UNITED STATES OF AMERICA

NUCLEAR REGULATORY COMMISSION

In the Matter of:

IE TMI INVESTIGATION INTERVIEW

of

Michael J. Ross
Supervisor, Station Operations - Nuclear

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NRC Investigation Site
TMI Nuclear Power Plant
Middletown, Pennsylvania

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NRC PERSONNEL:

Dorwin R. Hunter, Inspection Specialist

Donald C. Kirkpatrick, Nuclear Engineer

Owen C. Shackleton, Investigator

SHACKLETON: This is an interview of Mr. Michael J. Ross. The time is 3:48 p.m., April 25, 1979. Present in the room to conduct this interview from the U.S. Nuclear Regulatory Commission, is Mr. Dorwin R. Hunter. Mr. Hunter is an Inspection Specialist, Performance Appraisal Branch, Inspection & Enforcement, Reactor Construction Inspection. Also present is Mr. Donald C. Kirkpatrick. Mr. Kirkpatrick is a Nuclear Engineer with Inspection and Enforcement, Headquarters, Bethesda, MD. I am Owen C. Shackleton, I am investigator assigned to Region V and will act as moderator during the course of this interview. Prior to the interview, I presented to Mr. Ross a two-page advisement document from the U.S. Nuclear Regulatory Commission which set forth the purpose and scope of this investigation, identifying the authority of the U.S. Nuclear Regulatory Commission to conduct such an investigation, and setting forth those rights that Mr. Ross has to refuse to be interviewed. Mr. Ross answered three questions on the second page of this document. He answered all of them affirmatively. At this time I am going to read these questions and request Mr. Ross to respond. Mr. Ross did you understand all the information contained in the advisement document?

ROSS: Yes, I did.

SHACKLETON: Do we have your permission to tape this interview?

ROSS: Yes, you do.

SHACKLETON: Would you like a copy of the tape?

ROSS: Yes, I would.

SHACKLETON: All right sir, that will be provided, and on behalf of the Commission I extend our appreciation for your being here to furnish us information regarding the incident at Three Mile Island. For reference and for understanding for those persons who will be utilizing the information you provide, please, if you would, briefly set forth your experience that brought you to the nuclear industry.

ROSS: I spent approximately 8 years in the United States Navy, basically as an enlisted man. My speciality was electronics and reactor control. Included in that was one term in a tour of duty with Naval Reactors Branch and the Schenectady Naval Reactors Fuel Office in Schenectady, New York. Since then I came to Metropolitan Edison in 1968, served as a Staff Instructor at Saxton Nuclear Experimental Corporation in Pennsylvania for approximately 2 years, being assigned to Metropolitan Edison as a Shift Foreman in 1970 and coming to Three Mile Island at that time. Since 1970, I've been active in startup of both Unit 1 and Unit 2. I've held positions of Shift Foreman, Shift Supervisor, and in 1978, Shift Supervisor of Operation in Unit 1.

SHACKLETON: Thank you very much. And now gentlemen, I'll turn the questioning over to Mr. Hunter.

HUNTER: Thank you. Mike, we'd like to pick you up the morning of the incident and allow you to tell us when you came to the plant and your immediate activities that you were involved in at that time.

ROSS: My first contact really started at 4:35 in the morning when I received a call from my Unit 1 Shift Foreman saying that Unit 1 had suffered a trip and he had lost heated steam to Unit 2. At that point there was no indication that any thing was serious. His biggest problem was he did not have clean feedwater to feed the Unit 1 steam generators. We talked some 15 minutes, approximately, about what he should do, and not having any cause for alarm at that point, I got up took a shower, had breakfast, came to work, with no hurry in mind, arriving at the site, I think, somewhere around 5:30 in the morning--that's rough. On arriving at site, still not thinking there was any thing to be concerned about, I went to Unit 1 control room, which is my normal station, reviewed with the Shift Foreman what he was doing and where we were going with the Unit 1 plant. At that time, Unit 1 was approximately 525 degrees fully pressurized. In preparation, we were looking at possible deboration criticality on Unit 1 sometime that day after a refueling outage. Sometime, and it had to be between 6:00 and 6:30, I received a call from one of the Shift Supervisors, at this time I might

add that both Shift Supervisors were in Unit 2 at this time. He told me that, and that's one of the reasons that I started to come in, because both guys were down there and they were busy.

HUNTER: Maybe, excuse me. The two Shift Supervisors that were in Unit 2...

ROSS: Bill Zewe was assigned to Unit 2 and Ken Bryan was assigned to Unit 1, and I guess after the trip Kenny went on down to Unit 2, near as we can tell. The Foreman that contacted me was Dale Pilzitz from Unit 1. Sometime I received a call from Bill Zewe saying he really had a big problem and would I please come on down and give him a hand. I'm not sure of that time--it tough, it's dark somewhere between 6:00 and 6:30 in the morning. I then--and his words wasn't very ...he just said he had something he didn't understand real clearly, would I come. So I did, I still had no reason to rush down at this point. I arrived at Unit 2, and I'm still not sure of the time. When I got there, both Shift Supervisors were there, Joe Logan was there-- he's the Superintendent--George Kunder, a couple staff engineers were already assembled at Unit 2. At that point, I tried to ascertain what we really had. About the time I came into the Control Room, or shortly thereafter, all reactor cooling pumps were tripped. When we looked over, to my recollection, we did have high-pressure injection. It started--right after I got there we saw something on the source range monitors, and at that

time I told Bill if he wasn't injecting he ought to be also emergency borating. We saw a spike of some kind on that recorder. It bothered me real bad. When I look down, high-pressure injection was already established. Whether they reinitiated, I don't know, I never asked. When I looked down we had flow and we had boric acid going in.

HUNTER: Dale, when you came into the Unit 2 control area, were you in direct contact then with Bill Zewe?

ROSS: Yes, I came to the console and Bill said, "Look around, I got some problems here. I'm going to need some help shortly." I started to look around.

HUNTER: Any particular thing that you look at, at that time?

ROSS: I look at primary plant pressure. It was somewhere around, near as I could tell, 1100 lbs, in that area--not high, it was low. I thought high pressure injection was initiated and no reactor coolant pumps, the pressurizer level was really high--whether it was pegged I couldn't tell from where I was standing, but it was really high. And that was what was bothering Bill at the time. He had something he didn't fully and totally understand. Shortly, it must have been within minutes, we saw something on the source ranges on the recorder. It's a big recorder that sits up on a console. We saw movement on it and it

bothered us, so I told Bill I thought he ought to be emergency borating and he ought to be on high pressure injection. That he did immediately. I'm not sure that high pressure injection at this time was or was not on. Like I said, when I did look down, it was in fact on.

HUNTER: And that time the pumps was already off, as I understand it.

ROSS: Yeah, the pumps was off.

KIRKPATRICK: There's no high radiation alarms at this time, yet...is that right?

ROSS: Nothing that would have caught my eye. I look over, he had a couple of alerts, but nothing that would have said, "Hey we've got a problem." Okay, I did look over, and there was nothing--there was a couple in over there, but I think they were like let-down coolers and stuff like that, which are pretty much normal alarms.

HUNTER: Was there any thing else that caught you eye. Anything else that caught you besides the pumps being off, the pressure was low...

ROSS: The source range indication really bothered. It really bothered me a lot.

HUNTER: Do you recall looking at the steam generators at that time?

ROSS: No, they are on the other side of the console from where I was standing. I did not look at that particular time.

HUNTER: Okay, go ahead, at the point where you saw the source range and the emergency borating...

ROSS: The emergency borate had injected. After that I told Bill we ought to try to get a reactor coolant pump on, and we tried and we didn't get anything. I'm not sure of the time--it's one of the problems I have, being four weeks after.

HUNTER: Don't worry about the time, I'm more interested in the events. Emergency borate, in you words, would be through what flowpaths?

ROSSS: Basically, through the makeup path. There is, . . . you start the boric acid injection pumps, it comes into the makeup system and is injected with makeup pumps into the system.

HUNTER: Will that also include a manual pass, or could it possibly include a manual injection...?

ROSS: It could. At that time we were using just what was available. All he had to do, the emergency path was lined up to start to pumps, and that's what they did.

HUNTER: Okay. All right.

ROSS: Shortly thereafter, realizing we had a problem with cooling, we tried to start a reactor coolant pump, and we started the coolant pump. First they told me. . . .I was kind of standing back trying to absorb some of this stuff and I had just walked in. Shortly after they started, they said the pump didn't start. When I looked we could see the red light on the breaker and knew the breaker was shut. At that point they ascertained, the length of time was quite long, I'm sure, the pump only had a 100 amps. At that point we knew we probably had a dry well or something. The pump was tripped and we commenced to increase pressure and let the coolant flow out through the electromatic relief.

HUNTER: At the time the pump started, in relation to that time, were there any radiation alarms that came on?

ROSS: It was either right at that time or shortly thereafter. It's in the same time frame that everything--

HUNTER: Everything came on? Was there something that came on first, to you knowledge?

ROSS: It just started lighting up over there, and then the Superintendent stepped up, and at that point we realized that we probably had at least a slight emergency on our hands, and we declared that right away. That was declared by Kunder and Zewe, a site emergency. The time was, well, I know what the time was--around 7:00 in the morning by this time. But I wouldn't have remembered that.

HUNTER: This is a good breaking point from this event, because we'll know where to come back to it, okay. I'd like to go back a minute and pick you brain a little bit. When you came in and looked at the plant status, did you look at the power operated relief valve, the RV-2 valve, and the status of the reactor coolant drain tank?

ROSS: Well, the reactor coolant drain tank, unfortunately in this Unit, is around back. It's not indicated in the control room. I did look at the electromatic relief and all indications of it were in fact shut. They have a light with a brillant light that tells you when this thing is open. It indicated shut.

HUNTER: The light deenergized means the circuit was deenergized through the valve. It should have been closed. What about--let me go back and clarify something. You said the reactor coolant drain tank was not in the control room. It's not in the control room but it's behind the panel.

ROSS: Behind the panel. No, I did not look at the status of that.

HUNTER: You did not go behind there. Ok. What about on the computer-did you make a pass at the computer at that time?

ROSS: One of the Shift Supervisors at that time was trying to ascertain the position of RC-RV2--it was Ken Bryan. At that time he reported back to us that it was 200 and something degrees on his thermocouple, which is a fairly low reading. And about that time we went in and isolated it.

HUNTER: If you had experience in Unit 2 or Unit 1 of the powered operated relief valve leaking, safety valve leakage, what would you have expected that temperature to be if it was really leaking?

ROSS: If it was really leaking I would have expected something much higher than 200°, although I know that thermocouples are strapped on a plate. It is not a weld type.

HUNTER: Could you recall an example of what temperatures you have seen when a valve is leaking significantly?

ROSS: We've seen temperatures in Unit 1 on an electromatic relief when we had a valve leakage problem of 280°, 290°, 300°.

HUNTER: During your review of Unit 2 operations, it appears that the electromatic or safety valve was in fact leaking prior to the event, because looking at the computer alarms, looking at the temperatures, the tank was--the operaors indicate that the tanks were hot. They indicated that they were having to pump a few thousand gallons a shift out of the reactor drain tank, above and beyond what would normally apparently be pumped by reactor coolant pump seals. Were you aware of that this morning when you were there?

ROSS: No, I wouldn't have any reason to be aware of that. My normal station is in Unit 1.

HUNTER: I understand that, I'm trying to...

ROSS: I knew that they had a relief valve leaking problem. We were aware of that on both units, but nothing that I would have called gross. I knew they had a leakage problem.

HUNTER: Were you under the assumption that morning that they were not aware that the power operated relief valve was open, or going down?

ROSS: Yes. I'm under the assumption that they felt it was closed, because sometime in that time gap we went ahead and isolated it, and the reactor coolant pressure started to drop. So we felt that the electromatic had in fact been passing.

HUNTER: But before that, had it really entered their mind that it was open?

ROSS: I think that they looked at the indications they had, including computer, and ascertained that it was shut and just went on to something else.

HUNTER: Okay, the temperatures were low, indicating low, which might indicate that it might be weakened and not drawing?

ROSS: Yes, I would say, yes exactly.

HUNTER: The reactor coolant drain tank, temperature and pressure and level are indicated on a control panel behind, around from the operator--

ROSS: Panel 8A, right.

HUNTER: Which is around the corner. The operator, except for the computer, do you know if he had any indication on that, on the reactor coolant drain tank, reactor coolant system, reactor coolant drain tank system in front of him?

ROSS: No, he has nothing except the computer.

HUNTER: OK. In your tour--again, I realize that you just walked in. You were doing a tour and realizing that, I don't know what details, you look at "HIPSI"--if you mentioned high pressure injection. You mentioned that you did in fact look--can you recall when--I'm not worried about the time-when you came in, can you recall the high pressure injection light on? Did you look at it in that amount of detail?

ROSS: I looked down to see that we had flow from the high pressure, and where you look is on the back panel. I looked over the panel light to see what--

HUNTER: What did you see?

ROSS: I saw a flow indication, up in the 200 range in each leg. You know, it was up, normal indication.

HUNTER: Four legs?

ROSS: It looked to me like it was all 4 legs.

HUNTER: At that time?

ROSS: Yeah...like I said, I don't if it was after they reinitiated or not. I'm not sure at this time.

HUNTER: OK, that's fine. The site emergency then was declared. After you started the pump, the alarms went off, and the site emergency was declared. What activity did you become involved in then?

ROSS: Well, then we just decided to increased the makeup flow, but we didn't increase the pressure in the system. We let it essentially flow through RC-RV2. The electromatic is our cooling mode if we have no hole in the system. We put it in there and tried to get some flow through the system. We started that. Shortly there abouts, within minutes, Gary Miller came into the control room and took charge of the control room. Gary is our Site Manager and that time he appointed me as his Liaison for Operations as Senior Operations guy there. He's formed management staff that was going to report to him for the emergency. . .

HUNTER: What did this staff include?

ROSS: The Operations guy, which was me, and I was to give direction or counsel to the shift supervisors; a B&W guy by the name of Lee Rogers, and where he showed up, I'm not sure, but he's pretty quick; maintenance was going to be taken care of by Dan Shovlin, who's a Maintenance Superintendent; and Dick Dubiel was placed in charge of HP type areas; and Jim Seelinger was in placed in charge of the Emergency Controls Center and offsite activities, trying to give us some control and to divide duties a little. Basically, I would remember it that way.

HUNTER: You were receiving then, your instructions from Gary Miller.

ROSS: Yes sir.

HUNTER: And you then were. . . and who was orking specifically for you soon after that?

ROSS: Shift supervisors. I was giving instruction in operational type modes at that time.

HUNTER: And that would include Bill Zewe and Ken Bryan, both?

ROSS: Someplace in there, we sent Ken Bryan back to Unit 1 and his relief, someplace in there, also came in-another Shift Supervisor, Brian Mehler. So we kept Mehler in 2 and sent Ken Bryan back to 1 to make sure we had some operational type senior people in both Units, because basically we ended up with everybody down there. And with a radiation emergency going on, they were going to need somebody up there.

HUNTER: What did you get specifically involved in at that time?

ROSS: At that time Gary had specified and talked about what our goals ought to be at this time, knowing that we did have a problem. The seriousness, I don't think we fully realized. Our guidelines at that time was to try to limit offsite doses, try to keep the core covered and cool, as best we could, and to limit damage to Met Ed people and equipment. That was kind of our charter at that time. We talked about the plant status and we decided we'd continue to inject to increase the pressure as much as we could to keep high pressure injection going.

HUNTER: Would you expand on that some? Looking at high pressure injection, from that time the pump has been secured, the alarms are on, you discovered your main stream high pressure injection--what be the flow at that time?

ROSS: I would say the flow would still have been 225 per leg. At that time--I'm not sure what we gave the operator, we gave the operator a pressure drain to maintain with the electromatic block--electromatic relief valve, and I believe we gave them somewhere around 18-1900 pounds to maintain the system at 2000 pounds, in that area. They were letting the pressure build up like this.

HUNTER: Okay, and that was with one or two high pressure injection pumps running and--

ROSS: Two high pressure injection pumps.

HUNTER: Would they be throttling the high pressure injection at that time?

ROSS: They'd be throttled to maintain leg flows-225, but that should have already been set. I don't believe we throttled anything else at that time.

HUNTER: Okay, with this particular amount of time, this time then, you were actually maintaining in the range of 900 for four legs at 225 gallons a leg, and controlling opening the main door, opening motor operating valve on the RV-2 valve pressure, the pressure relief? Okay, how long did this go on?

ROSS: It seemed like a long time...an awful long time.

HUNTER: Yes, try to key to the next activity, like "we maintained this until this time," and we'll try to key it back into this place time frame.

ROSS: Someplace in there, we lost the auxiliary boilers and I had to break vacuum in Unit 2, and that was in the morning. I not real sure of the time, but it was well before noon.

HUNTER: OK, that's most important, is the activity. Don't worry about the time.

ROSS: We lost vacuum, we broke vacuum.

HUNTER: What did this do to you, this force Unit 2?

ROSS: We weren't really much steaming out of that generator, even though we'd brought the levels up. It didn't appear to us that we were getting any heat exchange from that at all, anyway, not much of it.

HUNTER: At this time, basically you're sitting with the safety, the high pressure injection system discharging out to the power operated relief valve, isolation valve, as necessary to maintain the pressure. What did you see on the Th, the temperature, Tc's.

ROSS: They were awful high on Th, indication that, yeah, we did in fact have vapor up in the legs. They were offscale.

HUNTER: Did you recall any thermocouple readings at that time?

ROSS: Not till later. We had asked for thermocouple readings, and they had come back questionable, question marks off the computer.

HUNTER: That means, what would the normal temperature on the computer be?

ROSS: Well, normal temperatures would be hard. . . In this particular Unit, we're talking about 1200^{0} or less. That question mark means it was out of the scan range, is what it means, or it had in fact a fault of some kind.

HUNTER: The hot legs were extremely high, what about the cold legs?

ROSS: I'm not real real sure. It looked to me like they were down low someplace, indicating there was stagnant flow someplace.

HUNTER: And at this time, you had seal water injection to the pumps?

ROSS: Yes...still on.

HUNTER: Seal continuously...were you at the control panel in the control room area when they had their first building isolation signals?

ROSS: I was close. I think that was somewhere in the morning again, quite early. I was back trying to map out our next plan is what I was doing. But, yeah I was there when they got an isolation signal. It was maybe 9 or 10 o'clock in the morning, I don't know.

HUNTER: Did you see any changes occur when the building isolated, that you recall, any significant changes in the ...?

ROSS: The only significant thing was that the operator reported that the building spray pump started. It started sometime in that area.

HUNTER: Sometime in the morning?

ROSS: Yeah.

HUNTER: The pressure to start the building spray pump is what?

ROSS: 30 pounds.

HUNTER: OK, so that one's 20--

ROSS: Two different pressure switches.

HUNTER: OK. Going back earlier in the morning, okay, there appears to be a building isolation when the pressure drifted up to 4 lbs. Do you have any recollection of that particular time?

ROSS: It may have, and like I said things were .... I remember at least once, possibly twice that we did get the isolation signal.

HUNTER: Okay. And your going through this high pressure injection, maintaining pressure, what will be the next--all of your boilers lost, or what would be the next key event--

ROSS: Broke vacuum.

HUNTER: Broke vacuum.

ROSS: Then we were ordered to shut our atmospheric dump to the atmosphere on the one generator that wasn't isolated. And it was a concern we were dumping activity and we were relatively sure we weren't. And we did that somewhere around noon.

HUNTER: That was to isolate the actual steam relief pump on the A generator, or the one that wasn't isolated.

ROSS: Right. And at that point we reestablished and started pulling vacuum again somewhere, right around in that same area. It's a little confusing to us exactly when it was.

HUNTER: That will be reestablishing the auxiliary steam from Unit 1--

ROSS: Right.

HUNTER: Or the auxiliary boiler and then getting the vacuum back.

ROSS: Trying to look for any kind of heat sink we could get, even though we were having trouble getting a circulation path, any heat sink would have better than that.

HUNTER: OK. The next key event that you recall?

ROSS: Well, Miller got orders to the Governor's office sometime in that area, and he had to leave. So we just kept on with what we were doing.

HUNTER: Who took his place then?

ROSS: Basically, he turned things over to Joe Logan, the Superintendent for Unit 2, and he was gone, I don't know, an hour an a half or so, and he came back. And we had been asking for recommendations from B&W at that point. At that point, the next key one I remember was making a decision, which was a hard decision, for all of us to blowdown and try to go on 1) core-flood injection and 2) possibly decay heat removal.

HUNTER: And you said that recommendation came from ...

ROSS: It was a joint recommendation that B&W concurred in. It was all people involved.

HUNTER: I just want to know where it came from so that we know who to talk to, okay? So, we're going through--

ROSS: It came out of the think group there, the five of us that were involved so co-equals, and that's what we did.

HUNTER: Lee Rodgers was involved in the think tank and he was directly--

ROSS: It was Gary, me, and at that point we tried to make a run, if you will, down as the core flood got on.

HUNTER: Okay, so we're at the point now where the high pressure injection is still going, the motor operated valve is being cycled by the operator to maintain pressure, and you are considering going down to the core flood tanks.

SHACKLETON: Gentlemen, we'll cut right here. The time is now 17 minutes after 4:00 PM, April 25, 1979. We will resume our interview when we turn the tape.

SHACKLETON: This is a continuation of an interview for Mr. Michael J. Ross. The time is now 4:18 p.m. April 25, 1979. Please continue.

HUNTER: We left talking about preparing to depressurize and go to the core flood tanks. Mike, would you continue that?

ROSS: And that we did, we came down ... one of our fears was that we weren't getting flow through the core, you can't tell from out there. We were hoping that all that high pressure injection was in fact going up through the core. Thoughts were that we can come down, get the four flood tanks to go in, verify the core was in fact covered, and keep high pressure injection going pushing water through the core. We did come in the Unit, and as near as I can tell, pressure only went as low as about 200 some pounds. Core flood tanks went in at some volume, probably a foot, foot and a half, not much. There was no inrush, tremendous inrush into the core, and hopefully that indicated there was some water in there anyway. At that time we decided we'd continue high pressure injection, hoping we'd get some natural circulation and break whatever steam void we did. Then I think what we started doing was alternating legs on high pressure injection at that time, trying to get one side to recirc a little more, the other flow back on one side. So we definitely had a--

HUNTER: Okay. Let's go back. What did you depressurized to go down to the core flood tanks, did you reduce the high pressure injection or did you just ...?

ROSS: To my knowledge, high pressure injection was not reduced until we actually got down there and we were trying to swap flow between legs to get the natural circ to break.

HUNTER: In the core flood tanks, basically, it appears you probably just flooded the core flood tanks on the system and you then blocked up with whatever pressure the core flood tanks were, would maintained. Then you indicate that you varied the flows to the four loops. Would you go into that all in more detail, how you do that.

ROSS: That one is a little hazy. We were back in the think tank, and one of the things that was recommended was that we try break, get some natural circulation of some kind going, maybe increase the flow in one leg and cut the flow back in one leg. Hopefully that would do something for us, which we tried. I'm--not being in the control room at the time, we were back in the think tank--I'm not sure how much they varied at that time, what there range was in varying.

HUNTER: What was the intent? Was the intent to increase the flow in one leg and decrease it in on the other.

ROSS: Yeah.

HUNTER: Was there any talk about maintaining the same flow, the same total flow to the core?

ROSS: Talk was to keep high pressure injection on in a reasonable high amount of flow. We didn't tell them that couldn't move more than ten gallons or anything, but the idea was to stay in the same area.

HUNTER: Okay. Let me make sure I understand. The intent was to try to, by varying the flow to the legs, to possibly establish some natural circulation?

ROSS: Grasping the straw in the middle, but looking to do something.

HUNTER: Okay, no problem. Then, go ahead and continue. Do you recall, not when, but maybe how long you were actually in this evolution?

ROSS: We talked about coming back out of it quite rapidly, but then we started to see some temperature changes in the legs and indication maybe we were going to get some flow. So we stayed there and continued this for a little while, and we eventually did start to bring Tcs and Ths closer together. We started to see Tc's come up and Th's come down. By then we had a recorder hooked up on the Th and it was a higher range then our instruments. They were telling us, yeah, they were seeing Ths come down.

HUNTER: Okay, and can you recall what temperatures they were talking about?

ROSS: Yeah, they were talking 700° and then we coming back on scale.

HUNTER: OK, and Tc's at that time, were they still low?

ROSS: Yeah, they were low.

HUNTER: And then they would be coming back from where, do you recall?

ROSS: 100 and some degrees...or 90 to 100. I don't know. Low.

HUNTER: I'm having a little trouble with...I'm not to sure I understand where the 100° water came from, except that unless--with high pressure injection going, where does it inject?

ROSS: It comes in a discharge to the reactor coolant pumps.

HUNTER: Into a vertical line, or...?

ROSS: Yeah, it comes into the line, right at the discharge to the pump, it comes into the side of the line.

HUNTER: Okay, in the side.

ROSS: And the thermocouples are in that.

HUNTER: What will be the water flow? What would you approximate the water flow at that time, coming into A loop, to pump discharge, would it go both ways? Would it go through the ...

ROSS: I would like to think it would go through the core.

HUNTER: Did you recall in the think tank, the discussion as far as what the flow paths were?

ROSS: We kept thinking, we were hoping that we weren't short cycling the core and back this way. But our thoughts were being, possibly were so cold we were getting a lot of injection into the core.

HUNTER: Okay, do you recall the steam generator levels at that time, or the pressures? Did you discuss those?

ROSS: Yeah. Seems to me they were like a 100 lbs generator pressure.

HUNTER: All right, you had flood up for natural circulation before you took the pumps off ...?

ROSS: That's correct. We brought the levels up for natural circulation.

HUNTER: And they were sitting there at that level, I suppose.

ROSS: 130, something like that.

HUNTER: Again, at low pressure, apparently.

ROSS: Yeah, real low pressure.

HUNTER: The next significant event that you can recall, that you were involved in?

ROSS: Like I said, we started to see the Tc's, and the next event was later that night. Once we had seen that we had talked about tring to get a reactor coolant pump. By then our Manager had called over and said, "you guys ought to go back solid," which we started to do-Jack (Herbein) called, and we were starting to go back solid, total injection, two makeup pumps, to take her back solid. At this time we started looking we saw all indications that the loop was in fact filling, both by the amount of water and the pressure kind of hung up and water flow kept on going with the RC2V tube isolated. This told us we were in fact filling all the loops. At that time we talked to B&W and talked about getting a reactor coolant pump started, and we discussed which pump we

would start, after knowing all the history on all the pumps, what pumps had been run by then and by that time I think about all of them had been run dry, by the way. So we talked a great length about which pump would start and at that point we decided which pump we would do. We then bumped the pump. When I say "bumped", we ran it just long enough to see the reactor coolant pressure change and get flow indication. And the reactor coolant pressure changed radically. At the time we bumped it, we were probably 18-1900 lbs and pressure dropped down to about 1100 lbs. We had about a 6-700 lbs drop, like right now. That was somewhere around 7:00, you might say.

HUNTER: Okay, let's go back a little earlier, during the afternoon. I think you said it was decided to go off the core flood tanks. You weren't getting down to decay heat removal. You weren't able to get down that far.

ROSS: We weren't able to get down.

HUNTER: And it was decided to go back up in pressure. Where did this come from? I take it--

ROSS: We had talked about it in the tank some, and also about that time, Jack Herbein called over and said he wanted the plant taken solid.

HUNTER: Okay.

ROSS: So that's were we headed.

HUNTER: So, you would then continue high pressure injection on two pumps, leaving the motor operated valve on RCV closed on the relief valve and continue up. Do you recall any significant changes during the time you were pressurizing?

ROSS: As far as Tc and Th continued to diverge for us at that time, and coming closer, indicating we were getting some flow.

HUNTER: They were converging at that time.

ROSS: The other significant event was that, without the pressure going up, we got up to like 16-1700 lbs, and pressure kind of held, indicating to us we were flowing into the loops. It didn't just take straight up.

HUNTER: What would that indicate, that you're not solid?

ROSS: Yeah, that's what that would indicate.

HUNTER: And that you had a bubble?

ROSS: Somepiace, yeah for sure. At least that was my analysis. We didn't talk about it, but I kept thinking, "geez, we've been pumping air a long time but pressure is not going up anymore. We must be filling loops." At that time we talked about how much extra water...

HUNTER: That was the context you talked about though, that you must be just filling the loops?

ROSS: Yeah.

HUNTER: And continuing to pressurize and then ... it seems like a long time to me. You're going out towards 7:00, I think, the pump was started, later in the evening.

ROSS: Around 7:30 I think.

HUNTER: So you bumped the pump.

ROSS: We bumped it once. We did see flow. We did see loop temperatures change and we did see a rapid decrease in pressure when we did that. B&W recommended that we wait 15 minutes at that time to protect our pump 'cause they felt that was going to be our cooling mode at this time. And we increased pressure quite high, we must have went 2200 lbs or 2300 lbs, maybe, in order to accomodate this pressure decrease, with our goal being, once we started to pump the second time, to leave it running.

HUNTER: Then you starting to save time and what happened?

ROSS: Then it went, it ran, pressure dropped down quite rapidly and didn't stabilize and we left the pump running. And it looked to me like when the pump was started we had a loop temperature somewhere in the area of 300-320°, in that area. That would at least tell me that we did cool the core. As a layman, anyway.

HUNTER: Okay. And then, at that time the pump was on, did you start to. . . did you maintain pressure or go back to normal pressure?

ROSS: What we did then, not thinking we had any further problems, what we did was kept the pressurizer heaters on, brought the temperature up, and we drained the pressurizer hoping to shift. . . . I guess we were kind of solid in the pressurizer--indications were solid anyway--to

shift the bubble to the pressurizer if there was a bubble anyplace else. We continued to heat the pressurizer and get it hotter and drain down a little bit on the pressurizer with the reactor coolant pump on. Later that evening we did see indication of the level coming down and pressure kind of stabilizing. I think that pressure was somewhere around 14-1500 lbs.

HUNTER: With the heaters on, you were heating--the power operated relief valve closed, the pumps on, the system is basically solid except if there was a bubble somewhere. At least you were steaming, you were going through a steam generator at that time. Then you were able to steam...

ROSS: By that time we had vacuum also, again.

HUNTER: Were you cooling do through the ... what was you cool down path?

ROSS: Dumping back to the condenser through the turbine bypass valves.

HUNTER: Pumping the water then back ...

ROSS: Back, and we did go into a cool down mode shortly thereafter, cooling the plant down. From what I remember, about 330°, we brought it down to, late that evening, very late we were like 250-260 in that area. That was about 2:00 in the morning, by then.

HUNTER: Looking at the pressurizer, since that probably was the only thing that was going on at that time, seems that things were fairly well straightened out by that time. I hope you were probably involved in that particular evolution, and you, in fact, had the pressurizer heaters on.

ROSS: Yes.

HUNTER: What would the pressurizer temperature be doing?

ROSS: Coming up.

HUNTER: If you were sitting at 1450 or 1350 lbs, you had a goal to come up to the saturation temperature, I presume. And then start draining?

ROSS: Yeah.

HUNTER: And get the bubble into the pressurizer?

ROSS: Get the bubble in the pressurizer and try to get to what we would call a normal cooldown mode. We'd have the pump on, we'd have the bubble supposedly in the pressurizer, we would be steaming the generator, except one generator bottled, we would go into a normal cooldown mode at that time. And basically, that's for we did that.

HUNTER: So, you ended up that evening, sometime that evening, with a bubble sitting at constant pressure, one reactor coolant pump on, normal charging makeup, reactor coolant pump seals.... Do you recall letdown at that time?

ROSS: We did not have any indication by then. Letdown was a source of problems all through this because we never determined what we had.

HUNTER: Give me the reason. See if you can key on letdown sometimes and maybe we'll try to put it together.

ROSS: I think earlier in the morning we had letdown flow indication, relatively low. And then later on we lost all indication. We felt we had some letdown and sometime in that period of time we went ahead a isolated the letdown and we saw the effect of the letdown relief valve

lifting back at the bleed tank. We actually had seen the flow spike. At the time we couldn't determine whether or not we didn't have any letdown flow or whether the instrument was screwed up. The instrument would move every time it would look like the relief valve relieved or lifted. It just continued to ... we did have indication, yeah, we did have letdown but we were not able to ascertain how much it was.

HUNTER: Okay ,in the letdown relief lifting, did that go to bleed tank?

ROSS: Yeah, it's a hard fight to the bleed tank.

HUNTER: Okay, could you tell that it was going to the bleed tank?

ROSS: Not for sure, there was no real way. We had indication that the relief valve was lifting and that--

HUNTER: What about the bleed tank level?

ROSS: It went up some, I'm saying but that--

HUNTER: Yeah, I'm trying to make sure that the line actually went to the bleed tank.

ROSS: Yeah, I wish I could say I could guarantee you that that's where it went. We had indications that the bleed tank pressure went up, which could have been just from the vent header, and also indications that level did in fact go up in the bleed tank. So it could have came from there, it should have came from there.

HUNTER: What was the letdown situation as you went on through the day?

ROSS. We continued trying to open bypasses and establish more letdown to give us more control in the situation we were in--open some bypass valves in the system that we could get to externally without giving anybody a big dose. By then we had relatively firm HP control in areas and they were all roped off and their was Scott airpack areas to get into .. things like this. We continued trying to establish and wondering why we couldn't get any flow indication. We tried somethings like valving in other demineralizers, some experiment trying to get letdown flow.

HUNTER: Did you end up with some?

ROSS: We also felt we had some, but we never ended up with any indication.

HUNTER: Okay, and that's were you left it?

HUNTER: The indication I'm talking about is actual flow indication in the letdown line. We had indication we had letdown in that we could control our level and our pressure somewhat but no indication of amount of gallons.

HUNTER: What about the makeup tank?

ROSS: The makeup tank level told us we did have some letdown.

HUNTER: I'm trying to visualize.... Would you still have been using the boron, the BWST, the Boric Acid, the Boron Water Storage Tank at this time or would you be strictly on the volume control tank?

ROSS: Still strictly on the volume control tank and making up as necessary from the BWST at that time.

HUNTER: Making up as necessary?

ROSS: Yeah. When the makeup tank get a little low, you open the value, suck a little water into the tanks.

HUNTER: Right. Where would it be going?

ROSS: Into the system, into the makeup tank.

HUNTER: Okay, the makeup tank is then being charged into, being added the primary coolant system.

ROSS: Yeah, right.

HUNTER: Were you leaking anywhere at that time, that you were aware of?

ROSS: Nothing we were aware of, and its kind of hard to ascertain the fact that we were changing temperature and cooling down at the same time. We had no reason to think we had any gross leaks anyplace, based on what we had seen.

HUNTER: Okay, I think that I have got up to the point where we're at 15 hours into the event. The pump is on, things are fairly stable. This is the first cut at our program to get your involvement. Are there any areas you can think of--not times or anything--but any activities that you were involved in that are significant--of course, I'm just trying to lead you through it--that you feel that are significant that we should discuss? Even if we don't, what will happen is, as we go to other people, I'm sure we'll key back into you and try to cross-reference your activities. But if there's something significant that we need to

get, that we need to look at, we don't want to miss anything. . . concerning the high pressure injection. One thing that I might ask that might key your thoughts, is that there are two boron samples that we're dealing with, that was earlier-one was 400ppm and one was 700ppm. Were you involved in that or ...?

ROSS: I heard the results of one of them, in the morning--

HUNTER: Which one did you hear?

ROSS: It was either 6 or 700.

HUNTER: Okay.

ROSS: Okay. I thought it was either. It was discounted in the control room the first time, of course, as being an erroneous sample. I think they had that piece of information--we had seen the spike on the source range, I can't be sure of that. 'Cause at that point we said, "oh man, maybe that sample is right. Let's..."

HUNTER: Did you get another sample at that time?

ROSS: There was two samples requested. I don't remember which can first. But on doing the second sample, when Dick Dubiel got involved and started isolating the building, I guess he had seen something, activity wise radiation levels wise.

HUNTER: During the second sample, you said that's when the building was...was Dick...

ROSS: No, Dubiel--let me rephrase that for you guys. Dick Dubiel is a person.

HUNTER: No, I understand that. I knew that--

ROSS: I said building was isolated, and he was saying get the people for sure out of the auxiliary buildings for both units, because he wasn't sure what was going on.

HUNTER: Did he see something at that time?

ROSS: Radiation levels on the sample line, I think.

HUNTER: OK, so he was picking up something... to get a boron sample...again, my understanding that that letdown sample would be on recirc through the sample room.

ROSS: That's correct. And the sample room being located in Unit 1.

HUNTER: Then you would have the hot lines... Do you happen to know what time that was? Do you have any feel for it?
Was there any...

ROSS: Before 7:00

HUNTER: Was there any event that happened that would key us to that time? I guess maybe drawing the sample would key us to that time.

ROSS: Yeah.

HUNTER: OK, and I got this sample, the technician would log that he drew a sample at time, I guess. Anything else?

ROSS: Radiation monitoring charts in Unit 1 possibly, in that the hot machine shop lines pass through the Unit 1 monitors.

HUNTER: OK. We'll key into that. So were trying to see when we saw the first radiation increase into the Units.

ROSS: I think Dubiel would have that time, 'cause he'd just come to work.

HUNTER: Just a general area, just a general question--and I go through the procedures of what you do when you trip the plant and try to understand--it's my understanding that as soon as you tripped the plant there are chemistry requirements this plant, that you have to get the chemistry, run boron, and reduce some other chemistry, iodine, that type of thing. So they would have put the letdown on recirc early, based on the fact that they had--the operators do a shutdown margin calculation also.

ROSS: Right.

HUNTER: Is that based on the boron that was there when they tripped or did they get a new boron sample?

ROSS: The first one's based on the boron at the time of the trip. Of course, he was trying to make sure that we are shut down. He corrected with actual borons in the plant.

HUNTER: How long does that normally take?

ROSS: It can vary. We are talking, probably by the time that the guy gets down there and gets a sample, we are talking about an hour or two hours, really, by the time the guy recircs it and gets the number back to us.

HUNTER: Okay. But probably the normal time frame would be before they turned the pumps off. That's at 7:00, that would mean you have three hours?

ROSS: Yeah, I would think that they would have them by then.

HUNTER: Okay, any other area that we can key on, or particular actions? Any comments?

ROSS: No comments, except that one of the big problems we had was keeping track of time.

HUNTER: One of the ..... Were things going on so heavy that you just couldn't--

ROSS: Grasp it.

HUNTER: Grasp the time?

ROSS: Time went by and we found we spent 20 or 25 minutes on something we thought we had spent 5 minutes on. I think if we knew that, that would have helped us an awful lot.

HUNTER: What about the numbers of people in the control room? You were in fairly early?

ROSS: Yeah, ECS moved twice throughout that incident. That added to the confusion in the control room, but--

HUNTER: Where--they moved once? From where? Unit 1 to...?

ROSS: To Unit 2, to Unit 1 and back, and back again, as far as I know.

SHACKLETON: Mr. Ross, could you define ECS for people not familiar with the terminology?

ROSS: ECS is a body of people, basically staff engineers, and it's emergency control center. Their job is to take care of and mitigate the offsite things, track offsite doses, predict offsite doses, communicate with the State and the NRC and our consultants in any emergency.

HUNTER: Where was the emergency center first located?

ROSS: Part of the Unit 2, first.

HUNTER: And that is where?

ROSS: They were around the area of the shift supervisor's offices.

HUNTER: Okay, and then where did they move?

ROSS: They went to Unit 1, and I recollect it came back once for just a few minutes, and then it was gone.

HUNTER: Numbers of people around the control board during the incident?

ROSS: Not excessive. One thing we did do, and probably increased the number of people around the control board is, in the morning hours we realized that we did in fact have at least a major plant problem at a minimum. And we assigned an operator to every panel and a shift foreman, a supervisor to back that guy up, allowing us to get back to the think tank and try to recall people in and put a guy at each panel, basically.

HUNTER: How did that end up with Bill Zewe and...?

ROSS: Well, Bill is responsible for control room operations and plant operations.

HUNTER: And did he have those people, both he and the foreman who were assigned, did anybody else helping Bill, or was there anybody else assigned to that particular position?

ROSS: Well, at that time Brian Menler was also onsite to assist Bill. He is another shift supervisor. But the idea was to get some supervision down to a lower level and concentrate on each individual item so we didn't miss something big.

HUNtER: Okay, and the foreman were assigned at the panel levels--that's my understanding...

ROSS: Yeah, that's right. And an operator to each section, so we should have 3 operators and it should have been a total of 3 supervisors.

HUNTER: What about the people back in the back, the numbers back in the back...

ROSS: here were a lot of people back there but they mainly stayed out of the way. A lot of the operators were back because we had run them out of the auxiliary buildings and they were trying to stand by the control room to see if there was anything they could do.

HUNTER: Were you still able to communicate adequately with Bill Zewe and these other shift supervisors?

ROSS: Yes, I think so.

HUNTER: You weren't having any trouble getting the word to him when the think tank had a direction, that was to you, and as I understand, and then to Bill as the shift supervisor?

ROSS: Yes.

HUNTER: In the morning, sometime during the interviews, we picked up that an entry was made, at least one, and I believe Greg Hitz made an entry into the auxiliary building with an operator to look at the auxiliary waste panel. Were you aware of that or, involved in that?

ROSS: Yes, we were interested in ascertaining what was going on in the auxiliary building--was it under water, what was going on, what was the vent air pressures, etc.

HUNTER: What came out of that, anything significant?

ROSS: He reported approximately 3 inches of water in some areas. But only at the peak sections, so in other words, the floors weren't totally, and he reported no gross major leakage.

HUNTER: What about the auxiliary building sump? Obviously, then that was full.

ROSS: Yeah, it was overflowing.

HUNTER: What about the miscellaneous drain tank?

ROSS: At that time he came back and I think he told us the level was, in fact, not overflowing at that time.

HUNTER: The makeup bleed tanks are indicated in the control room.

ROSS: Yes, they are.

HUNTER: What was their status at that time, do you recall?

ROSS: It's hard to remember...

HUNTER: Were they normal or abnormal?

ROSS: I would think they were fairly normal at that time.

HUNTER: So at that particular time, then, it was your understanding that you just had a few inches of water - the low points in the drain.

ROSS: Three inches at the lowest points in the drains, backing up on to the floors in some areas.

HUNTER: And that's all the questions I have.

SHACKLETON: We'll close the tape at this time. The time is now 4:46 and we will return in just a minute. The date is 4/25/79.

SHACKLETON: This is a continuation of the interview of Mr. Michael J. Ross. The time is now 4:47 p.m., April 25, 1979.

KIRKPATRICK: All right, Mike, I would like to go back to some of the earlier comments you made and try to get clarification on a few things. At one time you said after you had decided to go solid that you noticed

a lot of water was going in. You thought--it surprised you. Were the people in your think tank generally aware that the water level must have been fairly low, prior to that time?

ROSS: The water level in the loops, I think so, in that the reactor coolant pumps wouldn't pump I would say yes.

KIRKPATRICK: So that they did attribute the fact that they wouldn't pump to the fact that the water probably was low.

ROSS: Yeah.

KIRKPATRICK: You also said that the manager had called and said it was time to go solid. Had there been consideration of going solid prior to that time?

ROSS: Well, basically, we spent most of that morning in that mode. Most of the day in that mode.

KIRKPATRICK: In an attempt to get it to go solid?

ROSS: Yeah, we put it in the, all but letting it go out the code safety--we did increase pressure and, we maintained a high pressure, we maintained a high pressure injection.

KIRKPATRICK: What was the main reason that you couldn't get it to go solid?

ROSS: I think we never really let it go solid because we were worried about pushing water through the code safety valves.

KIRKPATRICK: I see. When you tried to pump it up, the pressure would go up? Is that right?

ROSS: Yeah.

KIRKPATRICK: Had there been any consideration to going ahead and opening up the code safety at the time you were pumping out?

ROSS: Just in passing. It was kicked back. I don't know who in B&W was talked to but we had talked about going flow through them, and nobody was real keen on that idea at the time.

KIRKPATRICK: So that you were hesitant to open them up?

ROSS: Not knowing whether it would ever reseat again, you know, once you wash water through a steam safety valve.

KIRKPATRICK: I see. You could not get enough pressure reduction with the normal electromatic relief valve in order to keep your pressure down, is that right?

ROSS: That's correct.

KIRKPATRICK: So you were trying to raise the water level but when you did that the pressure would go up.

ROSS: Right.

KIRKPATRICK: And you couldn't keep the pressure low enough with electromatic relief valves in order to add water?

ROSS: We ended up cycling the valve while adding water, is what we ended up doing. The valve would actually open and shut.

KIRKPATRICK: I see. So you know you were low in water and while trying to add water, you basically couldn't.

ROSS: I don't think we could ever fill the loops. That's what we would like to have done. We would like to have filled the loops but the loop system didn't seem to want to fill. The pressurize up and we had indications that we were headed, in fact, for solid and the pressure would go rapidly up. We'd opened the electromatic and flow it back, you know, to some level to keep injecting. Later in the day when we went in an attempt to go solid we did, in my opinion see a difference as we got up, you know, a few--15, 1600 hundred pounds--the pressure kind of held and everything was kind of filled, you know--it looked like to us.

KIRKPATRICK: Well, what was the main difference then that permitted you to go ahead and go solid?

ROSS: I think our Th temperatures were different, our Tc's--I think our plant temperature was different. We had washed a lot of high pressure injection water through the core at this time. That's my personal opinion. We had put quite a number of gallons through the system by then.

HUNTER: Did I hear you say that the Th, the hot leg temperatures and cold leg temperatures were different at that time?

ROSS: Yes.

HUNTER: Had they decreased, is that what you're saying?

ROSS: Yes. I think we had indications that we maybe had some flow circulation through there by then. That's the way I remember it right now.

KIRKPATRICK: Possibly could it have been also the steam--the fact that the steam generators were filled up and gave you better cooling?

ROSS: No. I don't think, because the steam generators were filled quite early. Very, very early. Hours and hours and hours before.

HUNTER: Were the--well, the steam generators were set near a full code at low pressurizer, I guess, weren't they, at that time?

ROSS: Right.

KIRKPATRICK: That's all the questions I've got.

HUNTER: Mike, what would you , what would be, at this plant you are better aware of some of the aspects of it than a lot of people. When you looked for a natural circulation what were you looking for?

ROSS: What you are looking for is the fact the Th and Tc do circulate. You are looking for any indications of flow. What you're looking is some difference between Th and Tc, but no great total difference between them. You are looking for some delta T across the core, you are looking for some difference between the two, but you are looking for indications that you do in fact have a temperature transporting one loop to the other.

HUNTER: All right, have you seen natural circulation at this plant?

ROSS: On Unit 2, I haven't. I've seen it on Unit 1 years ago.

HUNTER: On Unit 1, was it during the preop testing when you actually saw the--

ROSS: Yeah, I think we did a preop natural circulation test over there.

HUNTER: Okay, I don't have any more questions. Don...?

KIRKPATRICK: How many people did you have in your think tank back there?

ROSS: Well, it would be B&W, Miller, me, or HP guy on and off, Logan on and off, Kunder on and off.

KIRKPATRICK: All right thank you. I don't have any more.

HUNTER: Do you have any comments? Would you like to say anything?

ROSS: No.

HUNTER: We will, I can't promise you, but we will probably be getting back with you because we will be trying to pull out more details. We do appreciate your time.

SHACKLETON: Thank you very much Mr. Ross. The time is now 4:54 p.m., April 25, 1979.