average T-Ave of the core or the overall system. What we're looking at is an average temperature, or I'm looking at at this point is an average temperature of both loops in the primary system. And as I said, it should not have been as high as it was. It was there due to the loss of feed, and that was my job, to try to establish feed at that point, which is what I was trying to do.

The indications I need to do that are an increase in steam generator level. Steam generator level is on the bottom, so I have to wait.

The first thing I knew at that point was that I took an action, it was on those valves, and I had to wait for an indication.

Another thing I was looking at was steam generator pressure. I expected to see it down at that point, but once again, it wasn't doing what it was supposed to do. In other words, our turbine bypass valves which pull steam off the steam generator in a situation like this and control for a 1010 signal sent in to them to maintain pressure in the steam generator at 1010, that was a little lower than 1010. I can't give you an exact number on that. I was looking. It was right around 1,000 pounds.

So I looked over to see if the turbine bypass valves were open and they weren't, which is the way it should have responded, really, for what the pressure it was seeing in the generator. The thing that I was seeing was that I wanted T-Ave to start dropping. I wanted to cool down.

So I took the turbine bypass valves at that point into manual. And the control for these are sitting up here, where I'm monitoring over here. I took those to manual and I just cracked them. And the way I got that indication was that we have lights on those valves. So I gave them just enough demand signal that as soon as I got the red light indication on it, it told me that. I just cracked the valve open and I just cracked them open to promote some kind of cooling out of the steam generators.

What I received was a decrease in pressure on the steam generators, which was indicating to me that I wasn't getting feed also at that point, because it was just bleeding off, a generator sitting there dry. It bottled itself up.

You are supposed to try to maintain 1010 in it. So I started looking further. That is when I scanned the panel further.

My first indication was, when I looked down I looked to see and make sure, I looked at the pumps again and I came back across, and the tag that you may be hearing about that was over an indicator would be over this. It was a yellow caution tag, and it's on FWV-17B, which is a recyc valve for the feed pump, the B feed pump. We had problems with it.

That caution tag was just to indicate and tell the operator of the problem. And if the pump tripped, we wanted to give the pump recirc flow path to protect it.

At that time, that tag was hanging down where it was covering the upper indicating lights on the EFV-12B.

Mr. Frederick. It's doing it right now, as a matter of fact.

Mr. Faust. No, it was flipped to the side. This tag was hanging straight down.

Representative Weaver. Who put that tag on there? Not the person, but is that an NRC tag?

Mr. Faust. No, that is part of our --

Mr. Frederick. That's been on there for about a week before that. I think I put it on.

Mr. Faust. It is not uncommon for tags like that. In fact, you can see there are tags all over the place.

Representative Weaver. Does the NRC put any of these tags on?

Mr. Frederick. No.

Representative Weaver. These are all done by utility personnel?

Mr. Faust. Yes.

Representative Carr. But this is a standard thing throughout utility companies?

Mr. Faust. Yes, they have some sort of switching and tagging at all utilities.

Representative Vento. You noticed, though, in looking at that at this point that you weren't getting feedwater. In other words, the feedwater indicator or light here, is that right?

Mr. Faust. No. All that is is a valve. It is a valve in the feedwater train.

Representative Vento. And it was closed and that light was on?

Mr. Faust. Like I said, I made a first scan at it. That tag that was covering it -- I was actually sort of leaning over the panel. I don't know how to say it. I was just standing over it like this, because I was trying to see an indication over here on the panel.

Representative Vento. This is the valve right here that we're talking about in this diagram?

Mr. Faust. The upstream isolation.

Representative Vento. That's the valve right here?

Mr. Faust. Yes.

Representative Vento. And this one you were reading showed that it was going from open to closed or closed to open?

Mr. Faust. At this time it was closed. Once again, at this time it was going again from closed to open, as far as I could determine.

Representative Vento. Is that a normal procedure when you have had this valve -- this now has been, I don't know how many minutes you had said, eight minutes --

Mr. Faust. Well, the eight minutes I'm talking about is from the point from graphs that we have, that we can determine once we started feeding.

Representative Vento. I guess my question is, does it normally take that time for a valve to go from closed to open in this situation?

Mr. Faust. No.

Mr. Frederick. Some time confusion is in here. He may have noticed that. When he looked at that valve, it may have been only several seconds into the accident, and he was just impatient for it to open and that stuck in his mind. We have an indication that this thing is operating now.

Representative Vento. We have time limitations, so we're going to have to press on. Why don't you proceed?

Mr. Faust. I made a scan of it, found those two valves shut. The first one I saw was the bottom one, which would be down here, those indicating lights there. I announced it at the same time I was reaching for the control switch on that one and flipped the tag off the upper one. And the 12s were shut. That is what I called out, I believe.

Anybody who was concerned at that time knew what I was talking about as far as relationships to those valves. It was at that time that we heard from our loose parts monitor. There was very cold water going into a hot pipe. We knew we were feeding at that point.

I started regaining pressure in the steam generator also. I continued to feed. I watched T-Ave dropping. It was coming down as I started feeding the generators up. As soon as I got a level indication that I could tell -- as soon as I got level indication, then I started backing off on the feed rate going into the generators.

I established 30 inches in the generator for low-level limits and went back to a more normal situation for the generators at this point and just promoted cooling. I came down -- I can remember three temperatures mainly that I saw at that time. One was, as I said, 570. The next one I remember was 550. And then I ended up around 547, and I think 540 was the lowest I remember seeing it go. And then we seemed to hold there.

Mr. Frederick. His job now is maintaining the steam generator level and establish a controllable cooldown rate. He's taking manual action to make up for what the automatic system did not do. And once he gets it going in the right direction, he can just monitor it, and that is what he is doing.

Representative Weaver. What time was it now?

Mr. Faust. I guess it was eight or nine minutes.

Mr. Frederick. During the time that he was having the problem with the steam generators, I was having a problem with the pressurizer level. During the initial transient, the reactor trip, we expected the pressurizer level to drop rapidly as the system cooled off. You should see a tremendous shrinkage.

My job is to start another pump, the high-pressure injection system, and try to get ahead of the shrinkage, so that we can recover pressurizer level back up to around 200 inches, maintaining a minimum of 100 inches. That is what I was doing. I was starting an extra pump, and I did gain control over the pressurizer level during the transient and begin to turn it back up prior to the system low pressure signal that initiated the emergency safeguard system.

Now, the pump, the high-pressure injection pump that I was controlling and the valves received emergency safeguard signals. And when the plant reached 1600 pounds in pressure, that automatic signal tool control of the pumping valves away from it. In other words, I had no control over them as long as the automatic signal was overriding me.

So after I saw the initial turn in the level starting to go back up, then the safeguard system continued to inject more water to raise the level more rapidly. Over the next few minutes, it seemed to me that the pressurizer level was rising too rapidly. It was faster than I had seen it go before. So I just continued to monitor it, hoping that it would taper off as the pressure was regained in the system and begin to automatically control itself.

However, it reached about 385 inches, 400 being the upper limit, and the rate was still constant. Okay, it was my concern not to let the pressurizer fill solid with water, because a solid water system is difficult to control and we had never done it before. So I was very concerned about preventing the pressurizer from filling.

At this point, after having verified that the emergency safeguard signal had in fact initiated all the safeguards equipment and that it was now going to be a problem and that I was going ahead on full automatic and going to cause another problem, I bypassed the emergency safeguard system. In order to that -- it is right next to the makeup system -- I just stepped to the left and pushed six bypass buttons, which gave me control over the system. It didn't change anything except to give me back manual control.

What it did was cut off one high-pressure injection pump and shut two of the four injection valves. In other words, I cut the injection flow rate in half, looking for a drastic change in the pressurizer level rate of increase. I saw a slight tapering, and then it went right back on the same rate. And so, what I had done was not stop the increase in the level. Within a few seconds, it seemed to me, it went off the scale.

I had already remarked about this to the supervisor and said, we're about to go solid, which is undesirable.

Representative Cheney. At this point, can you quickly explain why you think the pressurizer level went up and did not perform as you thought it would perform?

Mr. Frederick. What I think now or then?

Representative Cheney. Now.

Mr. Frederick. Now, because of the loss of the heat removal from the steam generators, the hot leg in the primary system, with the water coming out of the reactor coming to the steam generators, the increase in temperature was sufficient to begin to generate steam in the pipes, in the high point of the pipe as the water got hot enough to start boiling, and it caused the steam generation at the highest point. So what had happened, we formed more steam in the system other than the one I was monitoring.

What had happened was that high pressure point had pushed the water from the rest of the system into the bubble.

Representative Weaver. What did you think was happening at the time?

Mr. Frederick. What I thought was happening was that the high-pressure injection rate was too high and that we did not have a leak in the system, so all we were doing was increasing our inventory. So I was reacting or putting too much water into the system, and so I cut back the fill rate and increased the drain rate to the purification system, because now I could control the valve that we originally shut to take water out of the system, trying to drain some of the water out.

Representative Weaver. Which valve are you talking about?

Mr. Faust. That is 376.

Representative Weaver. Go ahead.

Mr. Frederick. The valve designation is MUV-376.

After several minutes of trying to get the pressurizer level back, I thought I had control over it because I could see the pin occasionally dip down on the scale and go back up. So I thought I was very close to controlling it. But actually, it was just the instrument response to the abnormally high level. It was just bouncing. I did not know that at the time.

So after he gained control of the steam generators, we still had this problem with the full pressurizer level. We had conflicting instruments. We had a full pressurizer, which meant the system should be solid. We had a decrease in the temperature and a decrease in the pressure system.

Now, what we should have seen was a definite rise in pressure through the injection of the water. You should see a rapid pressure increase.

The temperature was high. That was what was causing the steam generation. So we had high temperature and low pressure, and we had a full pressurizer. So the pressure was going up. So these things were conflicting. And we were talking about it, trying to figure out what was wrong.

We began to distrust the pressurizer level instrument, and we later verified that it was working properly.

Mr. Meyers. When did you verify that it was working properly?

Mr. Frederick. The instrument technician --

Mr. Meyers. This is right around that time, as opposed to the next day?

Mr. Frederick. No, it was the same morning. We had an instrument man verify that the signals going to the indicator were correct. We just checked it from points on the computer and he gave a quick verification. It is unlikely all three pressurizer instruments would have failed at the same time in the same direction. So we assumed it was working.

So for the next hour or so, we continued to operate with full pressure, system pressure about 1200 pounds or so, and temperature relatively hot. But we attributed the low pressure to the problems he was having with the steam generator. In other words, the excessively fast feed rate he had would have caused excessive cooling in the RCS, which could have contributed -- could have caused the low pressure.

So when we got the steam generator stabilized as far as level and feed rate, the steam generator seemed to be masking what was going on in the pressure cooling system. So for the next hour or so we worked on trying to stabilize the steam generators, which we finally did about 50 minutes in or so. We eliminated the steam generators as being the cause of our problem.

And it was about an hour into it that we started having a problem with the reactor cooling pumps that led to us turning them off and losing the flow in the system.

Representative Cheney. At what point in this period were you aware when the relief valve dropped in the pressurizer?

Mr. Frederick. The relief valve opened in the first few seconds of the transient. During the reactor trip, the reactor opened. The reactor tripped on high pressure, because the turbine tripped. When the turbine tripped, the RCS begins to heat up, the pressure goes way up and causes an automatic trip. That is the way it's supposed to work. That's what caused the reactor trip.

As the pressure went up, that relief valve would have opened. It is a motor-driven valve. It would have opened to relieve the high pressure and bring it back down to the normal pressure.

Representative Weaver. Which? You're now talking about the relief valve up here?

Mr. Frederick. Yes. That's the one that we believe stuck open. That is when it opened and we had indications that it opened.

Representative Carr. Where is that indicator on these pictures?

Mr. Frederick. It's over in this corner of the panel. So when the light went out, that means that it went shut.

Representative Cheney. This is all automatic? You didn't have to do that?

Mr. Frederick. We did not have to do that at all. So, believing that we were stable for some time, we just continued to try and wrap up the plant and establish a cooldown rate.

The next problem is the reactor coolant pump vibration. Do you want to go into that?

Representative Cheney. Yes.

Mr. Faust. Do you want me to bring you up to date over on the secondary? I don't know where they want to head on that, because I had problems on the secondary that I was working on, in addition to this.

Representative Weaver. The problems you would have had would have been the same as in a coal or oil plant, would they not?

Mr. Faust. Yes.

Representative Weaver. Albeit they obviously are more dangerous.

Mr. Faust. What I had over there, if you want to just ignore that part of it, I had reestablished feed, emergency feed, and I was doing other things to try to get back onto the normal situation over there. But we were removing heat. So maybe that is as far as you want to go on it.

Representative Weaver. I have another question. When you found out in the midst of all this that this valve right here had to be closed, what was your reaction?

Mr. Frederick. He shouted it out.

Representative Weaver. He said "The 12s are closed," was that it?

Mr. Faust. Yes, I shouted out. I'm pretty sure I was pretty boisterous about it. It is not something I wanted to find or I expected to see.

Mr. Frederick. He shouted it out loud, and that is such an unusual thing that it took all of our attention away from what we were doing. We had to go see what caused that and to make sure that he was in fact opening them.

He nearly ripped them out of the panel.

Representative Carr. You opened them, now?

Mr. Faust. Yes.

Representative Vento. They were manually closed to begin with, then, or what? I mean manually, when I say dropped the panel --

Mr. Faust. Well, we can't tell that. In other words, these valves could have been operated locally, if that's what you mean.

Representative Vento. You don't know how they got to be closed? No one knows? You didn't do it?

Mr. Frederick. They can be operated from another building.

Representative Carr. And if they are operated from another site, the indication would be --

Mr. Faust. It would be changed.

Mr. Frederick. It would not be something you would notice unless you were looking at it.

Representative Carr. What I'm getting at is, the light responds to the valve. It doesn't respond to your switch indication.

Mr. Frederick. That's right.

Representative Vento. One other thing before we go on to the other problem in the secondary system, what you did next. This relief valve, of course, is a key part of this, apparently. But there was some tail pipe temperature and some other indicators there that were also available.

Who was responsible for watching those at this particular point? The tail pipe temperature?

Mr. Frederick. What you're talking about is the outlet temperature of the relief valve.

Representative Vento. And there's also a tank that this goes to that is not shown on here, and that has an indicator on it and a temperature and so forth. There is a thermocouple on here, and who was responsible for watching those in this particular process? It was just a generally shared thing?

Mr. Frederick. The points that you're talking about are not displayed. They are not on the console. They are in the computer. You have to manually call them up.

Representative Vento. You have to call those things up. But weren't they called up during this procedure at all?

Mr. Frederick. No.

Representative Weaver. How many minutes are in we in now? Where are we?

Mr. Faust. It is not a normal thing.

Mr. Frederick. About an hour.

Mr. Faust. We did not know a problem like that existed at the time.

Mr. Frederick. If the valve indicated shut, there's no reason to look at the downstream temperature.

Representative Vento. The relief valve indicated it had closed?

Mr. Frederick. It indicated not open. The red light comes on if it's open and the red light goes off if it is not open.

Representative Vento. The impulse to the valve was opening, but not the valve itself?

Mr. Frederick. It's not a valve indicator. It is the control signal, on-off switch.

Representative Vento. But there is nothing else in the display panel that tells you what the thermocouple reading is, what the tank pressure is, what the temperature in that is?

Mr. Frederick. The drain tank, what you're talking about, the quench tank, indications for that are on the reverse side of the panel. In other words, the consoles that are upright, you would have to go around to the back of the panel.

Representative Vento. So the only way you could get that is really calling it up from the computer?

Mr. Frederick. I did eventually go around there to look and verified that the tank was receiving water. All I could see was that it was heated up and under pressure, which I would have expected after the relief valves had exhausted.

Mr. Ries. How many people -- you said this was through the first hour you did not check this, did not call up the temperatures?

Mr. Frederick. That's right.

Mr. Ries. Who else was in the control room at this point, say through the first hour?

Mr. Frederick. Mr. Sheinman the foreman, the Unit 1 supervisor was there, and us.

Mr. Faust. What he was doing was he got procedures out so we could pick up, when we got the time, to look at the procedures to make sure we carried out actions that were needed and to make sure we carried them all out.

Mr. Frederick. So we're operating this on memory now.

Mr. Reis. What about alarms on the drain tank?

Mr. Frederick. The alarms -- this is a big problem. There is only one audible alarm in the control room for the 1600 alarm windows that we have, in other words, the ones that are displayed on the front of the console along with the ones on the reverse panel. So that during the emergency, I made a point of announcing that I didn't want anybody to acknowledge the alarm, that is, push the acknowledgment to silence the alarm, because that would make all the windows stop flashing, and I wanted to read them all to see what was happening. As we began to run out of ideas, I wanted to review all of the alarms that we received to see if anything was happening that we couldn't see.

So the alarms that came in on the drain tank were not displayed as being different from any other alarms.

Mr. Meyers. So if you had turned off the audible alarm, that meant that would have turned off all of the flashing?

Mr. Faust. They would be in and you would not be able to determine which ones were there first and which ones were normally in.

Mr. Meyers. Okay.

Mr. Frederick. There are several steps in the alarm process. As the alarm comes in, it sounds an alarm and a flashing light. And as long as the alarm stays in -- and you push the button, and the light will go solid. If in the meantime the alarming condition clears itself or goes away and you push the button, the light will go out and you won't be able to tell that it ever came in.

If you have three or four alarms at the same time, only one may stay lit out of the three or four. We had probably 100 or 200 alarms flashing within the first few minutes.

Representative Cheney. But only one audible?

Mr. Frederick. Yes.

Representative Vento. If they correct themselves, the alarm turns off and the light quits flashing?

Mr. Frederick. Yes.

Representative Vento. Well, if you weren't pushing the buttons and you just told us you wanted to have a full history of this before you -- if you don't push the button and the problem clears --

Mr. Frederick. Then there's a difference in the way it flashes. It would flash brightly if they are coming in, and they would flash somewhat dimmer.

Representative Vento. But you wanted a chronology of that?

Mr. Frederick. I wouldn't be able to establish the chronology. I just wanted to see what systems were affected by the transient and if we could see something. There are some alarms you expect to get. If you read over them, you just discount them as being normal.

B"t there may be a few that come in that you hadn't e. ced, and those are the ones I was looking for.

Representative Carr. Is there any way to isolate the individual alarm? In other words, to shut off the horn and the bell so you can think a little bit and get the lights to flash?

Mr. Frederick. No.

Mr. Meyers. Were you aware during this time that the reactor had a built-in sump pump that turned on, and what was the significance of that?

Mr. Frederick. The operator told me that the pumps were running. I had no indication of that in the control room.

Mr. Reis. Any indication what time?

Mr. Frederick. Approximately an hour.

Mr. Meyers. And that was water that had come out of the reactor cooling drain tank?

Mr. Frederick. Yes.

Mr. Meyers. So at 10 minutes that drain tank had overflowed? Since the knowledge of the 1019, the sump pump came out?

Mr. Frederick. Yes.

Mr. Meyers. So that means that the drain tank had sort of overflown at that point?

Mr. Frederick. Yes.

Representative Cheney. But you would not have had any indication in the control room that the sump pump was running?

Mr. Frederick. No. The sequence of alarms that comes out of the computer that they were able to read later on was backlogged. The alarms came in 100 at a time. The computer, the IBM typewriter just types them out one at a time. So as they were coming in rapidly, probably 10 or 15 per second, it just couldn't keep up. So there was a backlog of maybe two or three hours.

Mr. Faust. I don't know what time this fits into, but we had problems with the alarm typewriter, too, at this time. And I don't know what it was, but the easiest way for me to say it is, it sort of started eating the paper. In other words, it got off the track.

Representative Carr. Yes, we've all seen that in our offices.

Representative Vento. I was going to say, someone called about the sump pump and let you know that it was going. Does that go on frequently?

Mr. Frederick. The pump does cycle once or twice per shift on a normal basis. What it is doing then is removing the humidity. It is just about raining in that building. That's normal. The temperature is 100 degrees and the humidity is probably 60 or 70 percent, and it's just always sweating. And that water drips down on this basis and it pumps out on a regular basis.

Now, when he called and told me the pump was running, he also told me that the sump level was off scale high. That is when he called me. It wasn't unusual for the pump to be running; it was unusual for the level to be high and the pump still running.

So I called up the sump level on the computer through a manual operation and verified that mine was also reading off scale high, and told him to secure the pumps, turn them off, which he did.

Representative Cheney. Was that the last time the pumps operated?

Mr. Frederick. That is the last time they operated. As far as I know, they stayed off for the rest of the time, because soon after that we went to the auxiliary building and no one could operate them.

Representative Vento. But you told them to turn them off. Why?

Mr. Frederick. I told them to turn them off because the source of the water now was obviously not sweat : the walls. We were getting water out of the drain tank. So rather than transfer that water out of the building, I told him to stop it.

Representative Vento. How much was it at about that time?

Mr. Frederick. If the pumps had been running for 19 minutes until I told him to turn them off -- someone else would have to compute that. It is probably several thousand gallons that were transferred. They pump normally in a few minutes, like one or two minutes you can pump 200 to 300 gallons out of the building. So probably 50 or 70 gpm pumps each.

Representative Vento. Did this prompt any special action on your part when you realized there was some source of water coming from, obviously, not from the condensation but from other sources? What action did you take at that time? Obviously you've got a lot of things that were before you that were going on.

Mr. Frederick. I checked the radiation levels and they were not in a line state. And I figured that the volume of water in the building was either not highly contaminated or that it was -- it may have been highly contaminated in a small volume, but it was not enough to set off the alarm. Either way, it did not present a radiological problem at that time, so isolating the pumps, to me, would eliminate the problem, would take care of the problem.

Mr. Reis. You said earlier that an outlet temperature was not requested. In the utility's chronology they provided, it was requested at 25 minutes and again at 80 minutes, and it showed that at 25 minutes 285 degrees as the outlet temperature.

Mr. Frederick. That would not be abnormal. The temperature of the system being nearly 600 degrees, the outlet temperature of the valve, if it were open, should be 600 degrees.

Mr. Reis. Right. But wouldn't that indicate that it had stayed open rather than closed?

Mr. Frederick. No. You expect the pipe during the discharge to rapidly increase to 600 degrees, and it may take hours for it to cool off.

Representative Weaver. I want to impose a generality here to try to help me feel my way. It strikes me, from the answer you just gave now and the other things, that your gauges and other measuring devices were not telling you what was going on in this plant. That is what I am led to surmise.

Mr. Frederick. Let me make a statement about the indications. All you can say about them is that they are designed to provide indications for whatever anticipated casualties you might have. If you go out of the bounds of an anticipated casualty, if you go beyond what the designers think might happen, then the indications are insufficient and they may lead you to make wrong inferences.

In other words, what you're seeing on the gauge, like what I saw on the high pressurizer level, I thought it was due to excess inventory. In other words, I was interpreting the gauge based on the emergency procedure, where the emergency procedure is based on the design casualties. So the indications then are based upon my interpretation.

Hardly any of the measurements that we have are direct indications of what is going on in the system. They're all implied measurements.

Representative Weaver. But I'm not absolutely clear of the conclusion of design there, because you've got a gauge, you say, on the sump pump that, because of sweating, you expect some operation.

Mr. Frederick. I would not expect six feet of water. The level indicator tops out at six feet. The sump is six feet deep.

Representative Weaver. Well, when you heard it at six feet, what did you do?

Mr. Frederick. That's when I isolated the pump.

Representative Weaver. With the relief valve that is open at this point -- were you in the operating room when that relief valve opened?

Mr. Frederick. No, that's a different shift. The only way they found out it was open was to go around to the reverse panel.

Representative Vento. On a different shift they found that. But you weren't aware it was stuck. You've already said that.

But that's not the point I'm getting at, what I'm getting at, since you weren't there. But in other words, this tail pipe temperature apparently remained high for some time after that. You claimed it had been 574 in the system, and finding out that it was 280 an hour later didn't particularly seem unusual to you.

Representative Vento. But I'm wondering --

Mr. Faust. That's an average temperature. It actually should have been up around 600 degrees.

Representative Vento. If it had been -- in other words, what you're saying, if it had been 600, that would have indicated to you the temperature inside the system was the same as that tail pipe, and obviously the only way that could happen is if you've got the steam passing through there directly and it is still open. And you were reading at 300. But the thermal qualities, I guess in retrospect, are somewhat different.

Doesn't your procedure that you follow indicate what the temperature range would be for that or could be for that at all, do you recall?

Mr. Faust. We have a procedure that covers a leaking relief valve, if we suspect it. At that point we did not suspect it.

Representative Vento. So your parameters you were looking at were not necessarily based on procedure.

Mr. Faust. What maybe you should try to understand here is that we are trying to gain the proper procedure to go at it. We were into possibilities of several procedures, not just one, to cover what was happening. It hasn't been written, in fact. So we were still trying to determine which procedure to go by.

Representative Vento. Well, obviously the proper procedure here would have said that 300 degrees or 280 degrees in the tail pipe should have been an indication.

Mr. Frederick. That's the point he's talking about. In other words, what came out of the computer on the typewriter was an alarm that said: Temperature hot. But we could not see that, because the alarm typewriter was backlogged several hours.

Representative Weaver. Mr. Frederick, back to the sump pump. Where did you think this water was coming from?

Mr. Frederick. The drain tank, the reactor cooling drain tank.

Representative Weaver. What would that signify?

Mr. Frederick. That would signify that we had opened the relief or blown the rupture disk on the reactor cooling tank due to the exhaust of the r-.ief valve.

Mr. Ries. When did you start to assume that that was not closed? When you were getting all that water continuing to come out?

Mr. Frederick. I did not assume that it was continuing to come out. I just presumed that it came out and it was lieing there, anc this was the first time I saw it.

Representative Weaver. Enough came out to rupt--re the disk, is that what you're saying?

Mr. Frederick.. Yes.

Representative Weaver. And so the valves closed a..ain, but the water was up sufficient already.

Mr. Frederick. That is the way I was reading it.

Representative Weaver. On Wednesday you guys went off, what, at 3:00?

Mr. Faust. 3:30 in the afternoon.

Representative Weaver. When you caucused, did you have any feeling that there might be damage to the reactor?

Mr. Frederick. Yes. During the day we found out.

Representative Weaver. Significant damage?

Mr. Frederick. The possibility existed that there was. What everybody calls significant and what I call significant are different. During the time that the reactor cooling pumps were secured and the reactor cooling system temperature was recorded high, we felt that we were developing a problem in the core as far as excessive temperature. Now there was no way to tell what the core temperature was. I was just assuming it was very hot. It had to be at least 620 degrees. So, being without cooling water flow and without having circulation, that was the time when I was feeling that we were damaging the core.

Representative Cheney. Can we talk for a minute, Jim, about that?

Representative Weaver. Sure.

Mr. Frederick. We turned them off because of excessive operation and because the minimum temperature for operating those pumps had already been exceeded, the minimum temperatures. We were seeing degradation of flow, moving from 100 percent down to 60, 40. They were beginning not to pump any more water. They were securing themselves. Eventually they would have been spinning steam and not doing anything, the problem there being that we could have damaged the reactor cooling pump seals and developed a leak where the steam would come out through the pumps.

So, since the flow was degrading and we had the potential for damaging the seals, we decided then to secure the pumps, first to see if we could survive on just two pumps. And then we could not keep the other ones on either.

Representative Vento. And then you went completeli on convection cooling?

Mr. Frederick. That was the idea. Once we secured the pumps, we were already in the process of raising the steam generator level and we established natural circulation.

Representative Weaver. What events ther -- the problem is still this relief valve, right? What events finally brought about that -- brought that about?

Mr. Frederick. That decision was, I'm pretty sure, two and a half hours into the accident. Once we had established an equilibrium in the steam generators and we were on natural circulation, no one could comprehend why we couldn't raise pressure in the system.

Representative Weaver. Were you talking a lot about this?

Mr. Frederick. Yes. We were trying to decide what it was that was holding the pressure down. We had no indication of a leak in the primary system. A leak in the primary system should give you a radiation alarm. All we had was a high building pressure, which we thought was caused by a steam leak on the secondary side.

Once we bottled up the steam generator and isolated it -- one time we isolated it. The pressure came down. That convinced us it was steam. So the primary relief valve was not entering into the picture as a source of pressure building up.

But when we finally isolated the generators and eliminated them as a source of steam, then it occurred to us that some other source of water was going into the building, even though it was not radioactive. Someone suggested, isolate the automatic relief valve; it may be leaking. It was not thought that that was going to solve all our problems because that did not appear to be the problem, even then. But when we shut it building pressure dropped rapidly, and that allowed us to increase pressure in the system.

We could press up to about 2,000 pounds.

Representative Vento. During this period after, you didn't give us an average temperature. What was happening to your temperature? In other words, you said it started to drop in your initial sequence. It started to drop?

Mr. Faust. Yes.

Representative Vento. It was starting to drop. Did it start rising again?

Mr. Faust. Well, what came about was, when we shut the pumps off we had TH payout on our indicators.

Representative Vento. What does that mean?

Mr. Faust. In other words, they went high. They went off the high scale. They couldn't go any further.

Representative Vento. And during this time the pressurizer indicators were all right? These were indicating that they didn't -- at one point you said they were way down. But they were now indicating --

Mr. Faust. 50 percent was what I was shooting at. I was having a problem with the B generator in that this was just indicating to us possibilities of a primary-secondary leak, which led us to bottle up the B generator.

Mr. Frederick. The problem with the system temperature was that he was looking at an average temperature. The two parameters that you average together, he was able to lower the cold temperature, but the high temperature was pegged out. So that as it averaged, that value wouldn't change any more even if the system temperature went way above that. That temperature wouldn't go any higher.

So the average, with this cold temperature going down, it appeared that the temperature, the average temperature was going down, because the average would get lower, where in fact the system temperature was going up, because we just could not read it any higher.

Representative Vento. But it had initially started to drop. You suggested it went from 570.

Mr. Faust. Maybe we should reemphasize that TH coming out of the top of the core, in other words, was going up as far as we could tell. We had an indicator over on a panel that sits over to the left that is back behind that one man was monitoring, and he was indicating, I believe, that he could just see an indication of TH up around 800, which is as high as that went. And he said it looked like it was just bordering that.

But that was some input, too. And the TC was being cooled off by me feeding the generators.

Representative Vento. So in other words, what you're saying is the instrumentation was not adequate to give you -- to know the parameters of what was happening?

Mr. Faust. This board you see right now, if that had been up and had been in our display up in front, it would have told us a lot. That would have read up into the four-digit place. That would have told us what the core temperature was.

Representative Vento. Was that something that was just put in for this experience?

Mr. Frederick. Yes.

Representative Weaver. This was after the accident.

Representative Vento. But are they normally in reactors?

Representative Weaver. The thermocouples themselves are very seldom there. This is just an experiment.

Representative Vento. I see. In other words, they didn't know what the parameters were because it was off the top of the peg.

Representative Weaver. That's right.

Representative Vento. In other words, they didn't know what the temperature at the high range was. You had no way of knowing.

Mr. Faust. Not at that point.

Representative Weaver. Before the accident, did anyone ever question the idea that the levels of the pressurizer could possibly be different than the levels in the reactor vessel? Or just did you absolutely assume that that was the way it was?

Do you follow me?

Mr. Frederick. What everybody punches into you on an emergency procedure that involves a cooldown was, don't let the level go out of the pressure vessel.

Representative Weaver. Right now you read the leve of the reactor vessel from the level in the pressurizer.

Mr. Frederick. That's right.

Representative Weaver. Did anybody ever say, hey, I wonder if that actually was right, or that was just gospel?

Mr. Frederick. None of the transients that we had examined either on the simulator or through the emergency procedures supposes that you would develop a steam bubble in the plant in the tubes, somewhere other than the pressurizer.

Representative Weaver. So nobody ever questioned that?

Mr. Faust. Well, as far as we know, we don't know that.

Representative Weaver. But what I'm talking about is you personally. You never heard anybody question this?

Mr. Frederick. We always talk about emergency procedures and stuff. But if the level had went on in the pressurizer, we could not predict what would happen. We didn't have any emergency procedures or safety reports that told us what we could expect or any indications that would tell us actually what happened.

Mr. Faust. That is the level going out of the pressurizer. We didn't face that. We were faced with the full pressure.

Representative Vento. If this had happened somewhere else, you could have read it up here without any trouble? You would have read it if indeed the source of the loss of pressure was located anyplace else in the system? You would not have had the same type of problem?

Mr. Frederick. No, not really.

Representative Vento. Because it would have been demonstrated in the system. It would have been demonstrated by reading it off of the gauge. But insofar as you read it off of this at this source --

Mr. Frederick. If the leak had been somewhere else in the system, then that low pressure point would have caused the pressure to go down.

Representative Vento. Unless the reactor heat as such -- I suppose that you could still get a bubble, but you would have been able to isolate it.

Mr. Faust. I see what you're getting at. I don't think that's necessarily true. We are dealing with a very hot system that still might have forced the pressurizer level up with a leak elsewhere. But later on it might have gone down.

Representative Vento. That is another possibility. But I guess your procedures take that into consideration. Because of the tremendous heat here, this could have forced all of this up here, so you would have water up here, but the pressure down here, created by the intense heat, could have offset your gauges again.

Representative Weaver. No, the alarms -- you say how many audio alarms were going off right at first?

Mr. Frederick. There is only one audio signal in the room.

Representative Weaver. There is only one?

Mr. Frederick. Off the annunciators on the panel, there is only one.

Representative Weaver. The distinct differences -- there are not seven different bells going off?

Mr. Frederick. No.

Representative Weaver. There is just one.

Mr. Frederick. Right. If you get a panel alarm, you get a beeper. Then when the alarm comes in on the computer, you get a different beeper.

Representative Weaver. Those are only two different sounds, is that correct?

Mr. Frederick. Yes. The radiation monitors are a different sound, but we didn't have those.

Representative Weaver. Let's get to the spike. Who had the responsibility? What person had the responsibility for reading t! : strip chart?

Mr. Frederick. I was on it when it happened. Are you talking about the reactor building a pressure spike?

Representative Weaver. Yes.

Mr. Faust. And he pointed it out to me.

Representative Weaver. And then what happened?

Mr. Frederick. It initiated the reactor building spray. Before the reactor building spray even fully initiated, the spike was gone. In other words, the transient was only seconds. So the need to continue the reactor building spray was gone already.

Now, the reactor building spray, there are chemicals in there. There is acid and caustic, designed to remove iodine and to maintain the Ph. Okay, it is undesirable to spray that stuff all over the equipment. That is why I stopped the spray signal.

Representative Weaver. But what did the spike mean to you? What caused it? What caused that spike, that buildup of pressure?

Mr. Frederick. I had no idea at the time?

Representative Vento. Did you hear any noise at that time?

Mr. Frederick. No.

Representative Markey. Had the sprinkler system ever gone off before?

Mr. Frederick. No, never.

Representative Markey. What were you told if the sprinkler system did go off that it indicated? What would have been your visceral reaction? What did it mean to you?

Mr. Frederick. It shouldn't go off unless there is a buildup of the pressure. We see graphs that project a buildup of the pressure. It should round out the graph and bring it back down to normal.

Representative Weaver. Did you say hey?

Mr. Frederick. Yes.

Representative Markey. To who?

Mr. Frederick. The people standing around were engineers.

Mr. Reis. How many people were in the room at the time?

Mr. Faust. That's a hard question to ask us. We weren't taking count of the people in the building. We were watching the system.

Representative Markey. So you were the first one to notice it.

Mr. Faust. No, Ed was over at that point on the panel.

Mr. Frederick. I told Mr. Marshall, Mr. Logan.

Mr. Reis. Who are they?

Mr. Frederick. Superintendents, supervisors.

Representative Weaver. Was there any NRC persons there?

Mr. Faust. I don't know.

Representative Weaver. Did you have respirators on at that time?

Mr. Faust. I don't think so.

Mr. Frederick. I don't remember.

Mr. Faust. Because of conditions in the control room, there wasn't a necessity to have the respirators on full-time at that time, depending upon what the health physics people were relaying to us for the conditions in the control room.

Mr. Frederick. Several times we had communications problems because of the respirators. So we would just pull them off and say what we had to say, and then put them back on. I know several times when I wanted to talk to the superintendent or to the supervisor in charge I did have to take off the mask. I don't know if this was at that time.

Representative Weaver. Then after the spike occurred, you told the other people?

Mr. Frederick. I assured the spray and was assured that the building pressure on both channels was indicating back down to where it was. I discounted that as not being significant enough to stop what I was doing and let the makeup system take care of it. The building pressure was back to normal. It could have been an instrument malfunction that caused that. It was such a rapid spike that it did not immediately tell me that there was an explosion in the building.

Representative Markey. What about the sprinkler system being triggered, though? Your instinct must have told you there was something unusual going on.

Mr. Frederick. Certainly. But it could have been an instr-ment panel malfunction.

Representative Markey. Was there anyone else in the room at the time that occurred who would have had superior knowledge to what you would as far as what was going on? Anybody from NRC or Babcock & Wilcox?

Mr. Frederick. It wasn't until a day and a half or two days later that I was told that there could possibly have been a hydrogen explosion. No one brought that up at the time.

Mr. Reis. When you announced it or said, oh, we've got a spike, or whatever you said, was there a reaction from other people in the room? Did anybody else, when you walked back over to start fiddling with your other instruments, your makeup instruments, did anyone go over to try and analyze that? Or did it just get lost in the air?

Mr. Frederick. I think Mr. Marshall tried to figure it out, and Gary Miller was particularly interested in it.

Mr. Reis. You said it could have been an instrument malfunction. We all know that now, that it could have been. But at that time, did that occur to you or did anyone else say that immediately?

Mr. Frederick. Yes.

Mr. Faust. We both said it.

Representative Vento. Have you seen those type of instrument malfunctions before?

Mr. Frederick. On a graph.

Representative Vento. Have you seen them at this plant?

Mr. Frederick. Yes.

Representative Vento. In other words, you have had those type of instrument malfunctions before?

Mr. Frederick. Yes. Any kind of graph recorder, which is what it is, a little pen recorder like that is sensitive to all kinds of things, a bump on the arm or whatever.

Mr. Meyers. But this meant that the actual something -- what was it, reading pressure actually went to 28 psi. So there had to be something real. Whatever instrument was sensing pressure did sense a high pressu

Mr. Frederick. That's true. The trace on the graph would to me, which it did, indicate that it was not a pressure transient in the building due to steam release or the reactor cooling drain tank release or anything like that. It was sufficiently abnormal to be just completely out of my realm of experience.

Representative Markey. Could you show us what you saw there?

Mr. Frederick. This graph, both of them, in fact -- we saw it on one, the pen moved up to 30 pounds and then straight down.

Representative Weaver. That's red, isn't it?

Mr. Frederick. It's green. There's a red one and a green one. The green is low range. The red is wide range.

Representative Weaver. Now we know why there were two singers.

Mr. Frederick. This is a picture of the graph. This is the line that it was tracing. It went straight up and right back down again.

Representative Weaver. This is up, isn't it?

Mr. Frederick. This is up. This is high pressure.

Now, if I was going to see a pressure transient in the building due to steam, it would look like this, and when I turned on the spray it would look like that. And this time here could be several minutes. We're talking 15 or 20 minutes. A spike like this is absolutely meaningless to me. Now I know what it means.

Representative Markey. How long, to the best of your knowledge, was that visible?

Mr. Frederick. That's less than a second.

Representative Weaver. No. On the chart.

Mr. Frederick. It would be there for 20 minutes to a half an hour before it went around the corner on the chart. Usually on a chart like that one hour's worth of information is displayed directly in the center of the chart, and it just moves on around the side.

Representative Markey. So it would be in the center for about a half an hour. So it might be on the chart for about an hour.

Representative Weaver. We've been told it was up for two hours where it was still exposed.

Mr. Frederick. Probably seven or eight hours until it went all the way around and it went up in the spool. But you don't see that. All you see is the front of the graph like this. And what I'm saying is that this display here was probably an hour alone before it goes around the corner and you can't see it any more.

Representative Vento. Is this the single-pressure one or is there more than one here?

Mr. Frederick. These two are both reactor building pressure reporters.

Mr. Faust. There's actually four indicators right there, two low range and two high range.

Representative Vento. But the point is that they both recorded the same thing?

Mr. Frederick. I don't know that for sure.

Mr. Faust. They are recording -- one is more sensitive. In other words, in the low range --

Representative Vento. So when an instrument malfunction would occur on one, you would not expect it to occur on both, would you?

Mr. Frederick. The conclusion I made that it was an instrument malfunction was incorrect.

Representative Vento. Well, I don't know if it is or not. I don't know, maybe it was right. But I'm just saying it did occur on both of them simultaneously, at the same time.

Mr. Frederick. All I'm saying now is that what I saw on the graph did not relate to any of the procedures or any of the transients that I had analyzed previously. So that when I saw that spike and it went away and we were back to normal and I was able to secure the spray, I had to discount it as being something that happened that had very little effect.

Representative Carr. The spray sensors are different from the instrument sensors, right? Or does the spray communicate with this?

Mr. Frederick. The only way that you can tell that you're spraying the building -- another direct indication is the pump is running and the outlet valve is open and you have pressure on the pump.

Representative Carr. I'm interested in the spray sensor. The spray senses an increase in pressure independently from that?

Mr. Frederick. No. This is the instrument that activates the spray system.

Representative Carr. So if the instrument malfunctions, the spray will go off.

Mr. Frederick. You would have to have three instrument malfunctions.

Mr. Meyers. There are three pressure sensors. So actually, each of those has to independently --

Representative Carr. So there is a voting procedure.

Mr. Meyers. Do all three have to indicate high pressure or two out of three?

Mr. Frederick. Two out of three.

Mr. Vento. In the other instrument malfunctions, have you ever had these sprays go off before?

Mr. Frederick. No. When we tested this system, we did it with air to see if the nozzles would pass. You don't want to spray this. There are electrical wires and everything.

Mr. Meyers. What could have had two of those three sensing devices sense high pressure and lead them to think the pressure was high, other than high pressure, real high pressure, actual high pressure? Is there anything that decides the pressure is going up that could have led those sensors to think the pressure was high?

Mr. Frederick. A test signal.

Mr. Meyers. Would a test signal go to two of them at the same time?

Mr. Faust. No. In fact, you would have to hook it up.

Mr. Frederick. It would have to be a lengthy manual action to get it to do it, other than actual building pressure.

Mr. Meyers. Is there anything that you can think of other than excess building pressure that could have simultaneously led the meter to read 28 psi and to turn on the spray tanks or turn on the containment spray?

Mr. Frederick. No, it had to be high-level pressure.

Mr. Faust. There had to be a pressure surge in the building for it to happen.

Representative Markey. How long was the sprinkler system on?

Mr. Frederick. A few minutes.

Representative Markey. And did you turn it off?

Mr. Frederick. I turned it off. You have to do it manually.

Representative Markey. And what was your basis for turning it off?

Mr. Frederick. One, that the building pressure had returned to its original value. The spray system is designed to return the building back. And two, the danger of spraying the caustic and acid on the operating equipment in the building could cause more problems. And I told the supervisor I was going to secure it, and I turned it off, and he agreed with me that it was all right to do, because the building pressure on all four channels indicated low.

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Mr. Markey. Did the supervisor agree with you at that point, that it was an aberration?

Mr. Frederick. Because of the spike, we didn't understand it at the time, but we went on with the emergency procedures.

Mr. Markey. And because of the confusion, did you not have time to go back?

Mr. Frederick. Right.

Mr. Cheney. During this period of time -- between when you cooled off the reactor coolant pumps and discovered that the relief valve was stock open and got it closed, what was that an hour?

Mr. Frederick. You want to know how much time between when we turned off the pumps and when we shut the reactor coolant pump?

Mr. Cheney. Yes. Wasn't that the key time in terms of damage to the core?

Mr. Frederick. I believe it was probably about an hour -- the recorded time that I've seen was we turned up the pumps at 70 minutes, shut the valve at 2.3 hours.

Mr. Faust. These pumps went off at different times now.

Mr. Cheney. What did you think was the status of things? Was was going on in the control room?

Mr. Frederick. We were trying to establish natural circulation. We were looking for decrease in temperature to indiccate that natural circulation was taking place.

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As time went on, and that indication did not come about, we became increasingly anxious to do something. Eventually we restarted the pumps in spite of the damage that may have occurred to the pumps. We had to restart them, because natural circulation never did occur.

Mr. Cheney. And this is the same time when you're trying to figure out where the leak is in the system?

Mr. Frederick. Yes, where the low pressure is coming from.

Mr. Faust. I should say that I find it hard to say that natural circulation didn't occur -- myself, I feel we had some sort of cooling going on there -- to me, and if you look at it now, we had to have some sort of cooling going on. Temperatures were high, but from what you're hearing in reports, we did not get any melt -- that is, from samples that were pulled out of there, so it's telling me we were removing heat, which wasn't a desirable way to do it, but it was -- I guess you could say it was what we had at the time.

Mr. Frederick. Craig and I have speculated that the only cooling we had was from the B-loop, high-pressure injection that was going in the B loop. It had to move across the core, and then out the pressurizer through the relief valve. That was the only cooling water path -- flow path that we think we had.

Mr. Carr. What would be the source of the pressure spike say if you had a hydrogen explosion in the reactor?

Mr. Frederick. In the building, not in the reactor.

MR. Faust. It might have been down where the gases would have possibly, if you want to look at it that way -- this is if you want to try to look at that way, would have been down where the RC drain tank is, because that is inside a little containment building itself down there.

And that is where your gases would have been building up possibly. And if that is where it would have occurred, that is where I would have said it might have happened. And it looked more like it would have a burn.

Mr. Meyers. Why did you say it looked more like it was a burn?

Mr. Faust. Well, apparently we didn't lose anything if that spike occurred. What we were looking at, also, we were still monitoring the system pressure and nothing changed. That spike occurred; nothing changed in the system.

Mr. Meyers. You mean if it had been an explosion, you would have expected the equipment to be damaged?

Mr. Faust. Yes.

Mr. Weaver. Let me ask this question, then you can go on.

My question is -- well, Bob's question is -- your background and training, let's ask that first.

Go ahead, Bob, if you want to put it differently.

Mr. Carr. Well, what was your professional track which took you to that room that day? I don't want high school or anything like that, but were you in the Naval Reactor Program or what?

Mr. Frederick. All my training came through the Naval Reactor Training Program, six months at Bainbridge, Maryland; six months at a Westinghouse simulator prototype in Connecticut; and then the remainder of my six years in the Navy was on a submarine, operating an S3G core.

Mr. Carr. What is that?

Mr. Frederick. It's a General Electric steam plant for a submarine, the same type of pressurized water reactor, just on a small scale.

Mr. Faust. And it is also the difference in controlling features here, because they do controlling off rods due to highly enriched uranium fuel, where we do it on a boron control, a lot of it. There is a little shift in it.

Mr. Carr. But you are familiar with the reactors pumps -- house all this?

Mr. Frederick. Yes.

Metropolitan Edison has a training program, too.

Mr. Weaver. How do you compare the two programs, Metropolitan Edison and the Navy?

Mr. Frederick. Almost identical.

Mr. Carr. So you were at Met Ed and they have a training program, and did you operate any of there other reactors before you went to this one?

Mr. Frederick. Unit 1. We weren't licensed on it, but we operators-in-training.

Mr. Carr. Now, B&W also has a simulator, and did you go and do work there as well?

Mr. Frederick. Probably a total of 10 or 12 weeks on the simulator altogether. It is a computer; that's all.

Mr. Carr. In terms of your experience, had you at other times gone through the experience of going through emergency procedures, or was this the first emergency?

Mr. Frederick. No, we had had several. We had a safeguards evacuation.

Mr. Faust. You're talking about in the Navy now, too. And it is not new, going through transients in plants, for us.

Mr. Frederick. In Unit 2 we had several.

Mr. Carr. And of course there was your entire thing at the B&W simulator emergency procedures over and over again.

Mr. Frederick. Along with start-ups.

Mr. Carr. And is your background the same?

Mr. Faust. Almost the same. You could say it's almost identical, the same as far as schooling goes, right up until licensing at Three Mile Island.

Mr. Weaver. Did you have a six-year hitch?

Mr. Faust. Seven years.

Mr. Carr. When were you licensed?

Mr. Faust. The 30th of October, '77.

Mr. Reis. You were in the same class or something?

Mr. Faust. Yes.

Mr. Cheney. Are you licensed for a specific reactor?

Mr. Frederick. Only Three Mile Island, Unit 2.

Mr. Cheney. Then it's not good at another reactor?

Mr. Frederick. That's right.

Mr. Carr. One other thing in terms of the background of this whole event, is a lot of these events happened within the first 12 or 15 minutes, and things were very hectic. As part of your training, were you trained in rememebering things -- I mean, I can't remember what my secretary told me this morning. I'm kind of interested -- your brains were slammed rough a hectic event, and ever since that event, up to this day, and probably for several years or after, you're going to be asked to reconstruct what happened.

And my own experience in interrogating witnesses -- it isn't a question of lying; it's a question of memory cells trying to make order out of what was probably a pretty chaotic system, and it goes to really how confident are you?

I know that you're confident, because you wouldn't tell all this. But in the deep recess of your mind, is there something that you have omitted or something that you have put in the wrong sequence. I mean, you did five steps.

Mr. Faust. We're still doing that.

Mr. Frederick. In the course of an emergency like that, you may take 50 or 75 actions in a very short time, some of them being automatic, or things that you have drilled enough to know what to do; and in the course of trying to recover or doing something abnormal, you may attempt three or four avenues to try to get something to work, and the only one you remember is the one that worked.

That is what I'm finding now. All the things that I tried in the make-up system to reestablish the pressurizer level I don't remember valves I hit, which flows I tried to adjust. The only sequence of events that I can remember is the stuff that worked.

Mr. Carr. Have you gone out to the B&W simulator to try and perhaps -- try to go through this thing in your mind?

Mr. Frederick. I'm dying to go.

From what I understand, they have been able to reconstruct the accident on a simulator, but I would pay first class to get there and see it.

Mr. Carr. Do you think it would help your recollection?

Mr. Frederick. Sure.

Mr. Carr. That it might bring some things to life. I'm sure your stories aren't going to change radically, but would it refine your recollection to go out there?

Mr. Frederick. It would probably bring back a few things.

I'm not saying going down there would -- I would all of a sudden remember what happened.

But it is more curiousity than anything else.

Mr. Weaver. Do you think you were prepared enough; is that one of your motivations to go down there, that after this accident -- that you weren't prepared enough, they didn't give you enough training?

Mr. Frederick. I think that the training philosophy was inadequate. In other words, the basic assumption is that the design encompasses enough emergencies and anticipated casualties that what happened there probably couldn't happen.

So every time we approach this type of accident, the outcome was assumed. In other words, the safety systems all activated, the emergency feed system worked, and the transient was monitored down to a shutdown condition.

And although they would throw in a few instrument errors every once in awhile, the basic philosophy was everything is going to work, and it will be okay.

We never failed two or three safety systems on the simulator. As a matter of fact, the simulator is not capable of reproducing a solid pressure. The program breaks down and it doesn't work.

Mr. Cheney. Do you mean the simulator that B&W has?

Mr. Frederick. One of the drills you go through is manually controlling the plant -- in other words, no automatic system; put two guys on the pile and try to do a start-up and a shutdown manually, controlling every knob, and sometimes you make mistakes -- overfeed, underfeed, whatever, and the pressurizer goes solid -- well, that is when you reinitiate, because the computer can't understand that. The computer can only do what you tell it to do, and they have not programmed it for that.

Mr. Cheney. So you have never previously gone solid and been able to manage it.

Mr. Frederick. Been able to see what happens.

If they had a program to show you how a solid -- we have seen it in the Navy.

Mr. Faust. We are also taking things out -- like you said, we are taking things that normally, under conditions at plants, aren't set up for that. I mean, we were not setting it up to go manually in power or down. We expect certain automatic things to happen; the system should be lined up.

Mr. Frederick. A failure of the emergency feedwater system is always assumed to be the pumps didn't start or the automatic valves jammed shut, but only one train.

We have two emergency feedwater ssystems. In this case both of them failed simultaneously. That assumption is against the rules.

Mr. Vento. But they failed because of the pressure, didn't they?

Mr. Frederick. They failed because of the blocked valves.

Mr. Faust. The blocked valves were shut. They shouldn't have been shut.

Mr. Weaver. We had somebody yesterday tell us -- an expert on this kind of thing tell us that it was a minor thing, and there is no real problem.

Mr. Frederick. That transient we could have survived.

Mr. Faust. Even we feel that way. What happened though was that covered up a problem, another problem that developed in the plant.

Mr. Vento. But you opened those up. You opened those up, didn't you?

Mr. Faust. About eight minutes into it.

Mr. Vento. That was at eight minutes, but then you came back and closed those down because you were worried about going to a solid system?

Mr. Faust. No; that is feed. That was establishing the level in generator.

Mr. Vento. I want to ask you a question: Does the simulator that you have go through a scenario where you damage those feed pumps?

Mr. Faust. No, it doesn't.

Mr. Vento. It does not go through that type of scenario?

Mr. Frederick. It will go through a scenario, where out of the two emergency feed systems, one might be disabled -- one entire train, you can assume.

Mr. Vento. So they always leave you with this train that is operable?

Mr. Frederick. Sure.

Mr. Faust. In other words, you are saying we could possibly lose something here, but you would not lose them both.

Mr. Vento. I had another question, but it does not deal with the training program.

Mr. Weaver. Let me just make a comment here, because I think one of the central questions that each of us are going to have to ask ourselves that is relevant here, is that you can go on and get more training and put a solid pressurizer into the computer and train for that.

Really, the question we're going to have to ask ourselves is is that it, a few more things like this,in training people to handle them. Or are there an infinite number of potentials?

You know, there are 2 billion possible moves in the first four moves of chess -- 2 billion. In other words, there are an infinite number of moves.

Is this what we are dealing with here -- an infinite number of things that could go wrong -- or not? Or are they finite and rather simple, and we solve this problem, and we're all right?

I'm not asking you this question. It just occurred to me that that is really a central question that we're going to have to determine after we determine the facts. Then we're going to have to think about that conceptually.

Well, Bruce, go ahead.

Mr. Vento. Well, I don't want to if you have questions on training. I think you should proceed with that.

Mr. Frederick. The training -- by the way, I want to say this, the training that we get is in response to the examination procedures that the NRC uses. In other words, they know the type of questions the NRC is going ask, the type of response that they want to emergency procedure questions.

Invariably the NRC will say, "What are your immediate actions on this emergency," and you are supposed to memorize them and reproduce them word for word on a piece of paper.

That type of examination procedure I think is detrimental to expanding your training, in other words.

Mr. Carr. You train to pass a test, rather than operate a plant?

Mr. Frederick. Right. We should be probing deeper into how these keep changing.

Mr. Carr. I was going to ask about the licensing process. Is the licensing process merely a written examination?

Mr. Frederick. No, it is an eight-hour written and eight-hour oral.

Mr. Carr. Eight-hour oral -- do they ever -- do you go to the simulator and use the simulator as part of the testing procedure, in other words, they set up?

Mr. Frederick. Routinely, in the annual requalification, we do go down for training, but it is not supervised by the NRC. We run ourselves through a few drills and refresh our memories in the initial start-up qualifications that we go through.

The NRC did look over our shoulder while we were doing it, and the simulator was used in fundamental emergency procedures to show how we performed. But the NRC does enforce the training on a cold-licensing -- a person who has never operated that plant.

You will qualify for start-up on the simulator and on a similar plant; and then on your own plant, the initial start-up is done under supervision of the NRC.

Mr. Carr. Now, your license expires after one year unless requalified?

Mr. Frederick. Two years. Our licenses expire this October.

Mr. Carr. And you, to requalify, have to have what kind of an examination?

Mr. Frederick. The same exam, different questions.

Mr. Carr. Now, in terms of the questions, does the NRC make these questions available -- not that they give you the test, or make the examination public, but is there a published test guide, say, for studying for the examination?

Mr. Frederick. No.

Where we get most of our information for the test is from other people who've taken the test before. They say, "Well, they asked us these questions," and you can reconstruct.

At the Training Department at Metropolitan Edison -- writes a test that is very similar in format to the NRC exam, the same type of questions and the same groupings: emergency procedures, operating procedures, plant response, insurance, and controls. They are divided into groups.

Mr. Carr. Does Metropolitan Edison have a training program above and beyond the NRC?

In other words, the NRC qualifications say every two years you have to go through this, but does Met Ed have a different --

Mr. Frederick. We have it every year, and the Training Department is probably larger than any other training department in the country.

Mr. Reis. Is the test -- the NRC test, is it hard -- I mean, subjectively, obviously -- but we've taken tests through school, all of us, and some are harder than others; is it a particularly hard test to take?

Mr. Frederick. It is grueling.

Mr. Reis. It has got to be tiring if it's eight hours, but is there a big failure rate? Is it something that's really hard to take? Is it rough?

Mr. Frederick. I think it's particularly rough. In other words, you have a potential of some 5- or 7000 questions they can ask you, and over such a diversity of information, that it is difficult to prepare for.

Mr. Weaver. What is the failure rate?

Mr. Frederick. I don't know. No one in our group has ever failed.

Mr. Carr. One thing that strikes me from what you've said is that the two of you were at console, and you had a supervisor back in a box, behind that console -- well, there were three of you in the control room.

Mr. Frederick. Yes.

Mr. Carr. The two of you were from the same class and roughly out of identical experiences; how about the supervisor?

Mr. Frederick: He has been at it a few years longer, but basically, I think he'll tell you that his experience is similar to ours.

Mr. Carr. And so, essentially --

Mr. Frederick. He is also licensed on Unit 1.

Mr. Faust. He is a Senior Operator.

Mr. Carr. But in other words, you have people of the exact, almost the exact experience level?

Mr. Frederick. Experience levels are probably different, but training is probably very similar.

Mr. Weaver. Excuse me, Bob.

I'm going to call the Task Force back at 1:00 to meet with the supervisors. I'm going to leave now, but you can stay.

Mr. Vento. I had one question.

Mr. Weaver. Thank you very much.

Mr. Vento. Do you want to continue?

I have one question.

Mr. Carr. I have a couple of questions I would like to ask off the record, because I don't they have anything to do with the charge of the committee to come up with facts.

Mr. Vento. Fine.

I just wanted to ask a question: On the boron level in the water, what type of information are you getting back during this experience concerning that, and whose responsibility is it to monitor that?

Mr. Frederick. The Chemistry Department.

Mr. Vento. And what type of information were they getting back, or were you getting from them?

In other words, did you ever ask for a readout or any information on this?

Mr. Frederick. Yes, twice.

Mr. Vento. What did it tell you?

Mr. Frederick. It told us the boron concentration was extremely low. The first report we had was 400 parts per million. The second report, about an half an hour later, was 700.

Mr. Vento. What time did you call for that?

Mr. Frederick. I don't know.

Mr. Vento. But it was early?

Mr. Frederick. In the first two hours.

Mr. Cheney. And what does that mean when you say it was extremely low?

Mr. Frederick. Boron concentration should be in the neighborhood at this time in the nature of 1000 or 2000 parts per million.

Mr. Vento. That means it's being lost or absorbed.

Mr. Frederick. What it meant to us was it was probably a sample inaccuracy due to the other chemicals that we been introducing. That is what we assumed.

Mr. Faust. We were experiencing problems with our letdown, so it could have just been misrepresented, because we did not have a good letdown flow at that time. We were experiencing oscillation.

Mr. Frederick. Boron concentration is difficult to begin with.

Mr. Vento. Would it common to find it that low? Would it occur at 400 parts?

Mr. Frederick. No. But the fact that we were injecting sodium hydroxide would have made it difficult to make a boron determination because of the caustic present in the chemical solution. It would have thrown off the analysis.

Mr. Vento. Well, the sodium would have absorbed some of it maybe.

Mr. Frederick. The pH would have been masked by the caustic and it would have thrown off the results.

The Chemical Department can probably explain that better.

Mr. Carr. What was the first time you interviewed -- you were interviewed for a reconstruction?

Mr. Faust. The second night.

Mr. Frederick. The engineer on the site tried to get us the same day, but we were too busy. We answered a few questions but we really didn't have time. His name is Marshall. He's an operations engineer.

The next day was when we were interviewed the first time. That was by Met Ed again.

Mr. Carr. I think we will be off the record right now.

(Discussion off the record.)

Mr. Cheney. Let's go back on the record now.

In connection with NRC's presence on the site, were they a significant presence in the room?

Mr. Frederick. They were not present initially.

Mr. Cheney. But I think you told us they arrived about 10:00 o'clock.

Mr. Frederick. That's right.

Mr. Cheney. Were you aware of their presence in the control room?

Mr. Frederick. No.

Mr. Cheney. They didn't deal directly with you?

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Mr. Frederick. No. We made a point of keeping everyone away from the panel, because we were busy.

Mr. Cheney. Did you have any problem with the number of people in the room.

Mr. Frederick. Yes.

Mr. Faust. In the near future, that was one of the things that was one thing -- voice level had to be kept down, and people had to kept out of the area that we were operating in.

Mr. Cheney. So that made it difficult, in other words, because of the people that showed up?

Mr. Frederick. Yes.

Mr. Cheney. Who were these people, most of them connected with Met Ed?

Mr. Frederick. Yes, most of them -- radiological monitoring teams. More operators came in at 7:00 o'clock, their normal shift.

Mr. Carr. I notied that, in this diagram here, these are all radiation monitors, right?

Mr. Frederick. Yes.

Mr. Carr. So radiation personnel presumably would come in and come back here, right?

Mr. Frederick. No. We assigned an operations format to constantly monitor them and inform the Health Physics Department of any changes, and that was his sole job. So that kept people away from the panel. He related information to people who needed it.

Mr. Reis. There seems to be two major areas where you can get information.

After the first 10 minutes, when you caught your breath -- a little bit, anyway -- one, of course, or even during those first few minutes, for the first area of information -- one, of course, is the control room panel, what is going on, and the instruments, et cetera; and the strip charts, et cetera.

The other would be, say, an engineer who responded and came in, et cetera.

It is a broad question, but as well as you can answer it, do you think that not the design of the plant, in terms of giving you spurious signals, but in terms of the design of the control room, did the control room provide you, in a timely fashion, in an easy-to-read fashion, the information you wanted and needed? And alternatively, during the accident, that would be a general question given to hindsight, in the course of the accident, would the communications in the control room -- were they such so that when your supervisor, whoever was at the panel and needed information -- conceptual information -- in other words, this instrument, that instrument, and this gauge are reading things that don't jibe together -- what could that mean in terms of one engineer? Did you have that sort access, immediately, to an engineer, and when did you get it? Did it work well, so that you were able to conceptually figure out what was going on in addition to what the gauge actually read?

Mr. Frederick. The answer to the first question, the instruments, in my opinion, were not adequate. I can come up with a million questions on how to change them and the availability of additional input from the engineering staff.

It was not available to me, because I did not seek it out. I would give whatever questions I had to the supervisor, and he would refer them to whoever he could as far as more operators, more engineers, to get more information. And he would bring back whatever suggestions there were if there were any.

And if things were that confusing, that I had to turn and ask somebody a question, I would wait for their response and their instructions on what to do next and then take the prescribed action according to what they suggested rather than what was on the panel.

Mr. Faust. I would say -- well, I can't change it much from what he said -- we would continue to feed changes that we were seeing, seeing in the plant, to the supervisor; as well as if we thought we knew something that should be done, we would be saying that, too.

Mr. Reis. In terms of the layout of the plant, in general, do you think there could be some significant changes that would make your job a lot easier?

Mr. Frederick. Yes.

Mr. Faust. Definitely.

Mr. Cheney. Do feel at this point, after having been through the exercise now, and thought a lot about it, that you've got a pretty good understanding for what exactly happened inside the containment vessel?

Mr. Frederick. Yes.

The results of what happened are not clear; but as far as the progression, yes.

Mr. Cheney. In other words, now, with the benefit of hindsight, we're able to look back on the event, all of us, and say, "This was the sequence of events that led ultimately to having the core uncovered for a period. There are no major holes or gaps"?

Mr. Faust. Something that we haven't seen, and maybe Ed has, but we haven't sat down with all of the graphs and the information in front of us and, as a group, looked at it and tried to talk it out in that sense, whatever information was there. And I don't know where it's at right now. I assume the NRC has it.

Mr. Frederick. That is one thing that hasn't been done. They haven't given us the opportunity, as a group, to evaluate the information that they have accumulated and put additional input into what we were doing at the time, as a group. Individually, it is hard to remember when you bumped into the guy next to you and stuff like that. But as a group, I'm sure we could -- well, maybe not anymore, it's been almost two months. But we could have remember more.

Mr. Cheney. You could have had sort of a better debriefing?

Mr. Frederick. We did get together on our own a couple of days afterward and put together our thoughts, but as far as having the information from the computers and the graphs, as they had mainly gone out, we did not have that.

Mr. Cheney. Is there anyone in terms of helping us with our inquiry, recognizing that what we're about is trying to establish basically what happens so we can better understand the events at Three Mile Island, is there any area of inquiry that you think we ought to especially follow up on that we have not gotten into today?

Mr. Frederick. You're going to have to hit the general emergency, the radiological releases. The people that are here today, except for Gary Miller, they aren't the people to talk to. The general emergency was handled by the Health Physics Department and the unit superintendent, or the station superintendent.

During a general emergency, our job is to control the plant. They were in back of us doing the other stuff.

Mr. Cheney. They're worried about the releases off-site and so on.

Mr. Frederick. Right.

Mr. Cheney. Well, I would like to thank you all very much.

Mr. Meyers. I have one more.

You did have a feeling during the day, by the time you left, that there had been significant core damage?

Mr. Faust. We definitely felt like we had core damage.

Mr. Meyers. But did you think that the core had been uncovered?

Mr. Frederick. Yes.

Mr. Meyers. And that there had been metal, a metal-water reaction, or the hydrogen had been generated in the core?

Mr. Frederick. I hadn't concluded that; no.

Mr. Faust. It's hard not to think along those lines.

Mr. Meyers. But you did think the core had been uncovered for some time?

Mr. Frederick. Yes.

Mr. Faust. Well, there's a question about how long, or how much of the core. I couldn't say.

Mr. Meyers. But long enough for there to have been some oxidation of the fuel rods?

Mr. Frederick. At the time I was optimistically thinking we had a steam bubble in the top of the core, at the top of the vessel, not at the core.

Mr. Scoville. Were you discussing this with yourselves and others in the room?

Mr. Frederick. During the emergency, were we discussing core damage? Yes.

Mr. Meyers. Did anybody discuss whether it was possible that the steam bubble had gone below the fuel, the level of the fuel rods, and that there had been oxidation?

Mr. Frederick. I believe the engineers were working on trying to figure out whether or not it had.

Mr. Meyers. But they were thinking of that, of the possibility?

Mr. Frederick. I think so.

Mr. Faust. I imagine they would have been.

(Whereupon, at 12:25 p.m., the hearing was recessed, to reconvene at 1:20 p.m., this same day.)

AFTERNOON SESSION

(1:20 p.m.)

Mr. Weaver. The Task Force will come to session.

We are just informally carrying on conversations here. What we're trying to do is understand the facts.

Later on the Interior Committee, in drafting policy decisions, the Chairman of the Interior Committee, Congressman Udall, wants some members of the committee to have an idea of what happened at Three Mile Island. And Mr. Cheney and I, and others, are doing our best, not being scientists or engineers, to understand.

And so what we would like you to do is to identify yourselves for the gentlemen in back of us, and then to proceed to tell us what happened, as you saw it.

Why don't you start, Mr. Zewe.

Mr. Zewe. I'm Bill Zewe.

Mr. Weaver. Say who you work for and what your background is.

Mr. Zewe. I'm Bill Zewe. I work for Metropolitan Edison Company. I'm a Station Shift Supervisor.

Mr. Weaver. Okay, Mr. Miller.

Mr. Miller. I'm Gary Miller. I work for Metropolitan Edison Company as a Station Manager. He is Station Shift Supervisor, and I am Station Manager for Three Mile Island.

Mr. Weaver. You look over the whole thing, Unit 2?

Mr. Miller. Both units.

Mr. Scheimann. My name is Frederick Scheimann. I work for Metropolitan Edison in the capacity of Unit 2 Shift Foreman.

Mr. Weaver. Now, you are in charge of operations?

Mr. Millers. Operations and maintenance.

Mr. Weaver. For both units?

Mr. Miller. Yes.

Mr. Weaver. You are in charge of --

Mr. Zewe. Operation of both units on a shift basis.

Mr. Weaver. You report to Mr. Miller.

Mr. Zewe. No. There is a Supervisor of Operations for Unit 1 and also for Unit 2. And I report directly to them, or to Gary.

Mr. Weaver. And then you --

Mr. Scheimann. Shift Foreman, would be in charge of running the people and operating the plant. I report to Mr. Zewe.

Mr. Weaver. So we interviewed two fine young people this morning, Mr. Frederick and Mr. Faust; and they said there are three in the control room.

And you would be the third one?

Mr. Scheimann. I would be the third one.

Mr. Weaver. And you would be where, in the control room, too?

Mr. Zewe. In the control room in either unit. Normally, when I'm there on shift, I have responsibility for each unit.

You see, we have one Shift Supervisor, one Station Shift Supervisor, that has overall -- for both plants. And then there is one Shift Foreman in either plant. And then the Control Room Operators, under each of the Shift Foreman; and the Auxiliary Operator is under the Control Room Operators.

Mr. Weaver. Mr. Scheimann reports directly to you?

Mr. Zewe. Yes.

Mr. Weaver. Now, I've got the chain of command.

Mr. Cheney. Could we just ahve quickly a paragraph on each of their backgrounds.

Mr. Weaver. Please.

Mr. Cheney. Your educational experience, et cetera.

Mr. Zewe. High school graduate. I was in the United States Navy for a peri^: of six years as a reactor operator and a electronics technician.

Mr. Weaver. You mean a reactor operator, on a shift?

Mr. Zewe. Yes, I was.

Then I came to Three Mile Island in 1972 and was an Auxiliary Operator for about 18 months, and then a Shift Foreman for a couple of years, and then a Shift Supervisor for the last three years.

Mr. Weaver. So your training is in the Navy, your original training?

Mr. Zewe. Yes, it was.

Mr. Weaver. Mr. Scheimann.

Mr. Scheimann. I started off with eight years in the Navy. I was electrical operator on three nuclear submarines, and then I came to Metropolitan Edison. I was an Auxiliary Operator for approximately 18 or 20 months. Then I was a Unit 2 Control Room Operator for about two years. And then I began as a Unit 2 Shift Foreman.

Mr. Weaver. Mr. Miller.

Mr. Miller. I got out of the United States Merchant Marine Academy in 1963. When you come out of there, you have a commission, a license in the Merchant Marine as an engineer.

I went to work for the government initially, for a short period. Following that, in about 1965, I went to work for Newport News Shipbuilding and Drydock Company. I worked there approximately eight years.

Mr. Weaver. Building nuclear plants in ships?

Mr. Miller. Yes, I originally was a test engineer on submarines. Then I was the Chief Test Engineer on submarines, somewhere between 10 and 13 test programs initially, test programs on carriers and a cruiser.

My last job in Newport News was Manager of Construction for the Nimitz and the Eisenhower. I came to Metropolitan Edison in 1973 as the Test Superintendent. I was in charge of Acc ptance Test Program for the TMI Unit 1.

Following that, from 1974, I was appointed to Unit 2 Superintendent. In 1977, I was a Station Superintendent. At the beginning of this year, I became Station Manager.

Mr. Weaver. Very good.

I would just like to ask the two young men who were here earlier and ourselves -- you are all Navy people. Is this typically -- of the nuclear utility industry, or is this just Three Mile Island and Metropolitan Edison; do you have any idea?

Mr. Zewe. I feel it is pretty typical.

Mr. Weaver. If you go to Chicago and have a nuclear plant in Chicago, would you find that?

Mr. Scheimann. You would probably find quite a few Navy-trained operators.

Mr. Weaver. Have you any order that you would like to go in?

Who was there?

Mr. Reis. Mr. Scheimann was in the office behind --

Mr. Scheimann. I was down in the Turbine Building basement at the time.

Mr. Zewe. I was there. I was in the rear of the control room, in my office. There is a little office space in the rear of the control room, and I was in there.

Mr. Weaver. At 4:00 o'clock a.m.?

Mr. Zewe. Yes, at 4:00 o'clock.

Mr. Weaver. Why don't you then proceed and tell how things happened?

Mr. Zewe. The first thing that I noticed and heard was the alarms in the control room. And then I looked out through the glass windows of my office and I noticed that most of the alarms on panel 15, which monitors the ICS alarms, were in alarm at the time. Those are the ones right above here, that I can see directly from my office.

So I jumped up out of my chair there and started out in the control room area, and I looked and I saw that we had a turbine trip. And so I called out that we had a turbine trip, that the operators, Craig and Ed, were already up at the panels following the emergency procedures for the turbine tripping.

And I took a couple of more steps and heard reactor trip. I yelled out, "We just had a reactor trip, too." So I went over to the page system to announce to the plant that we did have a reactor trip and a turbine trip, which I did.

Then from there, I proceeded over to assist the operators in handling the emergency procedures for the reactor trip and the turbine trip.

Mr. Weaver. How many personnel are in -- at Unit 2, in the entire plant, at such a time?

Mr. Zewe. Well, there was myself, the Shift Foreman, the two Control Room Operators, and about seven other auxiliary operators in the A classification, and B and C classification.

Mr. Weaver. So 10 people in that plant?

Mr. Zewe. Between 10 and 12 people, yes.

Mr. Weaver. You said "alarms," by the way.

Mr. Zewe. Yes.

Mr. Weaver. I was just told there was one.

Mr. Zewe. There is just one alarm that sounds for all of the various alarms that we have, but individual alarm flashes -- a light. But there is only one audible alarm.

Any of the flashing alarms will trigger the one audible alarm; and then you hear the audible, and then you look up and see what alarm is in alarm, and it should be flashing.

Mr. Weaver. But there is only one noise?

Mr. Zewe. That's correct.

Well, let me just clarify that. There is one overall alarm, but we do have a separate alarm on the computer which sounds a little bit differently. And there is an alarm for the radiation monitoring system, which has its own alarm.

Mr. Weaver. Would you proceed?

What happened?

Mr. Zewe. I was over with the operator, who was at first Craig and Ed, over by the makeup system, to start a high pressure injection makeup, open up a high pressure injection valve to anticipate the shrink in the reactor coolant system once you have the trip, which is normal.

So I was over there for the first part it. And then, after that then, I went over to where the feedwater system is, to where Craig was at that time, because this was a couple of minutes into it, that my Shift Foreman came up to the control room, and it was about three minutes after the trip that he was up in the control room, so he was over by the primary plant for pressurize level, and I assigned him and the one Control Room Operator to monitor the pressure and the level, and to take action.

And then I went over to look over the secondary side of the plant, in the feedwater system, and assist the operator there, who was Craig Faust.

Mr. Weaver. At this point, you didn't really know what had happened?

Mr. Zewe. I did not know what had caused the turbine trip or the reactor trip. We were only reacting to the indications we had at that point.

The operators, at this point, knew that we had had the turbine trip, because of loss of feed problem. But at this time I hadn't realized yet that what had participated it was a loss of feed, and the reactor tripped because of that, too.

Mr. Weaver. Now, you say the shrink is a natural thing. Doesn't the plant automatically take care of the shrink, or do you have to do that?

Mr. Zewe. Per our emergency procedures, we try to maintain pressure -- a pressurizer level above the heater cutoff point. The pressurizer -- if the pressurizer gets too low, it automatically deenergizes our heaters, so that the elements are uncovered, and so they don't burn out.

Mr. Weaver. You're talking about the reactor core?

Mr. Zewe. No, the pressurizer.

Mr. Weaver. What did you mean by "heater"?

Mr. Zewe. There are electric heaters that are underneath the water in the pressurizer.

Mr. Reis. Why don't you explain their function.

Mr. Zewe. The pressurizer actually has a steam water interface that maintains the overall pressure in the system so that the rest of the system, which is at about 582 degrees, average temperature, is kept at in a water state by having a greater pressure than the saturation temperature.

And the pressurizer actually acts as a surge chamber, if you will, for the system, to provide the pressure and also to surge water back into the system or bring the water out of the system to maintain the primary system full of water.

Mr. Weaver. So you actually have a heater on the pressurizer?

Mr. Zewe. Exactly. The heaters come on automatically on low pressure to maintain the steam bubble in the pressurizer itself.

Mr. Weaver. What did you have to do though that wasn't automatic in these first few seconds? What I'm trying to establish is what is automatic, and what you had to do if you didn't do something that would go wrong?

Mr. Zewe. When the primary system trips, the primary system trips, the primary system cools off and the water contracts. This water goes from the pressurizer into the coolant system to make up for this.

So then we monitor the pressurizer level to make sure that it does not get down to the heater cutoff point.

Mr. Weaver. There's no automatic thing?

Mr. Zewe. Well, we have an automatic valve which looks at pressurizer level, which automatically opens to up to feed more water from our makeup and purification system right into the RCS, which effectively keeps up the water level in the pressurizer. That is the Bravo pump that was running, like it is normally.

And this valve would ordinarily makeup to the system. But we find that the pressurizer level actually comes down fairly close to where the heater cutoff point is if we do not start high pressure injection pump and open up another flow path of water into the system.

Mr. Weaver. That's all I wanted to know.

Why don't you proceed?

Mr. Zewe. Sort of on track here -- where do you want me to go from here?

end t4

Mr. Weaver. Well, let's go to Mr. Scheimann.

t5

Mr. Scheimann. Initially, I was down in the basement of the Turbine Room, and I heard some pipes rumbling, and I heard the word "reactor trip" -- "turbine trip" and then "reactor trip."

Mr. Weaver. Over the loudspeaker?

Mr. Scheimann. Yes, over the loudspeaker, whereupon I proceeded upstairs to the control room. When I got into the control room, I pulled out copies of the Emergency Procedures for Turbine Trip/Reactor Trip, and then I proceeded over to the pressure control station. What I was trying to do there was to monitor primary system pressure, as well as pressurized level.

At the time I proceeded up there, a minute or so later we had an automatic emergency safeguard initiation signal go in, whereupon all the equipment started up as was required, and the pressurizer level started to come back up to its normal level.

About this time, the pressurizer level continued to go up, and we had high pressure injection on both systems for a total of greater than 300 pounds per minute, whereupon we took in manually, bypassed the ES signal, such as to be able to gain manual control of the components.

Mr. Cheney. Why did you do that?

Mr. Scheimann. We did that in order to gain control, so that we could throttle on the high pressure injection flow to get it to where it would be in its normal -- what its required flow -- gallons --

Mr. Cheney. Because you were worried about going solid?

Mr. Scheimann. We were having too much flow going in there. It is what it amounted to, and we wanted to keep it from going solid -- yes.

Once we got the emergency safeguard system bypassed, we traveled back on all four of the high pressure injection valves until we got to 250 gallon per minute, per leg, which is the required amount; and pressurizer level was still coming up, so we started cutting back on one side.

Mr. Cheney. Who was reading the pressurizer level?

Mr. Scheimann. I was observing the pressurizer level myself.

We got up to approximately 380 inches, and we tool off on one string of the high pressure injection, which still left us two strings of 250 gallons a piece per minute.

At about this time the pressurizer level went up, and our indication was it was solid. And from that point we reopened the letdown valve, isolation valve, and attempted to let down at such a rate that we could take and try to bring the pressurizer level back into the indicator range.

Mr. Cheney. There are a couple of things here. One is at some point you had a relief valve on the pressurizer.

Mr. Scheimann. Before the reactor tripped.

Mr. Cheney. And at this point you had reason to believe that the valve on the pressurizer was still open?

Mr. Scheimann. I had reason to believe, by my indication on the panel that the valve had probably -- had lost its open signal and was closed.

Mr. Cheney. Even before you went solid?

Mr. Scheimann. I had no indication that the valve was open at that time.

Mr. Cheney. Would going solid ordinarily lead the valve to open?

Mr. Scheimann. It would depend upon what your pressure is. You would have to have sufficient pressure to lift that relief valve. And at that time we did not have sufficient pressure to lift the valve.

Mr. Cheney. And when you talk about drawdown or trying to drop the level, what precisely are we talking about there?

Mr. Scheimann. What it would amount to under a primary plan system. You have what is called the letdown line, which is rated for approximately 140 gallon-minute maximum flow -- I don't see it on this schematic.

Mr. Reis. Could you point out where it was.

Mr. Zewe. When the letdown comes down off of the 1-A reactor coolant pump, off that line from the pump, and it comes down through some cores into the makeup and purification system, which is always in service to purify the water and back in through the high pressure injection pumps; it puts it back into the cooling system.

What we were doing was just increasing our letdown flow.

Normally, our letdown flow is in the neighborhood of 45 to 50 gallons a minute. We could increase this up to 140 gallons a minute to draw more water from the reactor coolant system and put it into our holdup tank, which in this case is the makeup tank.

Mr. Cheney. You've still got some high pressure injection going in.

Mr. Scheimann. We still had two full strengths going in --

Mr. Cheney. It was just not enough.

Mr. Scheimann. That's correct.

-- so that we could get our balance back in to the observable degree.

Mr. Weaver. Is this something you've gone through before?

Mr. Scheimann. I've been on the pressure control station a couple of times during the course of a reactor trip, so I had seen the resultant increase in pressurizer level.

Mr. Cheney. Had you ever seen one go solid?

Mr. Scheimann. No, I've not seen one go solid.

Mr. Cheney. Have any of you ever experienced that?

Mr. Zewe. I've gone solid before, on purpose, in the Navy. We have to do some primary plant instrument testing. I have gone solid approximately three different times for special testing to align our primary instrumentation, but we haven't actually gone solid in the plant here, in this condition; no.

Mr. Cheney. Have you ever seen in under similar conditions in commercial, as opposed to a Navy facility?

Mr. Zewe. Not under these conditions, no; not solid like this, no.

Mr. Scheimann. I was mostly, from this point on, trying to maintain pressurizer level control for just about the rest of the time period we were in there.

Mr. Cheney. Were you watching light going and giving instructions?

Mr. Scheimann. I was calling out where my level was and trying to keep everybody posted as to what the conditions in the primary were at the time.

Mr. Cheney. Was somebody else making decisions as to what to do?

Mr. Zewe. Once Mr. Scheimann came up into the control room, I assigned him the primary pressure and pressurizer level responsibility, so he was on that. And I was trying to handle other problems in the plant.

Mr. Cheney. Would be ordinary then for him, based upon what you are reading, to give instructions as to what changes might be made?

Mr. Scheimann. That's correct. In fact, I had mentioned that we had cut back the one stream of high pressure injection.

Mr. Cheney. These would be your decisions then, the operators would carry them out?

Mr. Scheimann. Yes.

Mr. Weaver. And what were you doing?

Mr. Miller. I was supposed to go to Oyster Creek that day for the refueling meeting. I had gotten up at 4:00 in the morning. Bill had the Unit Foreman, I think at Unit 1, call me somewhere in that first couple of minutes to tell me we had tripped.

Mr. Weaver. You get called in the first couple of minutes?

Mr. Miller. Yes, I was called very early.

So I knew that Unit 2 had tripped, and I knew Unit 1 was in a hot shutdown condition for refueling. So I just, in that first period of time, waited at home and did some paperwork, and then I called back again somewhere around 5:00 o'clock to see what was going on. And that is where I kind of got into this, but I never interfaced with Bill, because I would not have taken his time; I talked to another man in the control room, so I wouldn't have to pull him away.

So I knew Unit 2 had had a turbine trip. I knew we had had a reactor trip. And I knew we were in the recovery.

Mr. Weaver. How many of these had you gone through before?

Mr. Miller. A lot -- in Unit 1 and Unit 2; enough so that it didn't concern me -- or from an overly concerned standpoint. I was more concerned when I called back in at 5:00, before I left for New Jersey, that I understood the recovery was under way.

And also, the way the two units are arranged at Three Mile

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Island, the steam facility -- it is hard to support both units, and to shut down hot conditions, so my concerns were priority kind of concerns at that time.

Mr. Weaver. What do you mean, "hard to support"?

Mr. Miller. We support steam; you need steam from a boiler that's fired by oil. You need that steam to maintain the equipment in its proper condition.

Pumps have seals on them that are maintained; feedwater is heated up with steam. And now I have no steam; both reactors are shut down. That kind of concern was what I was into at that time.

I called back in at 5:00 o'clock to understand specifically what they were doing, to understand the recovery, and also to give instructions -- to determine the cause of the trip, which would have been my concern, before we started back up.

Mr. Weaver. And then what did you do? Did you go to New Jersey?

Mr. Miller. When I called back in, I talked to another individual in the control room, and he described some of these parameters to me. I guess I felt uneasy about some of them, and I had a conference call set up, which occurred probably around 6:00 o'clock in the morning. And I, at that time, talked to a B&W representative, my boss, Jack Herbine, myself, and George Cutter, who is a Technical Assistant in Unit 2, more or less just to try and understand what was going on.

Mr. Cheney. What was it? What parameters was it that led you to think that this was a fairly unique situation?

Mr. Miller. Well, I wasn't talking to Bill, so I wouldn't have gotten a tremendous display of information -- I guess the pressurizer being solid, the pressurizer level

Mr. Weaver. The 380 inches?

Mr. Miller. Yes.

To me, it was solid, and I was concerned about that being solid and the pressure being low.

Mr. Cheney. And you learned that at 5:00 o'clock.

Mr. Miller. I learned that at about 5:00.

Mr. Weaver. And then did you go to the plant?

Mr. Miller. No. I, in my mind, was still going to New Jersey. I set up a conference call, and I included the B&W representative and my boss, plus a plant guide, to be sure I understood what we were doing on recovery and to talk about it.

Mr. Cheney. Where was your boss?

Mr. Miller. He was in Philadelphia, as I remember.

Mr. Cheney. Is that where he is normally.

Mr. Miller. This is going on my best recall, but I believe he was tied up with his Navy duties that week. But I can always reach him, the same as Bill could always reach me; so I called him down in Philadelphia at the Navy facility.

And more than anything else, I wanted to ask some more technical questions of the people at the plant to understand what they were doing.

Mr. Cheney. And why did you contact B&W?

Mr. Miller. Because the Technical Representative is a guy I trust; and also, since it was the pressurizer was solid, my concern was there.

Mr. Cheney. Aren't they on-site?

Mr. Miller. He was in the area. We have a guy on-site.

Mr. Weaver. There is a permanent B&W man there?

Mr. Miller. There has been at Three Mile Island since 1973, and not just one. They have a couple of individuals.

At this particular point, Unit 1 was finishing refueling, and Unit 2 was operating normally.

We had had more than one of them there for the refueling support.

Mr. Cheney. And how much -- what information did you have at that time? Did you feel you had all the information you needed?

Mr. Miller. As a result of the 6:00 o'clock phone call, Jack directed me to go into the plant. There were a lot of phone calls occurring then. I had to call four or five people to turn off the trip to New Jersey, and things like this. Time goes pretty quick when you're on the phone; so when I got on the phone with Jack and Lee Rogers and George Kunter, following that call, we could not get enough information. And Jack said, "Go into the plant and call me."

So I had gotten up at 4:00, and I had never gotten to first base as far as physically getting ready. I spent the whole time on the phone.

So I started to get ready to go. About 20 of 7:00, I got a call from Dan Shevlin, who's the Maintenance Superintendent; and before this time, I had called Dan Shevlin and Jim Sieman, who's the Unit 1 Superintendent, and told them to go in, more from a support standpoint, because now both units are in -- are down, and that is bad.

Mr. Cheney. That's not a good way to start the day.

Mr. Miller. No. I mean, you have a lot of priorities there.

So Dan called me -- Dan's the Maintenance Superintendent; he's not an operator, or trainer, or License guy -- Dan is simply a radiation man.

He said, "We've got a reading in the hot machine shop," and at that time then I just got in the car and started driving to the site.

Mr. Cheney. This is about two hours and 40 minutes in?

Mr. Miller. This is about quarter to 7:00.

Mr. Cheney. In the meantime, what is going on inside the plant? When did you discover that the emergency fuel water valves were closed?

Mr. Zewe. Craig Faust was over trying to clarify that the

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turbine tripped, and all the procedures that he goes through to verify risk; and he went over to verify that we had an emergency feed flow, so he was observing the steam generator levels coming down, which they normally would be coming down to about a 30-inch range, where they should be maintained for this tripped conditions. And he was watching them come down, and observing.

He verified that the emergency feed pumps had, in fact, started, and that the valves were trying to open up to try to regulate the steam generator water level.

He looked at it, and the levels continued to come down under the 30-inch point. So he looked at the indication on control valves that should be controlling the water level at 30 inches, and he took these into hand and opened them up manually, thinking that the valves just weren't responding properly.

So he tried that, and he still did not have any indication of the flow or a raise in water level. So he looked over his panel pretty quickly, and he said that the 12s were shut; and I heard this, and I was somewhat off to his left, over where Fred and Ed were at this point in time, and said, "The 12s are shutting."

And I said, "What? Why?"

And he said, "I don't know." So he started to open them up, and I went over there to try to open them, too, to establish them -- feeds to the steam generator. So we were there for a short while trying to feed the steam generators, using emergency feed and bringing them up to a normal 30-inch water level.

And Fred and Ed were still continuing to try to reduce the pressurizer water level, and try to determine why the pressure was low.

And I looked over on the turbine panel to look at other problems, or alarms, at this point. And I went over and looked and saw that the hot level was going off the scale -- high, and we didn't have any feed pumps running, the condensate booster pumps running, or any condensate pumps running, so I attempted to try to start the condensate pumps so we could have some flow and try to reject some of the water from the hot wall back to the storage tanks. And we were finally successful in starting the condensate pump.

And we didn't have any suction pressure to the condensate booster pumps, and the only thing between the condensate pump and the booster pump were the condensate polishers. So I went back to try to open up a valve to bypass the condensate polishers, and the valve would not open from the control room.

Just then an operator in the plant called and said that we had a leak by the one condensate booster pump and he needed some help to isolate it. So I went back and Fred and Ed were still trying to maintain the pressurizer level and the reactor coolant system pressure, and Fred had the feedwater stations on emergency feed and seemed to be doing pretty well at this point.

He had some problems trying to get the level, but he was working on it pretty well. We were joined just before we found that the emergency feed valves were isolated. We had been joined by another shift supervisor who had been in Unit 1 at the time, so he was over there within about six minutes after the trip, and his name was Ken Bryon. And Ken was also helping out, trying to determine what we had to make sure that we weren't missing anything and so forth.

All of us at this point were all talking together, trying to give ideas to each other as a possible solution to what we had seen.

Mr. Cheney. At this point, are you now into a set of circumstances you had never seen before?

Mr. Zewe. Yes. Everything looked like it was fairly stable, but we had the high level and the low pressure. And we had some inclination that maybe the pressurizer level instruments weren't reading correctly, because if, in fact, we were solid, we should have seen the pressure increase, because we were still feeding in water at this point and still trying to let down. So we should have had a higher pressure than the 12- or 1300 pounds that we had at that point.

Mr. Weaver. And the reason of this anomaly and difference is that the pressure relief valve on the pressurizer was opened.

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Mr. Zewe. Yes, but we didn't determine that.

Mr. Weaver. I have another question, and that is the 12s, the valve that was closed --

Mr. Zewe. There were two different valves that were closed, but they both served the same function.

Mr. Weaver. They were closed. What if they had been opened? Would we still have had the same eventual situation at Three Mile Island, everything else happening exactly the way it did?

Or was there a possibility that something would have happened later on, or nto happened if the valve had been opened?

Mr. Zewe. The only thing that not having those valves opened did is that they did allow the steam generators to go dry and resulted in the primary system losing its heat sink faster.

Mr. Weaver. S-i-n-k?

Mr. Zewe. Yes. Eye of heat being produced in the primary system.

And now I lost my water in the steam generator, so I'm now transferring the heat over to the steam generator, which results in the primary heating up. so the primary would not have heated up so far, initially; and it was also a rather large shock to the steam generators to have them dry, and then to refill them.

But the real problem was that the electomagnetic valve was stuck open, and it was depressurizing the primary plant.

Mr. Weaver. So the valve being closed played, a matter of degree -- it wouldn't have been quite so bad had the valve been opened, as I understand it.

Mr. Zewe. Exactly. It aggravated it, but it would not have put us in the ultimate condition that we were in. It did add to the confusion factor, and it was another area to where we devoted part of our time to. So in net effect, yes, it did contribute.

Mr. Weaver. I see that.

Mr. Meyers. Are you sure that the secondary did go dry, or it went below the level that you could read it?

Mr. Zewe. Our indication, when I looked at it, and I looked at it fairly hard, was that we never got down less than 10 inches in the steam generator, either one. And it got down to about 5 percent on the operating range, which is just another range of our indication.

So that shouldn't have been dry. But looking back now, if we didn't have feed for an 8-minute period of time, the steam generators would have boiled dry: in about 90 seconds to 100 seconds, they would have been dry. So I'm sure, at this point, they were dry. At the time, I didn't know that.

Mr. Meyers. Based on your calculations, you think they were dry?

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Mr. Zewe. They definitely were dry; right.

By observation, it didn't look like it, but looking back at it, with retrospect, knowing what we know know, they had to have been dry.

Mr. Meyers. But this is a property of B&W steam generators. That would not necessarily happen in Westinghouse; is that right?

Mr. Miller. Any plant has to turn feed on at some time. They might have had more time, based on their pipe configuration and the volume in the steam generator at the time of the trip. In other words, if your generator is a little bigger than B&W's and you've got a little more time, but the consequence of not feeding it is that goes dry. "Dry" is no water.

Mr. Zewe. We consider anything less than 8 inches dry from an operating standpoint, but in this case, in the 8-minute period, it was probably completely dry.

Mr. Chaney. So now you've got problems with your generator basically. And then at some point an hour or so later, however later it is, where you discover that the emergency pressurizer valve, the valve on the pressurizer is open, and you get it closed --

Mr. Zewe. The only way that we finally determined that that valve was partially opened was that we shut the blocked valve -- or the downstream valve, if you will -- from the valve that was open. Once we shut that, then we had indication that that valve had been open previously.

Mr. Cheney. And how long was that?

Mr. Zewe. That was approximately 6:20 or so.

Mr. Cheney. That was before you arrived at the plant?

Mr. Miller. Yes, at the 6:00 o'clock phone call, one of the questions we had asked is whether that valve was closed. On the panel, the valve had a command signal that said, "Go closed."

Mr. Cheney. So you asked, and checked it then?

Mr. Miller. I think they checked it many times before that.

Mr. Scheimann. I checked it many times, and there was no open indication for it.

Mr. Zewe. For that particular light, there is a very bright red light for that valve; and it is really probably the brightest light on our entire console.

Mr. Weaver. What are we talking about, the pressure valve?

Mr. Miller. Yes.

Mr. Weaver. Why wouldn't you just -- you want it closed, why didn't you just press is?

Mr. Miller. Well, the operator on the panel is thinking in his mind that the red light is telling it to go closed. It tells him it is closed.

Mr. Weaver. Well, can tell you, when I go vote, we use this card here. We have little boxes in the house, you know, when you put this card in the little slot and it says "Yes/No" -- and voting is very important to me -- that's it for us, and I always punch that "Yes" and the light lights up. Sometimes it doesn't light up. Then you've got to go to another slot and put it in, because it's not working. But I will punch it "Yes," and then I will put the card in again, because I want to be damned sure that my vote is registered.

And so then I punch it again even though the light is lit up.

Now, what I'm asking you is why wouldn't you --

Mr. Miller. When you punch that light, do you go look at the computer to see if it's punched in? That is where you're at.

Mr. Weaver. We have a score card on the wall, but my point is, but my point is would it ever occur to you that because of the importance of this pressure relief valve and the funny things going on, to just go punch that in? It wouldn't hurt anything, would it?

Mr. Zewe. Not at this point, no, but we did check other indications. We have thermocouples on the downstream side of the relief valve which are monitored on plant computer, and we did check down several times to see what the discharge temperature was. And shortly after we tripped, I would say

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within about 10 minutes or so -- after we had tripped it, we checked this temperature, and the temperature was not abnormally high. We knew that it had left it, and it should be a little higher than normal.

Normally, it does read around 175 or 180 degrees, and it was reading 220 degrees, which is not abnormally high for just having lifted. So we checked that at least three different times.

Mr. Cheney. Why did you check that.

Mr. Zewe. With the normal alarm status review, we had checked that, and whenever the Shift Supervisor came over -- I had asked him to look through there, and to see what the discharge was.

Mr. Cheney. So was that an automatic readout on the computer?

Mr. Zewe. It alarms the computer and prints out so you can monitor it there, and also request that that particular number -- and they will print you up the current value.

Mr. Cheney. If the valve was open, why was the reading so low?

Mr. Zewe. That I don't know.

Mr. Miller. Somebody is looking into that, because I remember it is thermocouple that is strapped to the pipe. It is not a temperature weld in the pipe. The pressurizer might be over 600 degrees; that is why it reads in the range he's talking about. It reads the outside of the pipe. There -- I believe Bill was checking it to tell him to confirm the light as he was discussing -- I don't think we know the answer. I think somebody is looking at the indication and the parameter and whether there was sub-cooling going on or expansion going on, or something that would have caused that reading.

Mr. Cheney. In other words, you feel like even though there was, first, the indicator light that indicated the order had been given to close the relief valve, which showed that you were closed; secondly, there was the tailpipe temperature reading, but it, too, was showing a relatively low level, lower than it would have been,given normal e perience, if the relief valve had been open. Is that an accurate statement?

Mr. Zewe. Correct.

Mr. Cheney. Were there any other indicators available that might have given you a readout in the control room?

Mr. Zewe. Well, the tank that the valve discharges to, that -- we did check it, and it was at a higher temperature, and a low level, a low pressure, indicating that either its relief valve was open or the ruptured disk had ruptured in the tank. And I thought that that was true, because -- well, it shouldn't have happened; but after we tripped, the relief blows and it puts too much energy into the tank. It could cause that condition in the tank. At this point, the tank was at zero pressure, at a high temperature, with no indicated water level.

So if the valve had just been opened somewhat, the pressure in the tank should be elevated to a higher temperature. But when it said no water level and zero pressure, that just indicated there was some leakage path from that tank into the reactor building itself.

So at this point it would be very hard to determine that that valve was still discharging into that tank.

Mr. Weaver. Now, in 1977, a similar relief valve opened or solenoid, and a similar signal was sent, and yet it remained open for 20 minutes. Have you ever heard of that?

Mr. Zewe. I don't recall that at all.

Mr. Weaver. Have you ever heard of that, Mr. Miller.

Mr. Miller. I don't recall it. There may have been a bulletin that passed my desk, but I don't recall one.

Mr. Weaver. Mr. Scheimann.

Mr. Scheimann. No.

Mr. Weaver. Have you heard about it before? I just mentioned it to you today. You've never heard of that?

Mr. Scheimann. No.

Mr. Miller. I never heard of the part about the valves sticking open.

Mr. Weaver. This is the first you've heard about it, my telling you?

Mr. Miller. No.

Mr. Weaver. You've heard of it?

Mr. Miller. I heard about it the night of the incident; somebody in the control room, in from the NRC, described it -- that at some date that Davis-Besse had occurred.

Mr. Weaver. On Wednesday night?

Mr. Miller. Yes.

Mr. Weaver. On Wednesday night, somebody told you that they had seen this Davis-Besse?

Mr. Miller. I might say this, in 1978, this valve, at this plant, had stuck open, but due to a different reason. The valve had stuck open due to a power failure, and that had been corrected. The valve had stuck open the day after the plant went critical, on March 29th; but the valve had stuck open that day, but it stuck open because of a power failure to the valve.

Mr. Weaver. I would like to repeat that right now.

As of right nc you've never heard of the Davis-Besse situation?

Mr. Zewe. I have not.

Mr. Scheimann. I have not either.

Mr. Cheney. And I understood you to say that you hadn't heard of the Davis-Besse situation until in the control room?

Mr. Miller. That's the first that I had heard of it.

Mr. Weaver. With the exception of possibly a memo?

Mr. Miller. There is possibly -- I don't remember if there was. I'm saying that it was possible he could find a piece of paper that was sent to the Station Superintendent with that on there. I don't remember that piece of paper.

Mr. Chaney. On their prior closings, did you have any -- I recognize, of course, that the relief valve is inside the containment, and nobody is going to know it until they take a look at it -- do you have any feel for why it failed at this time?

Is there any indication that would point in the direction of explaining what happened here? At Davis-Besse, as I recall, it was a relay that wasn't pressed?

Mr. Weaver. It was same thing. The solenoid did exactly the same thing; the valve did not close, but the solenoid sent the signal, where the energizing of the solenoid was no longer there.

Mr. Miller. The valve could have stuck open, in my mind, and there are other people looking at this for one of two reasons: One, the electrical setup that told the solenoid to do something was improper; secondly, if the valve could have maybe stuck up on a differential mechanical thing, like a difference in pressure.

I don't think we know today -- I don't know today why this valve stuck open on March 28th. With that drain tank being full of water, and the water path, the valve could have hung up, a difference in pressure. I don't know that, but that is the other possibility; and people are looking into it. I don't think any of us know.

Mr. Cheney. And when it did fail previously on Unit 2 --

Mr. Miller. When it failed here, it failed due to a power loss. We lost power to the valve, and it failed to open.

Mr. Cheney. It failed to open.

Mr. Miller. It failed in the open position.

We fixed that problem by putting redundant power supply to the valve.

Mr. Burnham. When it failed previously at Three Mile Island twice -- one in 1978, and one on March 29th; is that right?

Mr. Miller. In 1977, it was not Three Mile Island.

Mr. Burnham. I thought there had been two previous incidents at Three Mile Island.

Mr. Miller. I don't know of two, but I'm not trying to quote that for the record.

I know on March 29th it failed, because it was a pretty big transient.

Mr. Burnham. What did the indicator light say? Did you have the same problem with the indicator light giving you a misreading?

Mr. Scheimann. On March 29th, I don't believe that light was in there.

Mr. Weaver. Why don't we say 1978, say we installed this red indicator light that comes right off of the signal that goes to the solenoid -- valve, as a result of that problem?

Mr. Miller. At that time, we did not have that light before.

Mr. Cheney. And when that valve held previously, in 1978, what was different about it that led to circumstances where obviously you did not have the kind of problem that occurred this year?

Mr. Miller. At that point, they recognized that problem because they had had a failure of a vital power supply, so they had -- that led right to that valve.

Mr. Zewe. They knew what precipitated it?

Mr. Miller. It was a lot simpler problem in my mind.

Mr. Chaney. Was there a point in the morning there where all of a sudden lights went on, and you think, aha, maybe the valve stuck open?

Mr. Zewe. It was about quarter after 6:00 that we rechecked the discharge temperatures once more, and they were still reading about 220. And we said, "That's hanging up there too long, so let's go ahead and isolate the valve."

As soon as we isolated it, we saw the reactor building pressure, which had been 2.2 pounds or so, take a marked reduction; and that is when we realized, for sure, that the valve was at least partially open and blowing to the drain tank, and the drain tank was open directly to the building.

Mr. Cheney. Do you realize anything about -- remember anything about the sump pump that morning?

Mr. Zewe. Yes, I do; somewhere around a half hour after we had tripped and we had determined from the computer alarms and also from an Auxiliary Operator -- had called saying that his indication on the panel for the reactor building sump was that it was full, and he has a scale -- it's like a zero to six feet is the range of the sump -- and that the sump pumps were running.

So the Control Room Operator, Ed Frederick, told me about that and he suggested, "Bill, should we turn them off?"

And I said, "Yes. Tell the operator to go ahead and to secure the sump pumps."

Mr. Cheney. Why would you secure them?

Mr. Zewe. Because we knew that we had a problem with the RC drain tank, and it's water had got into the reactor building sump. And I did not want that water to be transferred over to the auxiliary building, because I didn't know how much water we actually had and I knew that we didn't have very much room for excess water in the auxiliary building.

Mr. Cheney. Were you concerned about radioactivity at that point?

Mr. Zewe. No, I was not. I was just worried about the volume of water and transferring water, not knowing the full story.

I had told Ed to tell the operator to do that, and Ed told me back that the operator, indeed, did turn off the two reactor building sump pumps. And I acknowledged that, and then we went on with the rest of the operation.

Mr. Weaver. I would like Henry to ask one question relative to this.

Mr. Meyers. That was a transient at Rancho Seco on March 20, '78, and they had had their relief valve blocked out because there had been leaks. Were you aware of that?

Did you get a copy of a similar letter? They sent a letter to Davie-Besse -- Babcock & Wilcox sent a letter to Davis-Besse on August 9, which discussed that Rancho Seco transient. Did you get that?

Mr. Zewe. August 9th of what year?

Mr. Meyers. '78.

Mr. Miller. In all fairness, I don't know how much mail you get, but mine gets trucked in and I look at almost every piece of it. If something had come that normally comes to my engineering people, who would get it and also would translate it into procedural change -- now, I don't remember seeing either of these, but you could find the letter maybe addressed to me. I would think I would remember it, but I don't remember it.

Mr. Weaver. Mr. Miller, I want to ask you --

Excuse me, Mr. Zewe.

Mr. Zewe. I believe this is the one where they had been changing light bulbs, and they had a short in their instruments. We had discussed this in our training review, and I remember a comment from my one Control Room Operator in Unit 1 at that point, saying "He isn't going to change any more light bulbs."

Mr. Meyers. Because this letter also suggests something that might be an unambiguous instruction, where it says "the pressurized level in reactor coolant system pressure share of the reac or coolant system is filled."

That is saying that the pressurizer water level isn't full.

Mr. Zewe. That is true. Our key parameters are that as long as we have water pressure in the pressurizer, that our main cooling system is full, and the water level in the steam generator is our main way of indicating removal.

Mr. Meyers. But that is as long as the temperature in the rest of the system is less.

Mr. Zewe. Right. At the highest temperature the saturation conditions occur in the pressurizer, that is true.

Mr. Meyers. Then you are aware that that temperature condition was necessary in order for the pressurizer water level to indicate a full pressure vessel. Were you aware that the temperature in the rest of system had to less than the saturation temperature?

Mr. Zewe. Yes, I realized this; yes.

But at the time, I felt that we still had the higher temperature system in the pressurizer and not in the coolant system itself.

Mr. Weaver. Mr. Miller, how many comparable messages do you get about transients in different plants or problems in other plants, or anything like this that cross your desk? Is this an unusual thing, or do you just get all kinds of them?

Mr. Miller. I get a good many of these; an awful lot of them come from the NRC themselves. They put out at least three categories of bulletins, plus B&W puts out things periodically. And those are handled by going into our structure, attempting to determine whether you need a plant change or a training change; and that is how he would have -- got that training memo.

Mr. Weaver. I have a couple of extraneous questions right now.

One, isn't the computer printing out dollar signs at this time? That's what we've been told.

Mr. Miller. I don't know whether Bill had the -- you know, there are temperature indicators on some instruments inside the reactor. When I arrived at the plant, somewhere around 7:00 to 8:00, I had an electrical engineer give me the N Core readings. He said the computer had questions marks, which meant to me that it was not in the program.

At that time, we sent the instrument guide to take the base signal reading and convert it.

I don't know, Bill, whether you had any other readings

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that were like that before I got there.

Mr. Weaver. Let me first tell you how it was described to me, and I think it was the press, so there's nothing sacred about this information. And that is that for the first -- I don't know -- hour or two hours, or whatever, the computer was just reading out at first, we were told, question marks and then dollar signs, meaning that it couldn't answer.

Now, this may have been later on. Maybe this was 7:00 o'clock, when the reactor vessel started going really bad, and therefore all your temperature readings were way above the 612, or whatever the limits were.

Mr. Zewe. Normally -- all right, if the computer -- it has a certain range to it, a certain range for the parameters -- if you are outside that range, or it doesn't know if it's valid or not, it will print up question marks, saying that for the input it has it really can't get a very good reading, so that is where a question mark would be.

At this point though, we were still using the console indication, our normal TC, TH, and so on, from the console, not from the computer. We were checking through the computer for alarms and indications. There is a physical limitation to the computer. Things were happening so quickly, and we had so many alarms and so many things happened at the computer monitors that it really could not keep up with the alarm response time -- like 20 or 30 items may happen in fractions of a second, but it takes a finite time for each of them to print out on line, and it begins to get backlogged.

Mr. Miller. It types out. It's a line-type thing, so there are physical limitations in the typing time. If it gets 100 things happening in five minutes, it starts to pile them up and then prints them out later.

He would be using the direct indications.

Mr. Weaver. Do you mean calling up the computer?

Mr. Miller. Looking at the console.

Mr. Weaver. Now I'm troubled by the newspaper reports. One report, early on, had it that there was just page after page of computer printout of question marks.

Mr. Miller. Looking back -- and we can come back to you with further information, but there was a period of time in the first two to three hours where the computer failed, I believe.

Mr. Zewe. Yes, for over an hour period, it didn't give us any information.

Mr. Cheney. Did you -- you mean you would query it and nothing would happen?

M . Zewe. No. The question mark periods, and so forth, the computer had hung up, where it really didn't scan the parameters and print on in a fashion where we could interpret it.

Mr. Cheney. It was unusable.

Mr. Miller. I think Bill would back this up. He was not using that totally. He was using his console to operate the plant, so when that went out, he just had to go away from it.

Mr. Weaver. What caused this? What was going on? What happened?

We have it here in the chronology that 1 hour 13 to 2:37 -- in other words --

Mr. Miller. I think, in fairness, the machine has got a tape, disk, and that sort of thing. It has experienced problems. It is not a vital piece of equipment to Bill's use of the emergency procedures or operations of the plant, so I would guess Bill would just simply have told an electrical engineer to call someone in and go on with the console.

Mr. Weaver. You haven't to have it in any way?

Mr. Zewe. No; it is just an operator's tool, but it isn't anything that's really that critical to the operation.

Mr. Miller. It certainly hampered us in the detailed analysis -- that is, your memory -- and that hurts.

Mr. Weaver. And there are sheets of printouts with questions marks on them?

Mr. Miller. I haven't personally seen any of those sheets.

Mr. Weaver. There are printout sheets though?

Mr. Miller. I'm sure there are.

Mr. Zewe. I'm sure the printout sheets are all available, but how long of an area we had that just prints out question marks -- I assume that that time there is accurate, but I did not go through it and say, "Well, it was out for this period of time."

Mr. Miller. That would not have affected any decision thought we would have made or Bill would have made at that time.

Mr. Weaver. And we don't know what caused the computer to go out?

Mr. Miller. I think we could probably come back to you. There was an electrical engineer who got it moving again, so he could probably be able to tell you that a component was replaced or something, I would guess.

Mr. Weaver. And it prints out question marks and not dollar signs, because the newspaper said dollar signs.

Mr. Zewe. That's right; it prints out question marks.

Mr. Cheney. Can we talk a little bit about the period when the reactor pumps were turned off and how that process happened, how you got to the point where you decided you had to turn off the reactor coolant pumps?

Mr. Zewe. We were at the point where we began to experience some flow oscillations, and we could determine on our panel board flow indication, and we started to have some flow isolations.

And George Kunter, the Superintendent of Technical Support, and myself, and Fred, and Ken Bryon, and the Control Room

Operators were all looking at it, and we had our operating curves. And we were right at the edge of our net positive suction limit for running through a reactor cooler pump, so we decided then to secure the two pumps to see if we could correct that flow, that oscillation problem. So we did this; we secured two pumps, and then later on, approximately half an hour later or so, then the flow oscillations were coming back.

They did subside for a short period, where we turned two pumps down. And then that, we decided to secure the remaining two pumps and to try to go on that full circulation flow.

Mr. Cheney. So you would have expected -- obviously, you did not want to turn off the pumps, but really you had to.

Mr. Zewe. We felt we were going to lose the pumps anyway, so to help protect them, we decided to secure the pumps.

Mr. Cheney. But when you secured the pumps, you did it with the expectation that you would be able to continue cooling the reactor?

Mr. Zewe. Yes, using that full circulation flow.

Mr. Miller. If the last two pumps were turned off 100 minutes into -- it would be 5:40.

Mr. Cheney. So what happened, once you get the pumps turned off?

Mr. Zewe. Then we monitored and we began right then to raise our steam generator water level up to a natural circulation condition, which is about 50 percent on the operating range and 21 feet, to enhance the natural circulation flow.

Mr. Miller. The plant is designed to use all those pumps to do this, so that is the context I think Bill would be doing it in.

Mr. Cheney. Is that the point at which the reactor may have been uncovered?

Mr. Zewe. After then -- it is sometime after that is when we feel now that the reactor did become uncovered; yes.

Mr. Cheney. And how did it come uncovered?

Mr. Miller. It was still relieving water through the valve.

end t5

Mr. Zewe. Now you have the system where you have the steam bubble in the cooling system.

Mr. Miller. You may have voids earlier for a short period, but now you begin to form a bigger void.

Mr. Cheney. Do you know that at the time?

Mr. Zewe. I did not know that at the time.

Mr. Cheney. What did you think was going on?

Mr. Zewe. Well, the first time that we realized that we had a problem as far as the actual core goes, is we started to see a change in our intermediate range indication, our source range indication, which took us by total surprise.

This measures the reaction rate inside the reactor. It monitors the neutron flux for the core, and our source range is just our first range of nuclear instrumentation. The intermediate range is the next range above that, and then we a third range which is the power range.

So both our source range and intermediate range were in their right respective places, until after we had shut off the pumps sometime like -- sometime after that, and I'm not sure of the time frame there, but we noticed that our charts that record the source range and intermediate range showed that our count rate in the reactor was increasing; and I didn't know why it was totally foreign to why the count rate in the reactor was starting to come up, because we had done a shutdown margin calculation, after we had tripped. And we were 6 percent

bw2

shut down. And we are required.

Mr. Cheney. 6 percent shut down?

Mr. Zewe. That just explains a condition of the reactor.

Mr. Cheney. You've got 6 percent to go?

Mr. Miller. As far as from a distance from being critical where you have a chain reaction, it is a good distance away from that. That's what that tells you. It is still making decay heat, but the reactor is positively shut down as a result of the introduction of negative activity through the boron. That is what that would tell, that he was that percent away.

Mr. Zewe. I didn't know why the count rate could be coming up, if we were that far shut down. That is a considerable amount of shutdown margin.

Mr. Cheney. But ordinarily the count rate would go up, as you pulled the rods and started to activate the reactor?

Mr. Zewe. Exactly.

Mr. Miller. The count rate would do that.

Mr. Meyers. Why was the count rate higher?

Mr. Zewe. At that point we didn't know why the count rate was starting to increase. So we began to emergency boring and put borated water into the reactor coolant system to add to the negative reactivity to the core.

Mr. Cheney. Through your high-pressure system?

Mr. Zewe. That's right. And prior to this we had been putting water into the reactor coolant system from our borated water storage tank, which itself had a lot of boratedwater in it, so that should have further increased our shutdown margin:

So we didn't understand why we had that indication of the increase in count rate.

Mr. Miller. He's got a separate tank with very high concentrations of boron in it. The borated water storage tank is a big 500,000 gallon tank that as the shutdown, norma' shutdown amount separate to that, he's got a very concentrated amount, and he started to put some of that into that same --

Mr. Cheney. And that is designed exactly for this kind system?

Mr. Zewe. Exactly. So it was just about this time after we had initiated the boron injection again, that we got the boron analysis from the reactor coolant system, and the first boron analysis that we got was 700 ppm boron, which was far less than it should have been.

Mr. Cheney. It would be less because there is some more activity in the reactor?

Mr. Zewe. No. It was just that we started out at around 1000 parts per million boron concentration.

Mr. Cheney. That would be normal under normal operating circumstances?

Mr. Zewe. Yes. That is where we were at 97 percent, and we had expected that the boron sample would come back at a much higher value because we have added boric acid from these

bw4

other sources.

Mr. Cheney. So instead of being 1000, it ought to be 1500 or 2000 or moving in that direction?

Mr. Zewe. Probably 1100 to 1125 or so.

Mr. Miller. But the water had been added from that borated surge tank was 2200, so we would not have expected it to go below 1000 in any case.

Mr. Zewe. That also the reduced boron concentration plus the change in the count rate, we really didn't understand why the count rate would be going up and why the boron concentration was low. That was very confusing at this point.

Mr. Cheney. Now how far along are you? You are at 100 minutes when you close off the second set of reactor coolant pumps?

Mr. Zewe. I would say it is around 6:30 maybe.

Mr. Cheney. So about 2-1/2 hours into the incident?

Mr. Zewe. Yes.

Mr. Miller. When he had the incident.

Mr. Cheney. And this is about the time you begin to get radioactivity measured?

Mr. Miller. A little after that.

Mr. Zewe. Radioactivity began to come up about quarter to 7:00 or about 10 to 7:00 or so.

Mr. Cheney. After you noticed the boron problem and the count problem?

bw5

Mr. Zewe. Yes. That was after that. We had attempted to start the reactor coolant pumps after we had seen this count rate change and the boron load numbers we had selected to try to start the reactor coolant pump to try to get some flow through the coolant system. So we were successful in finally starting the one Bravo loop coolant pump, but it did not indicate to us normal indication that it was running.

The breaker closed on the pump, but it did not give normal indications that we did see an effect on the count rate from the source range,and the intermediate range showed us that they came back down to a lower count rate value, showing that we probably were putting some flow through the core, even though the pump didn't give us normal communication.

Mr. Meyers. What physically was it that made the count rate go up?

Mr. Miller. I think physically looking at it afterwards we might have taken some water off the vessel. The device he's talking about, nuclear instruments outside the reactor vessel. vessel. By reducing the water level somewhat, there may have been more leakage of neutrons because there was not as much moderation. That is what I would guess.

Mr. Meyers. But there were neutrons, or just that there was less water to absorb them, whatever radiation was being produced?

Mr. Zewe. It was just physically more neutron leakage

bw6

from the core at that point.

Mr. Miller. If you'd take some of the water away, more of those would have escaped.

Mr. Meyers. So the higher count rate was an indication of voids?

Mr. Miller. Looking back, that is what we're saying.

Mr. Zewe. That is true.

Mr. Cheney. What did you find then when you arrived at the scene just about this time?

Mr. Miller. Well, as I say, I got a call right around this same time. You see the samples that were taken to give Bill's backup chemistry boron, those sample lines run from Unit 2 over into Unit 1, because that is where what we call the "hot lab" is -- that is where you take the primary samples from both units -- those lines physically are hundreds of feet long. It probably takes 20 to 40 minutes to get a representative sample. So when when they pulled the sample of the reactor coolant system out around 20 to 7:00, that sample showed radiation indications, and the technicians who were down there would have noted that right away, and they did.

Mr. Cheney. This is water out of the primary coolant?

Mr. Miller. Right. This comes off the left-hand line, I believe. It comes off that big pipe that the water showed radiation indications and significant radiation indications.

The lines themselves showed significant, and that is when I first got the call and started into the plant. When I arrived in the control room, they had already passed through the criteria and Bill had declared a site emergency, which is declared based on radiation indication.

So between the time of 6:30 and 20 to 7:00 until 10 to 7:00, we already were into the intermediate, and there was three levels of emergencies, local, site and general. He was already into the site emergency by 10 till 7:00.

Mr. Cheney. And you got there based on the boron samples or somewhere else?

Mr. Miller. He got there based on the radiation in the boron samples. Just our -- a side issue, taking that sample there showed us radiation in another area, prior to seeing it on the monitor, I believe.

Mr. Cheney. But you were picking it up in air samples?

Mr. Miller. This was a liquid sample taken for a chemistry reason, but it was out of the coolant system, so it would have fission products it. It showed the technician that he had radiation far above what he would normally get.

Mr. Cheney. Now are you talking about the boron?

Mr. Miller. The sample was taken for boron, but the water itself had fission products.

Mr. Weaver. Wouldn't at 5:40, when you had to stop the reactor coolant pumps, that is a major step, puts you in an extremely precarious situation, does it not?

Mr. Zewe. Yes.

Mr. Weaver. Why didn't you declare it then?

Mr. Miller. Because the plant itself is designed to have a loss of all reactor coolant pumps and cool down on natural circulation, so it would not have been any concern, where you got into the emergency point or into a radiation indication. Without radiation indicated, it would not put you into that type procedure alone. It is a serious thing, but it is not a radiation concern at that time.

Bill and the operators felt they were cooling the core using natural circulation, which is designed in the plant. The plant is designed to sit at 100 percent power and lose all power.

Mr. Weaver. Meanwhile the pressure is going out of the relief valve and so you're still losing water?

Mr. Miller. He's still putting water in.

Mr. Weaver. You turned off the reactor coolant pump?

Mr. Scheimann. We're still in high-pressure injection at this point.

Mr. Miller. He's still pumping water from the outside in.

Mr. Scheimann. Which is considerably cooler than the water inside is.

Mr. Miller. They just circulate the water around in his mind.

Mr. Weaver. Where's that little sketch?

Mr. Miller. In the operator's mind. Say we hear the pumps here. All that they do is take the water and put it into the reactor and it comes out and goes through the steam generator and goes back to the pump. It is a closed cycle system.

Mr. Weaver. Now the high-pressure pumps?

Mr. Miller: They sit outside and they inject water.

Mr. Weaver. They are not on here, are they?

Mr. Miller. No, but they inject water into the leg.

Mr. Weaver. And that's A, B, and C?

Mr. Miller. There are four places, they're four cold legs. They're four points of injection.

Mr. Weaver. What are the A, B, and C pumps.

Mr. Zewe. They're the makeup pumps. They're three high-pressure injection makeup pumps. The pump you're referring to here, they're four reactor coolant pumps.

Mr. Miller. So at that time when he turned the reactor coolant pumps off, he was still putting water into the system through these high-pressure injection pumps, plus he is still steaming from this steam generator taking some steam out.

Mr. Weaver. So the high pressure is still pumping water in.

Mr. Miller. And the steam generators are still steaming, so he still thinks he has cooling.

Mr. Weaver. And he wasn't getting cooling because?

Mr. Miller. He was getting some, but --

Mr. Weaver. Why wasn't it working?

Mr. Zewe. Because due to the voids that we had in the reactor cooling system, we did not have flow from the hot point, which was the reactor, from there to the steam generator.

We weren't transferring heat from the reactor to the steam generator, so that we could remove the heat by the secondary side from the steam generator, but we weren't getting it to the steam generator.

You see, you come out of the reactor and into the steam generator.

Mr. Weaver. And this actually goes over there; right?

Mr. Miller. Yes.

Mr. Zewe. And then the water passes through tubes that are inside the steam generator, and then if you don't transfer the heat from the core to the steam generator, you cannot use the secondary system to draw the heat out of the steam generator. So we had these voids which prohibited flow from circulating through the steam generator, so we weren't removing the heat from the core itself.

Mr. Cheney. Had you ever been through in any of your drills or your tests either TMI or the simulator, or in your Naval training the kind of situation where you got these kind of voids, steam voids in the reactor?

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Mr. Zewe. No, I hadn't.

Mr. Miller. No, I have never personally seen a plant with pressurizer solid this long in this condition.

Mr. Cheney. But it's not part of your training in terms of -- we're talking about loss-of-coolant accidents and so forth. This isn't something people are trained to deal with?

Mr. Miller. We all ought to answer that question separately.

In my mind, you would normally think of a loss-of-coolant accident as being a break in the system. You are pumping water on top of the core, and it is not analogous to this. Here you had a full system drawing voids which you would train for. It would be awful hard to train for, because you could not demonstrate it too well.

Demonstrating it might do damage, is what I'm trying to say.

Mr. Cheney. Even a simulated?

Mr. Miller. I think you could simulate it.

Mr. Cheney. Do you know if anybody has ever simulated it? You mentioned going through simulations of going solid, in the Navy.

Mr. Zewe. No, actually, in the Navy we have gone solid.

Mr. Miller. In this plant there has been solid in a test program. That is not the normal thing, you go solid when you do a pressure test. But, to my knowledge, the training program does not include the simulations of voids in the system.

Mr. Cheney. Do you think that is an oversight to the training program now, with the benefit of hindsight?

Mr. Zewe. At this point, I would say yes. Most definitely.

Mr. Weaver. Take me back just briefly on where we got these voids.

Mr. Miller. You are draining water. We are all looking back, but you're draining water off the system from here. You're pumping some water in, but you must have been draining some water off. This is hot. The water is just going to drain. It's all going to drain out here, so the voids are going to start to occur.

So the voids are going to start to occur, plus the core is hot, and it's forming voids, steam voids, that are coming up.

Mr. Weaver. What is causing that drainage?

Mr. Miller. Heat production and drainage.

Mr. Zewe. You're just flashing the hot water you have.

Mr. Weaver. We got down to saturation. I understand that. So therefore when the pressure went down, that water flashed to steam and you got the void. And then you could not get the void out.

Mr. Miller. Well, you were draining the system, and the core would have been fairly hot, as we all know now, very hot, and, therefore, getting it solid again was hard.

bw13

Mr. Weaver. I was going to ask you why you didn't call the NRC earlier, but now I'm beginning to see that you didn't really didn't know the voids were there, and that was the real bad situation.

Mr. Miller. Right. If you look from 7:00 o'clock on, you will find that from that time on, they were involved pretty intimately with us, at least at the technical level.

Mr. Weaver. What was the first time you just kind of had an uneasy feeling that there was core damage. I mean just maybe.

MR. ZEWE: When the source range and the intermediate range began to show the count rate increase.

Mr. Weaver. That was actual measuring of radiation.

Mr. Zewe. The monitors measured the activity in the core, and I know that something was really wrong at that point, but I didn't know for sure.

Mr. Miller. They don't measure radioactivity. They are used as an indicator of the amount of power which is proportional to the number of neutrons in here. From my standpoint when I got there at 7:00 in the morning, and the radiation indicators, the monitors were reading and going up, then I knew we had some damage, because that is where it comes from. It comes from the core, and so I knew we had some damage.

When the sample showed me radiation.

Mr. Reis. You mentioned when the source range measured, but what time was that?

Mr. Cheney. It was around 6:30, wasn't it?

Mr. Zewe. Yes.

Mr. Weaver. So then you called the NRC at that time?

Mr. Miller. From the time I got there, the calls that would have started at 10 till 7:00 would have included the NRC. When I got to the plant about 5 after 7:00, and then I took charge of the situation, and by 20 after 7:00 the radiation readings were high enough that we were in a general emergency, which is our highest category. And then we initiated the calls, and my guess is, is that there is a chronology, but before 8 in the morning, the NRC and everybody were on the phones, on hot lines with us.

Mr. Cheney. Now with a site emergency, it's automatic that certain things happen?

Mr. Miller. Yes.

Mr. Cheney. And that's the point at which the NRC gets notified?

Mr. Miller. They are one of the parties, along with about seven others.

Mr. Cheney. This is just a set of procedures?

Mr. Miller. It is an emergency plan.

Mr. Zewe. I really didn't think that we had core damage at this point up until quite some time after this. I felt the results were very large crud burst from the system, that we hw15

had a very severe transient.

Mr. Cheney. What's that?

Mr. Zewe. It's just that when you operate for a period of time, you do have fission products, and it's like if you have rust in the system, if you will, once you have a shock to the system, this breaks loose and comes into your system. We felt that we still had maybe a large crud burst, and the activity that we saw on the monitors was just from the water that was from the reactor building somehow getting over to the auxiliary building.

Mr. Cheney. Some way other than the sump pump route?

Mr. Zewe. Yes, some way other than the sump pump route. So we really didn't know that we had severe core damage or moderate core damage, or if it was somewhere between some core damage and a severe crud burst. We really did not know at this point.

At least, as I recall, I didn't.

Mr. Cheney. What triggers the decision that there is a site emergency? Is that also automatic?

Mr. Zewe. Yes. There are criteria for it.

Mr. Cheney. And what criteria were satisfied that morning?

Mr. Zewe. The radiation levels that were in the auxiliary building. Right here, if you look here, this whole panel here on 12. These are all our radiation monitors. They have an alert and an alarm function. Amber light and a red light. Just about 10 to 7:00, all of these alarms started to come in hot, just about the same time they were just going amber-red, amber-red, on all the indicators, and I knew that we had a tremendous problem at that point.

So that is when I made the announcement and sounded the alarm that a site emergency had been declared in Unit 2.

Mr. Cheney. And then things started happening?

Mr. Miller. Then from then on, when I got in we had by that time assembled some senior people in the control room and by 20 after 7:00 --

Mr. Cheney. Who else, in addition to yourself?

Mr. Miller. It was myself, Mr. Ross, who's the operations supervisor, had come over from Unit 1.

Mr. Cheney. These people work for you?

Mr. Miller. Yes. They are senior people.

Mr. Zewe. They had been there already. Almost everyone that we needed for the site emergency team were already there, before Gary arrived. They had been called in to help support us prior to the site emergency. The unit superintendent was there. The unit superintendent, technical support. The health physics supervisor was there. Various engineers in support capacities. Other shift foremen and other shift supervisors had been there anywhere from an hour and a half to a half hour up to this point. And once we declared the site emergency, I would say nine-tenths of everyone that we needed was already right there.

Mr. Cheney. Then at this point are you beginning to get concerned about radiation off-site?

Mr. Miller. Yes. At that point you are into the emergency plan which puts the organization into another status, essentially. When I came in and took the control room, then I put senior people in charge of various areas.

Mr. Cheney. So when you arrived, you took control?

Mr. Miller. That's right.

Mr. Cheney. And were you in control up to that point?

Mr. Zewe. Yes.

Mr. Weaver. Were you worried about so many people being in the control room?

Mr. Miller. The ones I didn't want, I threw out. We run emergency drills every year, and I run those drills. When I got to the control room, it was 7:15 in the morning, the radiation indicators were escalating -- that's the best way to put, and they were on everywhere.

I just took -- and I took one guy at a time, and I said, "You're in charge of that," and I put Mike Ross in charge of this. I took one other guy and I put him in charge of reading the emergency plan. I took one other guy and put him in charge of making all the calls. Another guy in charge of the technical support. And I had a B&W representative there, and bwl8

once that got going, we started making the calls.

The only concern I had was to get all the calls started, things like accountability, getting all the people on-site from various places and getting their name and number, make sure you've got all of them.

Getting all the off-site agencies on the phone. Getting the NRC on the phone.

The biggest thing is getting teams out there with radiation monitors. The whole emphasis shifts to founding out what you are releasing.

Mr. Cheney. This then becomes very automatic, in the sense that you have a very detailed plan all laid out?

Mr. Miller. It is very automatic.

Mr. Cheney. There's a small amount of judgment?

Mr. Miller. That's right. In other words, once you start making calculations, you know the wind speed, you know the source. You start getting people out to take radiation readings. You start talking to the health physics people who work for the state and they're EPA guidelines and action levels and a plan that define what you do.

Mr. Weaver. The next day, Thursday, we had a hearing where the NRC Commissioners appeared, and they mentioned that there was some release of radioactive materials that surprised them. They said these surprises occurred; they weren't informed of them. Can you elaborate on that? What is this building outside?

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MR. MILLER: The auxiliary building.

MR. WEAVER: That sort of thing. What releases did you have to make and why did you make them?

Mr. Miller. I have had a chance to look at some of those words too. I don't know that the word "surprise" is a proper one. We had the reactor building dome monitor which is a radiation indicator inside that dome, went to very high readings.

Mr. Weaver. What did you think of that? The high reading on that dome monitor?

Mr. Miller. I just didn't think about it in terms of fuel damage. I knew that it meant there was a potential to release things off-site. My only concern was to get readings.

Mr. Cheney. Did you have any question about the values of those readings?

Mr. Miller. I thought it was too high, but I didn't need to be convinced that it was high enough to be concerned. It was reading 40- or 50,000. I mean that was beyond what I had ever envisioned ever seeing on the dome monitor, so you can discuss whether there was shielding and moisture and whether it was beta radiation, and all that sort of thing.

But I did not need to be convinced. What I really wanted was somebody out there with a meter and an iodine kit sampling, and the wind direction. That is real numbers. That is really what someone is going to get out there. So that was our

bw20

concern,

From 7:30 on, quite frankly, we had a hot line to the Region 1 office of the NRC. From 10:00 o'clock on, I had five of them on-site, three in each control room. And I was willing to take advice and consent from anybody. There were no surprises, but the situation was a very serious one.

We didn't at that time have the thing terminated, we still were pumping HP water in and pumping it onto the floor of the reactor building. Still did not have the reactor coolant pump running.

Mr. Cheney. You're saying the pressurized valve was still open?

Mr. Miller. No, it shut, but now I have a void in the system in the hot legs, and I have no way to go, other than just keep pumping HP injection and try and cool the steam generator.

Mr. Cheney. So how is the water then getting out of the reactor vessel?

Mr. Miller. We were letting some of it out at that point.

Mr. Cheney. Trying to get of the void?

Mr. Miller. No, just trying to pump it across the core to make sure we have the coolant c[illegible]ered. That was the goal.

The same thing we haven't mentioned. The Bravo steam generator had been isolated by the operators because of that cold water injection, we suspected a leak in that generator had occurred, so we only had one steam generator, the alpha generator, and so we were steaming from that generator, pumping high-pressure injection water out of a 500,000 gallon tank into the reactor itself out onto the floor.

Looking back, we had a superheated condition in here and we had to have 4000 pounds to go solid. We could not get to that point, so our goal was just to keep cooling and pumping, and we tried various methods from there until eight at night, to collapse the voids.

Mr. Cheney. But you knew then that you had voids?

Mr. Miller. I know I had hot bubbles in hot legs at 10 after 7:00.

Mr. Weaver. Were you telling this to the NRC? Was somebody telling this to the NRC?

Mr. Miller. Yes, sir.

Mr. Weaver. What you've described to me sounds like, my God, this is on Wednesday really bad, and you knew it?

Mr. Miller. Yes, I knew it. I was talking to the NRC and to B&W, and I formed a senior think tank of my best people. That's why I did that, and every half hour I walked into a room that he talked about, and we sat down and said, "Where are we going next? Is the core covered? What is the readings off-site?" We were talking to the health physics people in the state from two phones, giving them readings.

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By noon, I had not had any readings. I had nothing even near an EPA guideline. My interest on, from 8:30 on, once the emergency plan was fully implemented, and I've done it four times, was to somehow get the stability to an operator, is a reactor coolant pump running, because you can permanently cool the core. That is where we were.

Mr. Cheney. But you say at 7:10 in the morning you knew you had voids?

Mr. Miller. At 7:10 in the morning, I knew I had bubbles in the hot legs, these two legs above the pressurizer, because the first thing we did was try to start the reactor coolant pumps again. The pump would energize, the current value would be one-sixth of normal, which meant it was pumping steam.

Mr. Zewe. But we did not know how large we were, or that the core was partially uncovered.

Mr. Miller. There's no indicator. I also had -- time is a hard thing, but somewhere early in this frame, I had an instrument engineer read. There are temperature indicators there inside the vessel, and we could not read them on the computer. We read the base voltage single down at the panel, and they indicated numbers like nothing, 200 degrees, 2400 degrees, which meant the core was very hot. If you believed them.I had no consistency, but I believed we were hot. I believed the core was covered at that time. And we had hoped just to pump water in, until we could get down to where we could a system like decay heat. So we, between the hours of 7:00 and 9:00 on two separate occasions tried to start reactor coolant pumps. We did not get any flow indicators, which meant there was no water in the pump.

Mr. Weaver. How did you finally get the water in there?

Mr. Miller. We just kept pumping water in all day and around the middle of the afternoon, well, we discussed this, the five senior people or four that I was using, so that I did not hamper the operators, we sat in a room and took all the suggestions, including anybody else that was there.

The NRC was on the phone. We weren't in a procedure that we'd never been in; we weren't scared. I didn't think we should evacuate the whole county, but I had 500,000 pounds of water, I knew I could pump all day.

I just wasn't at a stability point.

Around midday we came down in pressure, because you have a set of so-called "core fed" tanks that come in through two separate nozzles on top of the reactor vessel, and some of the operators had discussed it, and we decided to come down. In our mind, we thought if we got down, we could, number one, have some level indicator on the coverage, which would tell us that we were sure it was covered.

You can see we don't know how much heat we were going to get, but we were going to try. There is no level indicator on the legs, so you're going on pressures and temperatures, and you're trying to be sure your cold temperature is pegged low, your hot temperature is pegged high.

The amount of indication you had made it so you couldn't totally convince yourself the core was covered, and that was our concern, knowing that the emergency plan was working.

There was a lot of other dialogue going on with respect to the emergency plan and decisions about moving people, and my own people, when do I send them home, where do I send them going around the site making sure nobody was there, because the wind was blowing very slow, so the highest radiation was on the site, so I was trying to make sure nobody was on the site.

At the same time I had off-site teams on, and, for instance, when I got there at 7:30 in the morning, the wind was blowing towards Goldsboro, which is across the river. It is a long drive at 7:30 in the morning. In Harrisburg, I got a State Police helicopter to come in and take those people over there.

At the same time coming back to the plant, trying to just keep the core covered was our goal.

Later on in the day when we got rid of it, we pumped enough water in and go enough coolant to where the alpha loop, the A loop, should us that it was beginning to collapse.

Mr. Weaver. The steam bubble?

Mr. Miller. Yes, and we could see that with the

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temperature indications.

Now at the time in the middle of the afternoon, as I remember, we had problems with some pumps, oil pumps, to the reactor coolant pumps. We had no oil pumps, so then we couldn't -- you know, you take a chance on wiping out the pump, if you start it without an oil pump.

So we were working on that to somewhere that evening, early in the evening we did get an oil pump back. We did start a reactor pump up.

Mr. Weaver. You say the oil pumps failed?

Mr. Miller. There was a power problem. The supply to them was tripped, the breaker was tripped.

Mr. Weaver. They are not on diesel?

Mr. Miller. No. Everything was hybrid. In this auxiliary building things were hot, and I had to be careful. We had been very careful who we sent where, and plus you had to put all the gear on and serve into the area, try to make sure we didn't overexpose anybody to a degree for something you didn't have to do. That kind of thing, which eats up time and eats up decisionmaking.

But finally that night around 6:00, or I guess 8:00 o'clock, we got a pump started, a reactor coolant pump started.

Mr. Weaver. And that is because you just kept putting water in then until you got it primed?

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Mr. Miller. That's right.

Mr. Cheney. Then, so you got back to a much more stable situation?

Mr. Miller. You're back to a condition, you recognize the pumps are running. You know it's got a flow. You are -- in a condition where you can begin to go to the next safe level.

Mr. Cheney. But you've still got a bubble in the reactor.

Mr. Miller. By that time at night, we probably had collapsed most of the voids. We probably had seltzer water, a lot of air in the water, a lot of steam in the water, that type of thing.

Mr. Weaver. The hydrogen bubble comes later.

Mr. Miller. We probably had it then, but we didn't know it.

Mr. Zewe. We weren't making any more at this point in time, though.

Mr. Weaver. There was an indication or implication that you purposely released some radioactivity, because of the problems you had here.

Could you clear that up for us?

Mr. Miller. No. You've got to remember that during the day when we were supporting this primary system, we also had some water going in and out. In other words, you had some water you're trying to put in, you're bringing some out.

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Mr. Cheney. But it's all inside the containment vessel?

Mr. Miller. But some of the water comes to a tank that's outside, and that is probably releasing some fission product gases that go into the ventilation system through charcoal filters.

Mr. Cheney. But is that water in the auxiliary building? Was there any transfer there after the sump pumps were shut off?

Mr. Miller. No, except that you have -- the reactor coolant pumps have seal injection, for instance. That is a water seal on the pump that returns to the auxiliary building.

You also have letdown that returns to the auxiliary building.

They would have probably been bringing some fission product out, which would have been offcast and gone out through -- It is designed to go out through the ventilation system through charcoal filters. So not purposely but by design, some of that would have gotten out. And you have to remember we had we had radiation areas all over the auxiliary building. I mean you would open a door, it would be 300-R; you open another door, it would be 25-R.

We were running around that day, knowing we were releasing. We running around putting polythene down on the floors, trying to minimize overexposure. Now you've got a lot of exposure in guys to put a suit on, put a respirator on. It is a pretty detailed and hard thing to do.

We were trying to place piping diagrams to figure if there was anyplace we were releasing that we didn't know about.

The plant is designed with charcoal filters, so the part that's going to the ventilation system is not our major concern, our concern would have been, "Are we leaking anywhere else?" We made a survey of that building with an operator and a shift supervisor. That type of -- and it's going on at a fairly high frequency, and a lot of activity.

Mr. Weaver. Now the leak is coming from the auxiliary building. No place else. Is that correct? The stuff that did get out?

Mr. Miller. There's nothing out of the reactor building that I know of. The reactor building was isolated.

Mr. Cheney. Except for the water.

Mr. Miller. Except for the water supporting the system. We did not want to lose the seals to this reactor coolant pumps, because that was one of our ways out of this. So we did support the seals which would then bring some water back. We were also probably letting down some water.

Mr. Weaver. But that's going to the auxiliary building?

Mr. Miller. That would go into a tank in the auxiliary building which vents to a pipe that gets exhausted through the charcoal filters.

Now we could not go everywhere in the auxiliary building. We could have had leaks.

We were taking action to stop the release. The kind of action putting poly on top of the water, because we thought some of that water might have some fission products, since we thought by putting poly over the top of it, we could minimize the operation.

That is the kind of stuff we were trying to do in the, but there was an awful lot going on between the emergency plan, between that, and that is kind of where we were going through that day.

Mr. Weaver. And the NRC's being apprised of all of this?

Mr. Miller. We were on the phone, to my knowledge, from 7:30 or 8:00 in the morning, we had a hot line to Region 1, which is in King of Prussia.

By 10:00 we had five of them. We probably had 10 or 15 of them there by evening. And, in fact, I know most of them, and were asking their advice internally and technically. But it was clear that it was my decision. It was clear to them and clear to me.

Mr. Cheney. How does that set of relationships work?

Mr. Miller. Very directly, I gave them my radiation data, my off-site data. I told them the status of the plant, asked them for advice, and we very clearly knew that I had to make the decisions. But it wasn't a conflict-type relationship, it was a direct type of relationship.

Mr. Weaver. Help me to understand this. Listening to you for the last half hour, there is an enormous divergence, at least from what I have heard, between high-level NRC people and their view of what was going on at Three-Mile Island, and what you've described.

And so I'm wondering, is this a communications gap? I mean, they just didn't see the urgency, apparently, that you describe.

Mr. Miller. The people at my level. The technical people, the principal inspector for the plant, the people that came into the plant. I know most of them, because I've been around in this business awhile. We know we had a serious situation. We knew we were releasing, but we also had data from everywhere on the site. Data from all the places the wind had blown. We didn't have an incident, in our minds, that required like evacuation or closing the area. We did not have that. At this time that we had a serious problem, and we weren't out of it yet.

I don't know the communications within the state of the NRC. I talked directly to the health physics officer in the state through two hot lines. I talked to the Region 1 inspector. At no time was I told there was disagreement.

In a recommendation for action, at no time was I told to do something technically that I did not evaluate. There were no disagreements.

Now there is a gap that I don't understand. At the same time

I was talking to my own manager, and they knew what I was doing.

Mr. Cheney. There is a sense from the NRC, in looking at the transcripts of those days, that they were at a loss to know what was going on and what was happening.

Mr. Miller. If I went on to say anything else, I would be giving you my opinion. I will give you that, but I don't think that's what you want.

Mr. Weaver. Why don't you, if you don't mind?

Mr. Cheney. What we're curious about, I think, primarily, is how, once the crisis has occurred -- the accident has occurred -- how we go about managing the current event.

Are we talking about a problem here that arose because you didn't have any information or accurate information about what was going on inside the reactor and, therefore, they were puzzled, or because there was some kind of communications problem -- gap from what you had and what they had?

Mr. Miller. I knew exactly what was going on. I didn't know how to get out of it, but I had not been in this situation, and did not ever imagine that I would be, but I had no panic. There was no panic in the control room. We all knew what we were doing, and I stayed out of his hair.

The direction was coming from me. I knew all the radiation readings. I knew I had a hell of a problem. I was talking directly. I had an emergency plan. That emergency plan I practiced one a year. I talked to Jurusky and Maggie Valli. Those are the health physics people for the state.

So I was communicating with people I knew about things they knew about. I don't believe that communciation had ever been attempted to the senior levels.

You see the president of my company probably had the same problem, but he knew that I was trying to do this, so he didn't ask me what the hell I was doing.

Other people -- I was sitting in the control room, and I heard the NRC people trying to explain to their home office what was going on.

People at my level, they just could not understand.

Mr. Cheney. You dealt with the NRC people on your level?

Mr. Miller. And there was a hot line to the Region 1 office.

Mr. Cheney. Did you ever talk to Bethesda Headquarters of NRC?

Mr. Miller. Not that day. I did it through anybody I could, because the number of questions I was answering and the number of decisions I was trying to make were, you know, the frequency and the magnitude of this thing went by like, it was kind of stressed. It was very complicated. I don't know how to describe it. It was just 10 hours of hell, as far as keeping your focus, and I would not let myself get on the phone and lose focus. That is just not the way I'm trained.

Mr. Weaver. How much radiactivity was there in the control room?

Mr. Miller. There were periods of time that we had respirators on. I had my head physics guy, who's experienced. He came out of the Naval program. When we got above, I guess, MPC --

Mr. Weaver. What's that mean?

Mr. Miller. That's permissable concentration -- we put the respirators on. If the wind stopped, which it did that day, the wind blew. If you had to imagine this scenario from a side standpoint, the wind did not blow that day very much. It would go up to 10, to 20, to 30, and come back down.

Mr. Meyers. What? 30 what?

Mr. Miller. Millirem per hour. Part of your emergency plan is to break out your dosimeters and kits. We have a meter up there. We have a pocket dosimeter you can read. You could read a temporary device that is not totally accurate, but it is a good indicator of whether you are getting too much.

Most of the time, for instance, the emergency control center in Unit 1 became very high. High to me being probably 50- to 70 MR per hour, and we evacuated that and brought them to another place. We kept moving people around to get them out of this. No, we never got to a point where we considered evacuating the

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control room, because we weren't that high. And the system in the control ventilation system has a recirculating ability where it goes through filters. You should be able to live through this.

Mr. Weaver. What would happen if the control room had gotten so hot that you would have to evacuate?

Mr. Miller. That would be hard to imagine.

Mr. Weaver. I will ask you that next.

Mr. Miller. You would have to go to a separate panel, where we have some indication, vital indications, and operate from there.

Mr. Weaver. You can operate someplace else?

Mr. Miller. You can operate some basic parameters from another room.

Mr. Chaney. Where's that.

Mr. Miller. It is a cable room below the control room.

Mr. Zewe. Right underneath the control room we have an auxiliary panel.

Mr. Miller. I might say again that the control room venitlation systems goes through charcoal filters, so we could have gotten up to the radiation level in there, and we would have circulated and that should have removed it.

Now, if we had some situation that says evacuate the control room, we would have gone down below, that would have made it harder. Now we have a little less indication

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and a lot more places to run and look at things, but that could have been done.

Mr. Cheney. Is that room sheltered within the control room?

Mr. Zewe. Not really.

Mr. Miller. It is a different location. It might have less radiation. It is in a different room.

Mr. Weaver. If both were impossible to stay in, then you have no control anymore, although the plants still could possibly go into cold shutdown all by itself, couldn't it?

Mr. Miller. I would not leave the control room in this situation.

Mr. Weaver. I understand.

Mr. Miller. You can't get me in a situation where I would leave. You could not walk away from this thing, and say it's going to shut itself down. It wouldn't do anything immediately. You would have to make provisions to get back in later. That would be your goal if you had to leave for some reasons; but you remember none of us had experienced very significant radiation doses. If you look at our film badges, we got hardly anything, so I could have stayed up even if the reading had gotten pretty high. I would have stayed up there for a long time and switched crews to minimize health risk.

That would have been the way I would have gone. I would have never left the control room from a radiation standpoint.

Mr. Weaver. I understand. Now the possibilities of the control room getting that hot are not very strong; are they?

Mr. Miller. I don't feel they are, because the system is designed with charcoal filters and ventilation and recirculation. In other words, we are releasing and it is laying on the site, because there is no wind.

This system is designed to go into a recirculation internally, so you don't pull that in from the outside. That's why I'm saying that.

Mr. Weaver. Oh, you're pulling radioactivity in from outside, so when there's no wind, you're getting more in the control room?

Mr. Miller. Except you go into recirculation, and you don't have to. In other words, normally the air intake sucks from the outside on the site. It is a cement thing which is designed against airplane damage. If we're releasing radioactivity and it's going on the site, which is what happened to us that day, and we would have stopped that and gone into recirculation, but we did not have to pull out there, and it would have helped us minimize it, and we did that.

Mr. Zewe. We were on that from almost the beginning of the problem from site emergency.

Mr. Cheney. Would it be fair to say that if it got hot enough in the control room, so you had to evacuate, that you

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you were already beyond the hand of what's happening in the containment vessel?

Mr. Miller. I guess so. You could imagine me into that, I guess. I would not leave.

Mr. Cheney. Well, I am not suggesting you would have. I understand that. If the dose were high enough --

Mr. Miller. But I cannot imagine it getting high enough, so that I couldn't switch crews often enough to keep people in there.

Mr. Cheney. Even if the containment vessels ruptured?

Mr. Miller. I can't, no. If the containment vessel ruptured, I would rather stay there, because I would think I was safer right there.

Mr. Weaver. I'm trying to prevent a core meltdown, you see. I'm not concerned about core meltdown. I'm trying to understand, can you get that kind of radioactivity without a core meltdown?

Mr. Miller. No.

Mr. Weaver. Well, once you get core meltdown, you're done anyway.

Mr. Miller. I don't even know if that's true.

Mr. Weaver. My point is, I'm trying to prevent a core meltdown.

Mr. Miller. So was I. In the scenario you're describing.

Mr. Weaver. And I'm just trying to see if you get the radioactivity in the control room at such a level.

Mr. Miller. The control room design is that if one of these pipes breaks doubled-ended with fuel damage, you get radioactivity in that building in a very high level -- you get 60 pounds of pressure, and you can live up there in that control room and control it. That's the way the design is. That's why I'm saying that.

Mr. Weaver. I don't understand that.

Mr. Miller. The plan is designed so that if one of these big pipes falls down, the plant goes to -- this big building goes to 60 pounds. You have radiation in the building, and you stand outside the building in that control room and cool it down.

Mr. Weaver. It's containing the radioactivity?

Mr. Miller. Right. It's containing it, and it's designed to leak a very small amount like .1 percent, and you actually test this building at that 60 pounds every three years, and what I'm saying is you can stand outside in the control room.

That is my basis for saying that,it just isn't my gut feel, it's my basis from the design.

Mr. Chaney. If you would like at the whole accident at this point, when we talk about in terms from our perspective, trying to ascertain whether we've got the incident resulted from design error, for example, you might look at the fact that you can read the pressurizer level and get a wrong conclusion from that pressurizer level as to how much water there is in the reactor, that that might constitute a design error, where you've got mechanical errors like the pressurizer valve fails to close, how do you assess at this point recognizing it is a subjective judgment as to where the fundamental flaw was that led to this particular accident.

Mr. Miller. In my mind, it was just that the operator did not have enough information.

Mr. Cheney. Is that a design error?

Mr. Miller. In my mind, it is.

Mr. Cheney. The system failed to provide them with enough information.

Mr. Miller. The way I look at it, if these operators had shut that valve at 5:00 o'clock, that would have never happened. They would have been just as lucky as they were unlucky. In other words, they needed more information in my mind, and I don't say that from a selfish standpoint. The guys looked at -- you look at the computer printouts. They kept looking at the discharge temperature on that pipe, which means they were looking for a problem.

If there had been a flow indication or a more positive temperature indication, they would have shut the valve. But that is also said as an operator.

Mr. Cheney. Do you have any idea why the temperature indication on the tail pipe off the pressurizer valve gave the wrong reading?

Mr. Miller. The only thing I can come up with is an external thing on the pipe, and possibly due to the amount of water being shoved through that valve, they might have some, due to expansion, some cooling actually occurring.

Mr. Cheney. Discharging cooler water?

Mr. Miller. Well, the expansion across the valve could have caused some cooling physically. I haven't looked at it enough.

Mr. Cheney. But you see that as the fundamental flaw?

Mr. Miller. Personally, I think he just didn't have enough information. He was looking for more information. If he had had a little more information about that valve and that pipe, he would have shut the valve.

Mr. Weaver. Let me ask you this. In one instance we have an instrument malfunction, in effect, when you didn't get the reading that the pressure valve was open, right? In effect, it was an instrument malfunction?

Mr. Miller. Do you mean that the signal said it wasn't closed? It was closed.

The thing you've got to remember is that light is only -- it is not actual --

Mr. Weaver. I understand that. Nevertheless, you're doing your damn best, but the information you're getting was wrong.

Mr. Miller. The information he is getting is not telling what is going on.

Mr. Weaver. That's what I'm saying. When I say an instrument malfunction, I mean you're being sent the wrong signal.

On the other hand, you've got a correct signal from the pressure charge containment when you've got that 28 pound spike. So on one you believed the system and on one you didn't believe the system.

Do you follow me?

Mr. Miller. Well, let's look. In the afternoon, we had a pressure spike. The pressure spike was instantaneous. It happened very quickly and then it went away. And there was no difference in any of the system parameters other than that. We didn't see anything that would have knocked that up. We did not see anything that told us that the building had a pressure in it.

Mr. Reis. Are there other instruments that you would have looked to? If you had been watching it, would you have seen that? Or are there other permanent instruments that would have shown that, that could corroborate?

Mr. Miller. Normally when you see -- and Bill, you can say if you disagree with me. But if this building pressure instrumentation is to look for a pressure in the building which normally occurs due to the energy release when the water is freed through a pipe break, that normally occurs over a period of minutes and hours.

Now, looking back, everybody's saying, hydrogen burning. Yes, I understand it now. But at the time we would have looked for a physical break or a physical problem in the system, and we saw nothing. So therefore we said, all right. That's not unusual to see instrument error.

I don't want to get into how many instrument errors you have. But it was the only thing we had and it didn't get fouled up and we did not have any other indicators, and that is why.

Mr. Reis. Would you have, given what you knew at almost 2:00 o'clock, did you know enough about perhaps the condition of the core that you might have thought hydrogen was around? Why would you not have? And I don't mean to indicate that you should have. But why would you not have thought, hmmm, maybe that was hydrogen, maybe there's hydrogen in the containment?

Did you know enough about the core situation at that time to suggest hydrogen?

Mr. Zewe. I was monitoring the reactor building pressure at the exact instant that we were cycling the electromatic relief valve. Fred, I believe, was actually waiting to operate the valve, based upon my command. And I was looking at the RC pressure. We were trying to not exceed four pounds in the building and have isolation at that four pound value, when the pressure was somewhere around two pounds.

So Fred was cycling the electromatic valve. And I said, all right, Fred, open it now. As soon as he hit it, that instantaneous spike came up and came right back down. At that point, the building spray pumps started, too, and they started on a 30-pound signal.

So we all considered this for a couple of minutes on why we had that spike. No one knew. At that point I did not know that we had got as hot as we did as far as the reactor core goes. It takes at least 2200 degrees Fahrenheit to have water reaction to release hydrogen, to have it in the containment.

If we had known -- and I didn't at this point in time, nor did anyone that I was with, and there was in the neighborhood of eight to ten people that had seen that, too -- we didn't know that the temperature was that hot. The highest temperature that I had seen was about 780 degrees. That was the highest temperature I knew of, which was far below the point at which we could have the zirc-water reaction for the release of the hydrogen.

And since we had just operated an electrical valve, we thought that there was some way that we malfunctioned and caused an electrical upsetting or imbalance to affect the pressure indication.

Mr. Cheney. What is it you operated that led to the spike?

Mr. Zewe. The electromagnetic relief valve, the same one that stuck open. We were cycling it open to reduce the pressure in the reactor coolant system and sent it right to the RC drain tank.

Mr. Cheney. Are we working with the safety valve that we think malfunctioned or are we downstream?

Mr. Zewe. No, on that valve itself, the valve that had failed open. We had unisolated it and we were opening that valve up, cycling it to reduce the pressure in the system and venting it right into the containment.

Mr. Cheney. But I'm curious as to whether you were using the backup valve.

Mr. Zewe. No, the automatic valve that had failed.

Mr. Cheney. Is now working?

Mr. Zewe. We could still operate it from the console. We could open it up, but it would not shut all the way. Even on command, the valve would not shut completely. We could open it up, how far open we don't know. But we could open it up.

So we had unisolated the valve that we had shut previously to block it. We opened it up, and then we opened up on our manual control for that valve, to reduce the pressure. And the instant he did that was when we had the spike.

Mr. Cheney. In retrospect now, would that look like that was as a result of releasing the hydrogen?

Mr. Zewe. I think the hydrogen was already there, and that spark from the electrical solenoid provided the ignition.

Mr. Weaver. It is inside the containment?

Mr. Zewe. Yes.

Mr. Miller. The electrical energy he used to open the valve might have sparked it, which would have ignited the spark to the hydrogen, looking back.

Mr. Zewe. But we didn't know why and we did not suspect hydrogen at a high concentration at that point in time at all, because we did not know we had ever achieved those higher temperatures to create the zirc-water react on.

Mr. Cheney. You talked earlier about, when I asked you if you could sort of subjectively judge what specific event was most significant here, you talked about the lack of good information being available to the operators. Are there two or three things you would recommend by way of improvements on the reactor design that would have made life a lot easier that day?

Mr. Zewe. Yes. I would like to have actual limit switch type indication for that valve's actuation, so when the valve moves it trips a limit switch showing the valve is open, and when it shuts it trips a separate one saying that it is shut. The only light that we have right now is the electrical signal telling it to open or not to open.

Mr. Cheney. But that was put on after it failed once before?

Mr. Zewe. Yes, that was put on in '78.

Mr. Cheney. The fix was inadequate, in other words?

Mr. Miller. But that is because physically the valve is a canned valve and it would be very hard to get to it physically, without a different kind of designed valve.

Mr. Cheney. Is there any other thing you would like to see?

Mr. Miller. In my mind, you know, we were looking at something specific, so we were probably going to come up with specifics on that. But somehow look at maybe some more instrumentation as to what is going on in the core. From my standpoint during the day, it was hard, starting off with bubbles in those legs, to evaluate whether the core was covered, to evaluate it physically.

We did all of the things. We had the steam generator steaming. We had water going in. We did everything physically we knew how to do. But you know, you are still thinking whether that was covered.

Mr. Weaver. Well, it wasn't covered.

Mr. Miller. Yes, it was, during the day. Making sure.

Mr. Weaver. When it was covered, you didn't know if it was.

Mr. Miller. From 7:00 in the morning to 8:00 at night, with increasing radiation readings, convincing yourself that that was covered was hard.

Mr. Reis. When did you know that it had been uncovered?

Mr. Miller. I don't think I ever realized it until the next day.

Mr. Weaver. But you were worried it was uncovered.

Mr. Miller. I was worried that I wasn't keeping it covered from 7:00 in the morning on, same as he was. I was worried until we got to a stable point, which would be a pump running or decay heat. Those are the points that are stable and known to be stable.

Mr. Scoville. If you had known about the hydrogen at the time you saw the spike, how would your procedures change? What would you have done differently?

Mr. Miller. I don't think I would have done anything differently, to be honest with you. One of our consultants the next day told me that was the best thing that happened, was we were burning it up in that condition, because otherwise you would have had one heck of a problem figuring out what to do with it. You just can't get rid of it.

Mr. Scoville. This got rid of it?

Mr. Miller. This got rid of it. I could have seen us talking for two weeks on how to get rid of it.

Mr. Weaver. So in other words, you started to get lucky?

Mr. Miller. I don't know if that's the right word. Somebody said, if you had known. I don't know what I could have done. I don't know what I could have done different if we had known there was hydrogen in the building. We would have probably gone and deenergized all the electrical breakers we knew of. We would have probably minimized any electrical equipment starts.

It would have put another variable in the problem and made it more difficult.

Mr. Weaver. That indeed is what we did do.

Mr. Zewe. We would put in the hydrogen recombiner to reduce the concentration.

Mr. Miller. But that takes a longer time.

Mr. Weaver. Did anybody think, when you had the hydrogen bubble, of burning it?

Mr. Miller. Do you mean after?

Mr. Weaver. Yes. We've got the hydrogen bubble in there now.

Mr. Miller. You mean after the next day?

Mr. Weaver. Yes, Friday morning.

Mr. Zewe. In the core or in the building.

Mr. Weaver. I'm sorry. Forgive me, Jim.

Mr. Cheney. You talked about knowing whether or not the valve was open or closed, and the water level inside the reactor.

Mr. Miller. More indications in the vessel, because in my mind -- and Bill, you can disagree from your experience. But in my mind, we never imagined the core becoming uncovered.

Mr. Weaver. Before.

Mr. Miller. That's right. Now we end up with bubbles in those hot legs and the core was uncovered, and we know that today. And we ended up in a situation trying to collapse this thing and go solid. And the indication available to go from where I started to where we ended up was a design -- the only thing I can think of is more indication of what you had in the reactor.

Mr. Cheney. Do you have a lot of familiarity with other kinds of pressurized water reactors?

Mr. Miller. Some. For instance, the submarines are pressurized water. The carriers are pressurized water. The cruisers are pressurized water.

Mr. Cheney. Is their design better than this one from the standpoint of managing this kind of problem?

Mr. Miller. Well, number one, a submarine is like a tenth of this thing or less. And number two, the pressurizer is higher than the loops in most of the ones I know of.

Mr. Cheney. Is that a significant factor?

Mr. Miller. To an operator, we probably would like it higher than the loops, physically higher.

Mr. Cheney. Because you're less likely to be able to get --

Mr. Miller. If you're going to get a bubble, it's going to get there first if it's highest.

Mr. Cheney. I thought that was the theor, behind this one?

Mr. Miller. That is the theory behind this one, except when you get those candy canes higher than the pressure reactor, once you get the bubble outside that pressurizer and get it in those candy canes, you are going to have a hard time, with the pressurizer being lower, ever getting it back.

Mr. Cheney. I would call that, then, a fundamental design flaw.

Mr. Miller. But you asked what else I would do. One of the other things is put vents in those candy canes, so you could vent it off. And in fact, I think Duke has those vents, I have learned subsequently. But they weren't put there for that reason; they were put there for another reason. But they would have helped.

Mr. Cheney. Is that also a B&W reactor?

Mr. Miller. Yes.

That would help us. We had no way of venting the system. If we could have vented the highest point, we could have filled it up with water to that pump and run the pumps sooner.

Mr. Cheney. But obviously nobody thought of this when it was designed.

Mr. Miller. Starting out, nobody thought about us getting to there.

Mr. Zewe. We have vents and everything. But that is just manual valves operated from inside the containment itself.

Mr. Cheney. There's nothing you can do from outside?

Mr. Zewe. That's right, there's nothing you can do from outside it to operate it.

Mr. Reis. Well, we've heard that a fundamental flaw dealing with the pressurizer outlet or inlet coming off, that is so low here and you end up with a problem. Do you think just having the level indicators in the core would take care of that, or is that more fundamental than you would be able to get around with the level indicators in the core.

Mr. Miller. I don't mean to say not having level indicators in the core is a design problem. The question was asked, what would I have liked to have had in order to get out of this, and I would have liked to have had more instrumentation over where the water level was. I didn't say it was really a design flaw.

The other problem is probably more fundamental, if you agree to this. It is a design flaw -- I just haven't thought about that. It is just something I would rather not say without thinking on and looking at the whole system.

Mr. Weaver. And we don't mean to have you characterize this.

Now let me go over this again. You styled the earlier situation as unlucky, and then you had a burn, probably triggered or possibly triggered by the spark when you sent the signal to open the relief valve and the burn occurred as what was a good thing to have happened. So you got lucky.

Mr. Miller. I said one of my consultants styled it that way. Like Bill said, we didn't imagine the zirc-water reaction. Had we known the building had that much hydrogen in it, then that would have been another hard variable to deal with.

Mr. Weaver. Now we're down to where you've got a hydrogen bubble. Would you describe just very nerally --

Mr. Miller. Let me say one thing. The hydrogen bubble that I think we're talking about--subsequent to the first days, this first day or day and a half, now we ended up with a reactor coolant system pressurized with some hydrogen on the dome of the head, not in the reactor building. The burn occurred in this building. The burn occurred in the building.

Mr. Weaver. Of course it did. I keep forgetting that.

Mr. Miller. The hydrogen bubble that we're talking about is in the top of the reactor vessel.

Mr. Weaver. The burn occurred in the containment.

Mr. Miller. That's right.

Now, the next days we had this hydrogen bubble within the reactor vessel. And by this time, we had also assembled a pretty sizable amount of technical competence from outside to help deal with that.

Mr. Weaver. Would you briefly describe, then, what you did to try to handle the hydrogen bubble in the reactor?

Mr. Miller. In all fairness, you should get that description from a lot better qualified people than me. But what we did, basically, was, number one, we used the pressurizer, we used the physical parts of the system to calculate the size of the bubble. And then, by spraying water into that pressurizer, we were able to spray it, get it to dissolve in the water and get it out in the water and vent it.

Mr. Weaver. You're spraying inside?

Mr. Miller. In other words, if you get a pump running inside you can strip it off. It is soluble to some extent in water. And you can, by spraying in the top of that pressurizer, you can strip some of it off and then vent the pressurizer off slowly. So then you can take it out of the system.

Mr. Weaver. You're taking it out of the core, into the pressurizer.

Mr. Miller. And into the reactor building.

Mr. Weaver. Is this dissolved hydrogen you're taking out of the core?

Mr. Miller. You dissolve it. That's part of the design of the system.

Mr. Zewe. You put it back into the water, and then you spray it and it comes out of the solution again, and then you vent it.

Mr. Miller. In other words, you take it, you get it in solution in the water which is going in the pipe, then you spray it in the top of this vessel. Now you've got it into steam space, and then you vent the steam space off, and that takes it away and puts it in the building.

Mr. Weaver. And that's actually what you did?

Mr. Miller. That's what they did.

Mr. Scheimann. The more you take off through the steam space, as the water comes back into the reactor vessel, the more you can absorb from that steam space in the reactor vessel into the coolant and then back up to the pressurizer.

Mr. Miller. And you can, by taking the water level and an inventory of the system, you can calculate, because the gas acts different than steam, you can calculate the size of the gas bubble, which is what we did. And we were able to calculate it was gone, essentially by that method.

Mr. Reis. How did you -- if it's up here in the head of the reactor vessel, how did you get it into this pipe?

Mr. Miller. We were circulating water.

Mr. Reis. So that was dissolving it.

Mr. Miller. You dissolve it in the water and it goes with the water. And as you spray, that tends to physically strip it off.

Mr. Weaver. By "strip it off" --

Mr. Miller. It comes back out of solution, like a steam bubble does.

Mr. Weaver. You're putting it into solution, you're dissolving it by increasing the pressure.

Mr. Miller. The pressure-temperature relationship.

Mr. Zewe. Your water, for any set of conditions, will hold a certain amount of hydrogen.

Mr. Weaver. Sure.

Mr. Zewe. If I remove some of the hydrogen over here, when it comes back it can absorb more, and I'll remove it over here.

Mr. Weaver. I understand that. I just wonder, what were you doing to enhance the hydrogen dissolving in the water?

Mr. Miller. Just keep circulating and spraying. You keep venting it off, so now your ability of your water keeps removing it.

Mr. Weaver. So in other words --

Mr. Miller. Time. Time and venting it to the building.

Mr. Weaver. You could not increase the dissolving. There was nothing you could do?

Mr. Miller. You are physically limited by the ability of the system.

Mr. Zewe. You can raise pressure and force the gas into solution better. But then you have a physical limitation as to how high you would like to maintain pressure for the condition. So we held a pressure band which said, all right, at this set of pressure and temperature conditions the water could only absorb so much of the gas, hydrogen. But you had to keep degassing it.

Mr. Weaver. You had to keep the pressure in the core, because otherwise the hydrogen would have expanded.

Mr. Miller. That plus you want to physically keep the pressure there normally. I would tell you that normally this plant has hydrogen in it. We put hydrogen in it purposefully, because you have oxygen in the water, and with this reactor and the gamma flux in the reactor, by putting hydrogen in you keep that oxygen down. It keeps corrosion down. So you normally do run this plant with some hydrogen in it.

Mr. Cheney. Actually in the reactor?

Mr. Miller. Yes. All these plants do that to maintain low oxygen levels, because you see, water does disassociate in this reactor. So you get hydrogen and oxygen, and you get an excess of hydrogen to make sure you keep making water rather than make oxygen.

Mr. Weaver. Now there was some problem about you were putting lead up? The recombiners?

Mr. Miller. We were venting this to this big building, plus the waste gas tanks which were accumulating some of the gas that we were getting had a lot of hydrogen in them. And we put those into this big building.

Now the problem is, what do you do with the hydrogen in the big building? There is a device called a hydrogen recombiner that attaches itself to the ventilation system on that building, and you just take air out and put it back in the building, and this combiner takes the hydrogen and burns it and forms water.

Mr. Weaver. But what was your problem in doing that?

Mr. Zewe. You are bringing out this atmosphere, which is highly contaminated.

Mr. Miller. It's got xenon in it, for instance, which is radioactive.

Mr. Zewe. You're bringing it out to this unit, which is in the fuel handling building right next to the auxiliary building. So to keep from the increased radiation levels out here, you will shield the piping, the hydrogen recombiner itself and the lines going back in, so that you won't have radiation dosage problems to the people that are operating the unit.

Mr. Weaver. The reason you've got the hydrogen recombiner here without such protection is that you did not anticipate it to be radioactive?

Mr. Miller. It wasn't designed to be operated with the building -- with that many fission products in it.

Mr. Scoville. Was the recombiner down at the time of the incident.

Mr. Miller. The design of the plant is, you have so many days to hook it up and run it on a maximum pipe break with one percent fuel damage. If we had higher than that amount of fuel damage, with more fission products in the atmosphere, this shield had to go in. That is better technical detail.

We could have run it without the shielding. But we had to put some lead in.

Mr. Zewe. And it isn't anything that you have to have done right away. You can plan for this.

Mr. Thurber. Could I ask one question? Had you known, for example, from all these indications in that spike -- let's assume that there was hydrogen present. How would that have affected your notification to the state or to any condition relative to the emergency?

Mr. Miller. If we would have known that the hydrogen in the building, if I had known I had a lot of it?

Mr. Thurber. Yes.

Mr. Miller. It would have probably caused me to seek a lot more senior technical advice as to what to do with it.

Mr. Thurber. If you knew -- in other words, what I'm saying is, if you had real positive indications of hydrogen, would you have gone to the state officials in some sort of an alert situation and say to them that, we now believe that we have this, and let them make some judgment?

Mr. Miller. If I had known we had hydrogen in the building, then I might have, from my standpoint, made a different recommendation on evacuation, for instance, if I had known all that. But I would have told the state people what I was dealing with, that I had hydrogen in the building, also.

I would have, additionally, if I had the B&W guy there, I would have asked B&W to give me some idea of the percentage in the building. I would have been trying to put it into a percentage to understand what I had. If somebody said I just had some hydrogen in the building, that doesn't tell you enough. What percentage have I got? Is it 4 percent? 8? 18? That would tell a guy who knows something about hydrogen what the probability of explosion was.

And if somebody had just said they had some hydrogen, then the next question would have been to seek more technical advice. If we'd had a lot of hydrogen, then I would have personally said we should evacuate around the area.

Mr. Thurber. Are there any specs on that?

Mr. Miller. On hydrogen in the building?

Mr. Thurber. Yes.

Mr. Zewe. There is an explosive range for hydrogen and air. Hydrogen and air, from 4 percent up to about 94 percent, is explosive range. If you get purer than that, above 94 percent, hydrogen won't burn; lower than that, there isn't enough oxygen.

Mr. Miller. To my knowledge there's not a hydrogen specification for the building. This plant, design for a loss of coolant accident, you would expect some hydrogen. It is a long-term thing, though, and that is why the recombiner is there, to get it out.

Mr. Thurber. That's based on LC LOCA?

Mr. Miller. Right.

Mr. Thurber. That's not what we have here. Of course, we don't have a lot of things.

Mr. Miller. I don't have a specification covering it. But if I had had it, I would have used it.

Mr. Thurber. You would have had to make an independent judgment?

Mr. Miller. I would have made an independent judgment myself. But I was talking to enough groups that I would also listen to a lot of people.

Mr. Cheney. Do you have any idea what the capacity of the containment vessel would be in terms of containing, without significant leakage, a hydrogen explosion?

Mr. Miller. The containment building would have contained all the hydrogen we could make.

Mr. Cheney. In terms of explosion?

Mr. Zewe. It depends on what the pressure would be from the explosion.

Mr. Cheney. Do you have any idea what the stress factors are on the containment vessel?

Mr. Miller. I know the containment is designed for an earthquake. I know it's designed for a 707 going so many miles an hour hitting it. I know all that. I know it's got four foot of concrete. But I don't know about the explo.ion.

Mr. Zewe. I guess they could probably calculate what percentage hydrogen.

Mr. Miller. I don't believe that calculation's been made. I could be wrong. I just don't believe we have made that assumption in calculations that I remember in the analysis. We could find that out. But I'm not the guy to ask that question.

Mr. Zewe. We did not realize we had it until after we had burned it. So then, since we didn't add any more to it --

Mr. Miller. If we had to have hydrogen anywhere in the system, I'd rather have it in that big building.

Mr. Cheney. That's understood. But it seems to me that one of the risks in this particular accident--obviously, the containment vessel worked and there was no problem. There would have been if there had been a breach on the containment vessel.

Mr. Miller. That's true.

Mr. Cheney. If you had any kind of a breach at all, given the levels of radioactivity that have been measured internally, they obviously would have been very serious, and it strikes me that the most serious point in terms of potential leaks was that point at which there was the hydrogen explosion. That's the only time we came remotely even close, conceivably, to breaching the containment vessel.

Mr. Miller. If you had to pick a point where you came the closest, not arguing what "close" means, that's true.

Mr. Weaver. Let me ask you this. Can you see the flag? That's the Rayburn House Office Building across the way. Can you see the flag on it? It's right in the middle over there.

Mr. Miller. I can't see the flag.

Mr. Weaver. Well, it's right up there. I watch it frequently and I love it very much.

But during this period of time -- Friday, Saturday, Sunday -- my office is right up there. We watched that flag constantly to see which way the wind was blowing.

And I want to ask you this: Knowing everything you know, and suppose you had been -- you know everything, but you're not on this job. You're not involved with Three Mile Island, okay. But you are this knowledgeable, very knowledgeable, highly trained person. Would you have been as concerned? And your information is coming from the newspaper. The hydrogen bubble is in there and all.

Would you have watched that flag?

Mr. Miller. I don't know the answer to that. I just don't know the answer. I can tell you this. I have a daughter that lives ten minutes away from that plant and I never moved her.

Mr. Scheimann. My family also lives within 15 miles of the plant and I never moved them.

Mr. Weaver. Of course, you would have never left the plant yourself.

Mr. Miller. But I certainly would not hurt my daughter. That's the best way I can describe it. If I thought there was danger, then I certainly would have. If I had, in my own mind, from what I have been trained and known, if I had been sitting where you were -- my parents were calling me trying to find me because of the kind of things that were printed in the newspaper. I was inside, communicating what I thought was accurate information. But none of it got out.

Mr. Weaver. But you said yourself --

Mr. Cheney. None of it got out through the press?

Mr. Miller. The context that I read days later disappointed me.

Mr. Weaver. Well, there's no question about it that it is an imperfect system. It's hard to make judgments on that.

But you said a little while ago that if you had known that there had been hydrogen in the containment, that you would be more concerned.

Mr. Miller. That's right. It would have been another problem that day which would have had to have been assessed and had-to have been dealt with, and I would have dealt with it.

By 2:00 in the afternoon I had the ability to talk to people in Lynchburg or anywhere else, and I would have been talking to them.

Mr. Weaver. Now, the danger of the hydrogen in the core, in the reactor core, was that it could expand down below, push the water down so that it revealed the core; is that the danger?

Mr. Miller. If you had depressurized the system at that time, if you had dropped the pressure, then it would have expanded and possibly put a gas bubble over the core. And again, you would have had -- you see, it's still making heat and you would not have been taking the heat away. The core would have heated up again.

Mr. Weaver. Now how about an explosion in the reactor vessel?

Mr. Miller. I never detected that that was a serious concern, personally. I didn't know how it was going to initiate. I heard discussions. I think we were more concerned from depressurization and uncovering standpoint.

Mr. Weaver. What would an explosion have done to the core; do you have any idea?

Mr. Miller. Well, I don't know where we're going to get the explosion internally. We have no oxygen. If you want to go in and put a bomb in there and explode it, yes, that is a concern. But that is the context.

Mr. Weaver. I'm talking about the hydrogen in there.

Mr. Miller. The concern on the hydrogen was that it would expand and uncover the core again, not an explosive concern, therefore. But we knew we could strip it out. We knew it would take time, and that was the context of that concern.

Mr. Weaver. Well, if you were not afraid of an explosion, why didn't you burn it out?

Mr. Miller. You can't. You've got to have oxygen.

Another thing. You can get it out of the reactor system by taking gas out of the reactor system. It's something we do, we know how to do. We do that in operations. I just told you we put hydrogen in. When we take a plant down for maintenance, we do take the gas out of it normally. So that is not an abnormal operator action. So we knew we could degas it. Our concern was to do that without depressurizing, so it did not uncover.

Mr. Cheney. Who did you talk to in terms of making the decision as to whether or not to recommend an evacuation? Was that strictly your own decision?

Mr. Miller. During the day of the 28th, after the night of the 28th, I had a pretty senior management structure that had taken effect. In other words, the vice presidents of two of our companies were helping me or had taken charge of the overall operation.

They had taken control of the ultimate decisionmaking from me by that night. That day I dealt with my health physics guy, who was coordinating all of the off-site teams. And he was using the Environmental Protection Agency guidelines and the emergency plan guidelines, which give you action levels at certain readings, to take action. You go indoors, you stop eating food, this type of thing.

He was dealing with the state radiological health people direct, Zuruski -- I don't know the titles -- and Rally, Margaret Rally, who we deal with normally on this type of thing. And then we would say we did not recommend an evacuation, and then they would concur with that decision.

Mr. Cheney. And your decision not to recommend an evacuation, is that a judgment call or is that based upon procedures that are spelled out?

Mr. Miller. It's based upon procedures that are spelled out, plus judgment.

Mr. Cheney. You get a certain numerical reading?

Mr. Miller. If I get 5R whole body projected dose, then I'm told to evacuate. If I get .5, I tell people to go indoors. But that's my recommendation to the state. It is their responsibility to decide that.

Mr. Cheney. They decide whether or not to evacuate?

Mr. Miller. That's their decision. It's their decision as to whether or not they move people. I'm supposed to give them all the information I can and make a recommendation.

Mr. Cheney. But your recommendation is almost automatic?

Mr. Miller. It's based on action levels in the guide. But the judgment part is based upon what I know the plant is doing. So I've got to give them input into whether I think the consequence in the plant is going to get severely worse quickly. So that is the judgment, if you call it that.

The other part says that I have done these off-site surveys that give me this level of radiation. The Environmental Protection Agency says that if you're going to get beyond 5R or 25R thyroid, you do this, and that is the basis of moving people.

Mr. Cheney. And you never came close to that?

Mr. Miller. We never came anywhere near that. We were a thousandth of that.

Mr. Cheney. What was your reaction when the Governor made the decision to evacuate children and pregnant mothers?

Mr. Miller. That was not made on the 28th.

Mr. Cheney. I know. That was much later.

Were you involved in that at all?

Mr. Miller. I thought it was precautionary, and it was a personal decision on his part. He's the Governor of the state and he's got different concerns than I do. I did not think it was necessary. But he lives in a different world.

Like I told him, I did not move my daughter and I wouldn't move her.

Mr. Cheney. How old is she?

Mr. Miller. Ten.

Mr. Scoville. This goes back to the issue of the hydrogen bubble and its danger, the hydrogen bubble in the reactor cooling system. Although you said there was no particular concern in your mind regarding the explosion of that bubble over the weekend, Saturday and Sunday, were you aware of discussions that oxygen was being produced by radicalysis?

Mr. Miller. There was discussion there could possibly be production of oxygen, that's right.

Mr. Scoville. Did you believe it?

Mr. Miller. There were an awful lot of technical people on the site at this time, and there was a senior group making decisions and deciding which data and which assumptions were going to be taken as the ones to go on. It was hard to decide because of the number of assumptions there are in deciding that.

Mr. Weaver. Let's stop for a moment and go off the record.

(Discussion off the record.)

Mr. Miller. When you get beyond the 28th and start talking about the number of calculations being made about various things, there were so many people making them that I wasn't aware of all of them. And I was an in-plant guy at that time, and my opinions aren't the ones you should take to make a judgment.

Mr. Weaver. We're taking them all.

Mr. Scoville. I guess the point of my question was really this: When you were deciding which procedure -- you said there were many procedures you could pursue to get rid of the bubble. Was the fact that it was contemplated by some that oxygen was being produced and the bubble might explode a significant factor in making the determination as to what procedure you were going to follow?

Mr. Miller. No. You would take gas out with the same procedure, take it out using that system the way Bill and I described.

Mr. Scoville. To your knowledge -- and I understand you may not know this -- was the theory of producing something that Met Ed came up with or did it come from the NRC?

Mr. Miller. I don't believe it came from either. I think it came from a separate consultant that they both had talked to personally, possibly an expert on hydrogen and oxygen.

Mr. Scoville. Thank you.

Mr. Meyers. Were you concerned that water in the containment or the fact that sodium hydroxide had been sprayed might have caused equipment -- or degradation of equipment, of instruments, such that you might lose control at some point?

Mr. Miller. No. The reason for that would be that we were designed to pump that whole tank into the building.

Mr. Meyers. Pump the tank into --

Mr. Miller. If you had a loss, a LOCA, a loss of coolant accident, the whole 500,000-gallon tank goes in the building. You have a safety tank on the outside of the building with boric water in it. You put that water in to keep the core down, keep the core cool. You would pump 500,000 gallons of water right into the building.

Mr. Meyers. But with the water going into the containment, would that cause disruption of the 480 volt power supply or cause equipment failures or whatever?

Mr. Miller. You would have had enough instrumentation left to operate what you needed to at that point.

Mr. Meyers. So you were not concerned that the conditions in the containment, whether by rising water levels or the fact that sodium hydroxide or the fact of radiation or temperature or whatever, might cause loss of instruments or equipment?

Mr. Miller. If I had to pick, we could have lost pressurizer level and steam generator level, which would have complicated the operation for us.

Mr. Meyers. That is one reason why I think some people were concerned, if you lost control of that equipment inside, that then you would know less of what was going on and you wouldn't be able to --

Mr. Miller. That's true. At the time, during the day on the 28th, though, we had only pumped 20 feet of that tank into the building, and we didn't feel we were at a level -- I didn't feel where we were at a level where we were going to cover those instruments yet on the 28th.

Subsequent to that, we had small leakages which accumulate over hours and months to the point where the building had more and more water in it, and then the concern became a lot more of a concern, because we now were controlling the thing or reading those instruments, and we were looking at backup ways of telling what those levels were.

On the 28th, though, we had not put enough water in where I had that concern that day.

Mr. Meyers. Did you know where the equipment was, so that at what level the water might be where it would start to interrupt certain things?

Mr. Miller. Yes.

Mr. Cheney. One other question, if I might. When we toured the facility -- I gather it was last Monday -- we were told, I believe, as I recall, that one of the condensate pumps tripped and that that started the whole sequence of events.

Mr. Miller. I don't know that we have determined that. I don't think we have determined the source.

Mr. Cheney. What the initiating trip was?

Mr. Miller. That's right. I know the feed system stopped pumping water. We know that the main feed pumps both tripped.

Mr. Weaver. What you're saying is something there may have tripped before that?

Mr. Miller. Or a valve.

Mr. Zewe. Something resulted in that condensate pump causing it to trip.

Mr. Cheney. What was suggested to us was the possibility of some kind of a break in the power supply.

Mr. Zewe. That isn't true, to my knowledge.

Mr. Miller. Remember, from the plant design standpoint, this equipment is in the non-nuclear portion of the plant. It does not have the quality assurance because it is not safety-related.

We know we lost the feed system, and the plant should have been able to handle that from a reactor standpoint. I don't think the company has gone back and decided what the really initiating point was.

Mr. Cheney. So in your mind, we really don't know that?

Mr. Miller. That's right.

Mr. Zewe. They are still looking today at it. They are still trying to gather information and postulate just why that condensate pump tripped and what the motor failure was that initiated it.

Mr. Weaver. As to Henry's last question about the possibility of instrumentation being eroded by the various chemicals, we read in the paper that days before you were supposed to get into the final cold shutdown, that the last instrument failed. That was the quote in the newspaper.

Mr. Miller. On the day of the incident, like I told you, that was not a concern. In the following days, we had a level in this pressurizer. We had a level in there and we wanted to keep a level in there, because you could keep steam on top and maintain pressure.

The level instrument that says how high the level is in there, they failed one at a time, and we eventually had the last one fail.

Mr. Weaver. Why did they fail?

Mr. Miller. They failed because of either radiation or liquid level in the building. They are down in the basement. But we had anticipated that could occur and we had made evaluations of what we would do with the system. We had alternate ways of looking at that level other than the direct reading.

Mr. Weaver. But it does bring out what Henry said. Instruments did fail because of it.

Mr. Miller. But we by that time had devised backup ways, and also, we could have taken that vessel solid again and still maintained the coolant.

So the concern was that, okay, we're going to have to -- it's going to be a little harder to operate.

Mr. Meyers. But if you had kept it solid, would you have continued -- at that point, would you have continued to pump?

Mr. Miller. We might have. We might have shut it off and used natural circulation. Natural circulation probably would have been better because that is one more piece of equipment. The pump could have failed, too, and then you would have had to have used natural circulation.

Mr. Weaver. Gentlemen, I want to thank you very, very much.

Mr. Cheney. It's been very, very helpful.

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(Whereupon, at 3:55 p.m., the hearing was adjourned.)