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Staff. On my right is Herb Abercrombie. He is Superintendent of the Browns Ferry plant. Sitting next to him is Tom Knight, who is Chief of the Reactor Engineering Branch, the Division of Nuclear Power.

Over on the right we have Bert Morris, who works in Tom's Branch, and we have Pelar Metcalf, who works in Engineering Design. We have Ed Edmonson, who has worked at Browns Ferry, and John Rathjen, who is also in the Division of Nuclear Power. I believe that covers all of the TVA people.

We have got three people from General Electric: Hank Pfefferlen, who is directly behind me; Monte Ross and Dick Gridley. So they will be prepared to address any questions.

MR. PLESSET: Since many of you were not here yesterday, I might introduce some of the people up here. Of ACRS members, Mr. Etherington and Mr. Ebersole. Dr. Bates is a Federal designated employee for this subcommittee meeting. Then we have consultants, Dr. Catton, Dr. Zudans, Dr. Theofanus, Dr. Wu and Dr. Acosta. So now you know us, and why don't you proceed?

MR. DOMER: We have a lot of ground to cover here this morning. I want to emphasize that we want to answer any and all questions you might have; but we do have a lot of information we want to pass along to you, so we will do our best to keep it moving as much as we can.

We are pleased to be here and meet with you, and that is all I have to say. With that, I would like to introduce Ed Edmonson, who will give you a presentation on the description of the normal operations of the scram system.

MR. EDMONSON: If there is anyone here who can't hear me, I am Ed Edmonson. I wish you would just call me Ed. And please ask any questions.

I am going to try to explain to you the normal operation of the control rod system and what is supposed to happen and tell you what is going on out there. I am sure all of you know that the BWR control rods go in from the bottom, so what I have got right here is just a little drawing that shows the typical control rod and normal operation of the thing. Reactor control moves the rods in and out and causes the control rods to enter.

We have drive water coming in. Right here we have got a little representation of control rod drive, and I want to talk about the normal operation of the drive when the operator moves the rods.

The insert. We have drive water coming in, a direction control valve which opens and lets the water under the piston, approximately 260 pounds above reactor pressure, which moves the rod in here, coming out through this valve. We go to exhaust.

On a withdrawal it is a little bit different. The drive water -- this withdrawal valve will open and push this down on the piston. The exhaust path is right out through this way. Now, that is the normal operation of the control rods.

I am going to change a little bit now and just talk about the system as a scram system. We know the operator, if we get into trouble, something that the operator can't respond to, we want all of those rods to insert and shut the plant down.

I have taken away the direct control valves, so right now we are just talking about the scram system. All we have got to do, underneath of the piston here you see a scram inlet valve and scram outlet valve, and you see that they are normally closed. Now, these things, they are closed. We have 1500 pounds of reactor water coming in. It charges the accumulator. This 1500 pounds will push the piston all the way down in this accumulator.

The nitrogen, which started off around 560 pounds -- the piston with the bottom out is going to now have about 1100 pounds here and 1500 pounds, and the valves are closed. You have got the scram inlet and scram outlet valves. On the scram, all we have to do is open this and the water is going to go in and the rod will go in.

These things are spring loaded so that when we take the air away from them, the scram outlet valve will open prior to the scram inlet valve. That prevents excessive pressure on the walls of the control rod drive. These valves on the shelf condition are to be open. It requires air pressure to maintain them closed. Everything is fail safe. This is a fail safe function. So you want to keep air on these things.

Here you see the scram pilot valves. Now, this portion of it, what we are talking about right here, this is typical of 185 rods. When we get over to the backup scram valve, that is common to all of them.

MR. CATTON: What would happen if you got water in the air side?

MR. EDMONSON: Water in this?

MR. CATTON: Yes. Would they still unload if pressure was decreased?

MR. EDMONSON: Yes, I think they would. Also, Browns Ferry has got drivers on those. I had never seen any water in them. Like I said --

MR. CATTON: I don't think anybody plans on the water. I was just curious.

MR. ZUDANS: When you open the scram valves, where does the air go?

MR. EDMONSON: Out into the room.

MR. ZUDANS: Out into the room.

MR. EDMONSON: Yes.

MR. ZUDANS: The drain is then next to the valve, the opening is right there next to the valve?

MR. EBERSOLE: Just a little hole right in the side of the valve.

MR. EDMONSON: Yes, about the size of my fist, electrically fitted. You have a solenoid that holds this valve closed in the condition we see right here. Now, the normal path to the air is through -- these are common to all of them. The air supply comes through here, through here, really into here. This is an electrical solenoid.

The electrical part of the thing, once again, is fail safe. The reactor protection system would deenergize that coil and will let this thing open.

MR. ZUDANS: Where does the air go when it opens, out right there into the room or back through a series of blinds?

MR. EDMONSON: It goes out into the room. The actual path, what I am showing you right here, you will see that the air is coming right in through this wall.

MR. ZUDANS: That I understand, but where does it go when the solenoid opens?

MR. EDMONSON: Right out into the room.

MR. ZUDANS: Right at the body of the valve?

MR. EDMONSON: Yes.

MR. ZUDANS: Without any lines?

MR. EDMONSON: Yes.

MR. ZUDANS: So the water would not matter.

MR. EDMONSON: No. The actual path at that point of the scram is going to be like so, routed through here, and the two valves. This is a pipe, this one, and this was the discharge and this one is still open. It will keep the scram valves open. But yes, it discharges right into the room of the valve. The same is true with these backup valves. They are over on the wall.

MR. CATTON: How big is the hole that the air discharges through?

MR. EDMONSON: I would say about half an inch, a pretty good size.

MR. EBERSOLE: So each valve is like half an inch? I thought it was about a pencil head or thereabout. Is it a half-inch?

MR. EDMONSON: When you get inside of the valve and you look at those diagrams, the actual exhaust port you can stick your finger in. These are the smaller ones. These are much larger.

MR. EBERSOLE: Each valve, then, has about a half-inch exhaust port into the atmosphere local to the valve, then.

MR. EDMONSON: Yes.

MR. EBERSOLE: And if I take an enthusiastic painter and paint all over all of these things, he would not close them, would he?

MR. EDMONSON: No.

MR. EBERSOLE: I believe you said that the air is dry so you don't have water in it.

MR. EDMONSON: That is right.

MR. EBERSOLE: So it runs through a dessicant of some sort.

MR. EDMONSON: Yes.

MR. EBERSOLE: You know these things are supposed to be seismically designed. I am going to shake your can of dessicant. Is there any normal flow through these lines that would carry this debris into the valve which would cause a failure? In the normal mode of operation, is the air system flowing at all through normal leakage?

MR. EDMONSON: Yes.

MR. EBERSOLE: It is leaking some, isn't it?

MR. EDMONSON: Yes.

MR. EBERSOLE: But if I shook the can of dessicant up, I would provide entrainment to this -- is there a filter downstream of the dessicant?

MR. EDMONSON: There is a filter there.

MR. EBERSOLE: Downstream of the dessicant? So it would stop the dessicant.

MR. EDMONSON: Really what they have done, we have only shown two valves here. This is the backup circuit. Actually there is a parallel path disk identical to this where we can go in and take this one out of serv'ce to clean the filters and do whatever, so I don't see any problems at all there.

MR. EBERSOLE: Really you are protected from the dessicant by filters.

MR. EDMONSON: Yes.

MR. PLESSET: Go on.

MR. EDMONSON: We just talked about the electrical part, taking the voltage right here and showing the discharge path. These are typical for each of the 185 rods locally. Now, this one, these are back over on the wall at the CRD system. They are a little bit different. Anyhow, when they discharge, you see, we have one discharge path here, and due to this check valve right here, when this one opens we have a parallel discharge there.

Here we deplete the air to each hydraulic control unit. Here we deplete the entire header.

MR. EBERSOLE: Is there any crosstie between the instrument air supply and the normal air supply for emergency use?

MR. EDMONSON: At the dry wall area?

MR. EBERSOLE: No.

MR. CATTON: The plant service area.

MR. EBERSOLE: Do you have an emergency crosstie?

MR. EDMONSON: I don't know about that.

MR. ABERCROMBIE: It is all one source.

MR. EBERSOLE: You don't have an emergency crosstie to service air into the instrument air system, then, do you? Some plants do that.

MR. ABERCROMBIE: There is another set of air compressors which supply service air, but they still have the same criteria for nonlube, nonoil.

MR. EBERSOLE: Dry air.

MR. ABERCROMBIE: Yes.

MR. EDMONSON: I am going to go a little further here and talk about these vent valves.

MR. ZUDANS: Before you leave that, could you explain the function of the backup scram?

MR. EDMONSON: That is pretty simple. Let us say that these --

MR. ZUDANS: What is it backup to? Just the air system?

MR. EDMONSON: Well, there is a backup to these. If these valves right here do not discharge properly, if you deplete the entire header, these are going to open anyhow.

MR. ZUDANS: Okay, but there are no hydraulics except the fluid or the water backup lines or backup wells for discharge. Just those two scram valves. That is all you have, right? Only the controls have the backup. Only the air system is backed up. There are just two scram --

MR. EDMONSON: There is only one scram inlet and one scram outlet valve.

MR. ZUDANS: That is all you have?

MR. EDMONSON: Right.

MR. EBERSOLE: Has there been any recorded incidence of the 1500 pound water that extends into these valves managing to get itself into the air systems?

MR. EDMONSON: There is no way to do that. That air system -- I mean --

MR. EBERSOLE: It really depends on the internal design of the valves, and I don't know what that is.

MR. EDMONSON: Are you talking about this thing?

MR. EBERSOLE: Yes. There is no way for the air to become waterlogged. Not at that point, anyway.

MR. EDMONSON: It doesn't work that way.

MR. EBERSOLE: Well, TMI got into trouble because they got water into the air system through an unusual route, and here --

MR. EDMONSON: That would be unusual. They would have to come up through half-inch steel bar. Right here is your valve, so there is no way for water to get in.

MR. EBERSOLE: Are there any other possible sources?

It is an open structure, what it is, so there is no access of water to air in that particular device. '::e there any other devices within the air system where water is separated by a diaphragm or whatever?

MR. EDMONSON: Not to my knowledge.

MR. EBERSOLE: And you feel there is no way to get water into that system, that air system.

MR. EDMONSON: Any time you compress air, you have a chance for moisture.

MR. EBERSOLE: No, I am talking about foreign sources of water. There is none.

MR. EDMONSON: No.

MR. EBERSOLE: I know you get conde..sation. You have your dessicant to do that, and then you have got to prevent the system from getting dessicant in it, which you do with filters. All right, I am done.

MR. EDMONSON: We have just talked about deenergizing the scram pilot valves. That is done by the reactor protection system. And you see coming off here -- I am going to go ahead and open the scram inlet and scram outlet valve, and here is the idea.

We are going to electrically deenergize these and discharge air, and the valves are going to open. The scram outlet valves are going to open first. Immediately after that, the scram inlet valve. The water is going to go under the piston. It has got to go somewhere. It comes through the outlet valve to the six-inch header, the Scram Discharge Volume.

I have drawn it simply here. Here is your six-inch header. Here is your two-inch drain line going into the instrument volume. We deenergized here. Electrically we also deenergize the vent and drain autoclose solenoids. These are going to discharge atmosphere the same way that these did. They are going to take the air off of the vent and drain valves, and they will close also.

Right here I have shown a manual oscillation valve from the control room. The operator has a hand switch. He can open this valve. It will block the air here, deplete the air to these things, and he can close those valves if there is no scram signal in them. If the scram signal is in, naturally this air header would be depleted and he could not reopen the valves. I have also shown our 3 gallon, 25 gallon and 50 gallon switches on the instrument volume.

Now, what we just talked about is the way the thing is supposed to work. We deenergize here. These valves open. The water pushes the drive in. That is what happens. It works.

Now, in talking, within an hour after the happening, with the operators, and the shift technical adviser was there, what they saw on the vertical core display -- this is typical, once again, of this 185 of these. It shows the control rod position. It is probably also the revision number of my drawing, but anyway it shows, in addition to that position, it has four small lights there.

Here is a blowup of what you see. You can see the positions of that rod. It has got four lights there. Now, the first one is the accumulator. We have a pressure switch and a level switch down here, and since you have got 1500 pounds over here, 1100 pounds here, any passage will be water into the gas. We have a level switch. If we get water in there, you get some enunciation.

If this pressure should sag and drop down, he also gets an enunciation, a little amber accumulator light. Here is a rod identification number. If it drifts, if you ever get a drift alarm, the thing is right here. You have a little blue scram light, a direct indication of what the scram valves did.

There are switches actually on the valve that are in series. When both of these valves come off of their seats, and it requires both of them, they turn on this blue scram light.

Now, what the guys observed on the east side was that those control rods were sitting there, the blue scram lights were on. They knew that the valves had to be opened from that, but the key was that there was a recognizable position in the window right there. That told me that that rod not only had stopped going in but it settled out. And it settled out at the time that it had a full scram signal. The water had a path in, no doubt about that. Since it did not go anywhere, that header was full of water.

MR. EBERSOLE: There is no pressure indication on the dump volume per se for the dump volume pressure.

MR. EDMONSON: Down here.

MR. EBERSOLE: Yes.

MR. EDMONSON: No.

MR. EBERSOLE: Why not? Would you like to have it? If not, why not? It is cheap.

MR. EDMONSON: It does not matter to me.

MR. EBERSOLE: Well, that would have quickly verified your problem. Anyway, you don't have it. Carry on.

MR. EDMONSON: I'm not so sure. I'm an electrical man. Those faucets and valves are beyond me. Anyhow, that is the operation of the system.

Now, you notice I haven't talked about electrically how we deenergize these. I believe I have satisfied all of the guys before that that works, and in your handout I gave you a writeup and a little sketch of justification for the proper electrical operation.

Has anybody got any questions?

MR. PLESSET: Does that complete your presentation?

MR. ZUDANS: I would just like to make sure. The backup on scram is only on the head portion of it?

MR. EDMONSON: That is correct.

MR. ZUDANS: It drains the air from the scram valves so that they can open up.

MR. EDMONSON: Yes.

MR. ZUDANS: There is no backup on water lines of any kind. In order to get the scram you have to move those two valves.

MR. EDMONSON: That is correct. I think you were talking about a problem with just one valve.

MR. ZUDANS: I understand. There is no backup also on normal insert and withdrawal. You have to operate the pair of valves, and they are the same valves all of the time. So the whole thing depends on these valves being able to function properly, right?

MR. EDMONSON: Yes.

MR. ZUDANS: Thank you.

MR. EDMONSON: In a worst case, it would be one route. The redundancy in that thing --

MR. ZUDANS: We understand that.

MR. PLESSET: I think we should go on. I think you have answered Mr. Zudans' question three or four times. That should be enough.

MR. DOMER: The next subject is the as-built design, the scram system, and John Rathjen is going to make that presentation.

MR. RATHJEN: My name is John Rathjen. I am with the Nuclear Maintenance Branch of the TVA. In presenting the as-built configuration of Browns Ferry Scram Discharge System, we prepared these handouts which duplicate all of the Vu-graphs which I will be working with this morning. They are in the same order as I will be presenting them except for one insert I see you have found.

Because of the detail that was included on it, it had to be slightly larger than the Vu-graph. There are also some additional drawings which had a great deal of detail on them, and because of the reproduction, we lost some detail. However, we do have the full-size drawings available, and you will have the complete detail of those.

By way of introduction to the mechanical configuration, I would like to digress a little bit by going over part of it that Mr. Edmonson went over by starting off with a simplified control rod drive hydraulic control system. Represented here within the dotted lines is a schematic of an individual hydraulic control unit.

There is an individual unit provided for each drive, and each hydraulic control unit in turn contains all of the valving and hardware necessary to correct the flow of the normal insert and withdrawal to direct the movement of an individual rod. Under normal operation, the control rod drive hydraulic pump provides pressure that is routed in the proper direction through the directional control solenoid valves to either of the insert or the withdrawal side of the double acting piston on the control rod drive.

However, under the situation which we are discussing, the scram conditions, when a rapid insertion is desired this pressure is provided by a more direct route from a precharged accumulator which will direct pressure into the insert side of the control rod drive to the inlet scram valve, which we have already discussed.

More importantly for rapid insertion you require rapid evacuation of any hydraulic fluid from the opposing side of the double acting piston. This is accomplished by the opening of the Scram Discharge Valve, which slightly leads the insert valve in the opening.

Each rod as driven will displace approximately three-quarters of a gallon of water, and it is this volume which adds up to approximately 140 gallons for all 185 rods. And where it goes and what receives it, that we call the Scram Discharge System and we will look at it next.

This corresponds to page 2 of your handout, and it is a simplified isometric of the Scram Discharge Volume, which is a system of two headers, all located on the east and west side of the reactors, which is represented in red here, these two banks, made up of six-inch diameter piping.

These are located on the 565 elevation of Browns Ferry, and they are located directly above two banks of the hydraulic control units. So on the east side directly below this header system are 93 hydraulic control units, on the west side, 92 hydraulic control units. Each of these hydraulic control units is routed by one-inch stainless steel, direct discharge water into this header system, running from both header systems to an individual instrument volume tank.

Also shown in red is a two-inch line coming from the east approximately 170 feet long to get to its instrument volume connection. Shown in yellow off both banks is a vent system for each header which directs down to an individual vent valve for both the east and the west sides.

Also coming off of the instrument volume tank on this drain line is an individual drain valve. The two vent valves are both one-inch valves that are schematically operated by a diaphragm. They are normally closed. They are spring loaded to the closed position. And the drain valve is a similar valve except that it is a two-inch valve.

Not shown on this drawing are the flows that occur downstream from the vent and drain valves. We will get into detail on that later on. I will simply say that right now they go down through the floor and eventually tie into the clean rad waste system.

Under normal operating conditions these valves are open. Upon receipt of the scram signal, these valves go to the closed position to contain and limit the amount of water that is displaced by the control rod drive discharge system.

Page 3 of your handout is a closeup look at the instrument volume tank that we saw on the previous schematic. Shown here are the two-inch line connections running from the individual east and west headers. The tank is equipped with valving and piping that connects these six-inch liquid level sensors. The six are rated on a configuration which gives us three different tank level readouts, the lowest being the 3 gallon level, the second at a 25 gallon level, and a remainder of the switches at the 50 gallon level.

Also shown on here is the drain line, the drain valves, which goes to the closed configuration during scram, and a relief valve which is provided on there and set to relieve at 1250 psi.

I would like next to look at the detailed drawing on the Scram Discharge System, which is page 4 of your handout. It is laid out in isometric form similar to what the previous simpler schematic was that you looked at, except that it contains all the detail and is actually made by site personnel of an as-built configuration.

This is one of the drawings we have the full size on. It contains all of the dimensions and is a little difficult to read on the reduced size. Again in red I have shown the six-inch piping, which consists of or makes up the headers, the two-inch piping which routes from both of them to the instrument volume tank. The instrument volume tank is in yellow and is in a large scale here so you will see all of the detail.

You can see that on the drain side of the instrument volume tank, we had the relief valve and the drain valve which both tie into the same loop vent and tie down through the clean rad waste system. In addition here we have shown the flush connection which has been added to both units 1 and 3 but which are not yet on unit 2 at this time.

This particular sheet drawing shows the configuration for unit 3 at Browns Ferry. The next Vu-graph shows some variations in the configuration. They are functionally the same but there are dimensional differences in some of the routing of the pipe. This is the configuration that was in effect at the time of the incident.

You notice I have two red marks here where the vent lines go through the floor. That is the point at which the cut has been made at NRC's request in the vent line to provide a positive atmospheric vent to the header system itself rather than tying into the clean rad waste. This has been complete on all three units.

I mentioned that when we made this cut, the stepup from the clean rad waste system was capped off and the vent line was rerouted over to discharge above a floor drain for the dirty rad waste system. It is regarded by us as a temporary configuration at this time, and we will talk about some of the long-range plans later on.

MR. ZUDANS: Could I ask? You said that the vent valve is pneumatically controlled, designed to close when you lose the air pressure.

MR. RATHJEN: The vent valve will fail to the closed position. It has to be held open pneumatically for normal configuration. So if it failed to the closed position, which is the position it would go to during a scram --

MR. ZUDANS: That means during normal operations you monitor the position of that valve by what means?

MR. RATHJEN: We have a mode indication on the valve position in the control room.

MR. ZUDANS: Just on the basis of the current in the solenoid, or actual position of the valve?

MR. EDMONSON: The head switches on the valve stem.

MR. ZUDANS: Thank you.

MR. RATHJEN: There are light indications in the control room.

MR. CATTON: Do you have alarm on the air pressure loss?

MR. EDMONSON: Yes. If the control rod pressure sags, you get an abnormal --

MR. CATTON: Yesterday we heard about the drain time into these various systems, and it looked like the SDIV drains much faster than the Scram Discharge Volume. Do you plan to do anything about that?

MR. RATHJEN: Will you repeat that? The SDIV?

MR. CATTON: Yes. Your instrument volume drains much faster than your Scram Discharge Volume on the bottom side of that figure up there, which would mean that your instrument volume is not going to tell you a great deal about the amount of water that is in the discharge volume. What do you plan to do about that?

MR. RATHJEN: Well, if you will bear with me, perhaps if you can save that question, because we have personnel coming up to talk about it, a few of those, and I am just trying to get through the configurations that I have.

MR. CATTON: You mentioned one change, but I can wait.

MR. RATHJEN: It was just an opportune time because the graph just shows physically where that is located.

As I mentioned, there are variations between the three units. Basically we are addressing unit 3. However, we did complete a drawing which shows the variation on the piping arrangement, especially on the vent side of the header, for units 1 and 2. Functionally they are the same, and as shown, on this side is the east portion of the vent system on the scram header, and the west side, both for unit 1. On this side is shown the configurations for unit 2.

Again, vent lines are shown in yellow, and the header itself in red. This illustration is equivalent to the inserted drawing in your handout, where you can see on here there is quite a bit of information contained on this one drawing, so we gave you a larger version. We color coded them.

This is not intended to be an absolute drawing. It is simply a flow diagram which will give us a good perspective on the overall clean rad waste system which the scram header vent lines and drain lines for each unit tie into. It is an extensive system, and the portion shown in yellow represents that portion with the clean rad waste system that is manifold defensel; to the secondary paths into the same header line drain line that the scram discharge system has.

It is basically laid out on four elevations, with the reactor building equipment drain sump located in the lower part of the reactor building, the bottom of that being at elevation 509. If we worked backwards, it is a little easier to follow. Starting down at the sump we have the eight-inch drain line which exits approximately nine inches under the minimum water level of the sump, so that is always isolated from any other drains that exit to the sump by the water that is contained in here.

This sump is vented through a heap of filter up into the reactor building ventilation system. And if we follow back up through this individual eight-inch line, the first elevation at which it Christmas trees out is 565 floor elevation, which you will recall is the elevation at which the hydraulic control units and the scram discharge headers are located.

On this floor there are 30-odd different stub-ups going to various drains, and it is at this elevation where we have the two vent lines or had two vent lines, and the single drain line for each unit that ties into the system, located here in red.

The system that is marked in yellow in its entirety takes in approximately 65 to 70 total of different drains. The majority of them are normally closed during system operation. Maintenance valves are open to drain on a particular line or a valve in a panel. A large number of them are blanked off.

So for approximately 65 to 70 total different stub-ups that go into the system, a large portion of them should be no flow to this particular drain line. The line continues running up through the 593, to the 621, and through the 639 floor elevations, eventually at its high point going up to drain the reactor building equipment and fuel pool ventilation ducts. They are checked at that point with a check valve located in the line that is set to relieve equivalent pressure of five feet of water.

There are too many individual stub-ups in the system to go over individually; however, on pages 7-A, 7-B and 7-C of the handout are a tabulated accounting of each stub-up. There are variations between the three units, so they will be described as to which is effective for each unit.

Does your handout include these red numbers on it?

MR. ZUDANS: Yes.

MR. RATHJEN: These numbers corresponded to the left-hand margin of that tabulation, which will aid you in the following of the handout. You can trace it out and compare that tabulation to the schematics here.

In addition we have actual as-built drawings showing floor-by-floor elevations in the planned view that are included in your handout, and we will take a look at those.

MR. ZUDANS: In this line, are there any valves on this line at any location?

MR. RATHJEN: There are no valves in the drain system. It is simply a piping system that will drain, in some cases, a seal or an area here, a valve, or, for example, if you have maintenance work to do on a header panel and you want to isolate the drain at panel, then we open that valve and let it drain into the drain system. That would be under a downtime, not an operating configuration.

MR. ZUDANS: And it drains by gravity completely.

MR. RATHJEN: Yes. Most system gravity feed atmospheric pressure, which is the same for the control rod drive scram discharge system. Under norm l conditions it is open to atmosphere. Only during scram conditions does it close off and build up the discharge pressure.

This is a planned view of the 565 floor elevation, which is showing unit 1 on this side, unit 2 and 3 on this side. Since unit 2 and 3 are very close to the same, that will suffice to show both configurations. Now we have one for all four floor elevations, but typically we have a riser coming up at this point from the reactor building sump. It rises up to the 565 floor. These are on bedded piping runs.

They spread out in this configuration in this particular case, for unit 3. This stub-up would be located underneath the instrument volume tank that we looked at. It would be the line that receives the drain portion of the cycle. This would be the vent line connection for the west side, the vent line connection for the east side.

I neglected to mention the graphic drain. The total system from high point on the six-inch header system to its connection on the instrument volume tank has a slope of about 2-1/2 feet that would be six inches for the east side. It decreases for the west side, and was verified right after incident 2-B. Negative slope all of the way. No traps. So it should properly drain.

MR. ETHERINGTON: That slope is on the drain line. Does the six-inch header have any pitch?

MR. RATHJEN: That slope I addressed was on the six-inch header, the high point of the six-inch headers, through that two-inch line connecting it to the instrument volume.

MR. ETHERINGTON: All right.

MR. EBERSOLE: Mr. Rathjen, this is a lot of detail that you are going through here. Is it fair to say that you have enhanced the venting by putting new vents in? Although it is still not a safety degree function, you have improved the venting system as an interim measure.

MR. RATHJEN: It is NRC's idea and it has been approved.

MR. EBERSOLE: Anyway, you have done something to it.

MR. RATHJEN: Yes.

MR. EBERSOLE: But it is still not a safety function per se.

MR. RATHJEN: After this event it has no possible component between it, nothing to fail, and that is going directly to the atmosphere. It is a positive vent in that sense. In that sense it is an improvement.

MR. EBERSOLE: It is unimpeded. Now, on the drain, have you done anything to enhance the drain? You know, you were going through a lot of things, but in the long run, there really is not safety function per se. Is that correct? You are counting on the instruments and the dump volume to do whatever has to be done.

MR. RATHJEN: We have not modified the drain.

MR. EBERSOLE: So you really haven't improved the drain, have you?

MR. RATHJEN: It has been tested extensively on the run.

MR. EBERSOLE: In the long run you can fool with the drains and the vents until something freezes over, but you will still be dependent on the instrument and the instrument dump tank to tell you and do the proper things in time, whether you have 10,000 ways of doing what you are doing.

MR. RATHJEN: Yes.

MR. EBERSOLE: Now, the crux of it is the instrument dump volume doesn't tell you what is going on in the main dump tank. It doesn't tell you that the water is still in there. So I understand you have interim measures to verify whether these are empty or full.

MR. RATHJEN: You are referring to the sump?

MR. EBERSOLE: No, I am talking about the main dump, the two big headers.

MR. RATHJEN: The scram discharge.

MR. EBERSOLE: So the crux of it is you are supposed to be at this time continuously monitoring -- is it continuous or intermittently monitoring?

MR. RATHJEN: Continuously. It is a recorder.

MR. EBERSOLE: It is a recorder monitoring of some state of the dump volumes.

MR. RATHJEN: Yes.

MR. EBERSOLE: What is it, ultrasonic?

MR. RATHJEN: It is ultrasonic.

MR. EBERSOLE: So you know on a continuous basis whether there is water in it or not water in it.

MR. RATHJEN: Yes.

MR. EBERSOLE: No matter how you do all of these things.

MR. RATHJEN: That is right.

MR. EBERSOLE: Is that right?

MR. RATHJEN: That is true.

MR. EBERSOLE: So that is your main current thrust of safety.

MR. RATHJEN: That is what is in existence right now, and we will address what we will do.

MR. EBERSOLE: Does that monitoring give you a modified identification of how much water is in there or any water at all or what?

MR. RATHJEN: Yes, it is accurate down to within about a half-inch.

MR. EBFRSOLE: So it is a good visual.

MR. RATHJEN: Past a half-inch we would get an actual readout of what levels are in there.

MR. EBERSOLE: That is great.

MR. RATHJEN: We use that on several other forms of testing.

MR. EBERSOLE: And someone is eyeballing that on a chair or something all of the time? You don't have any automatic function.

MR. RATHJEN: All these units are set up and there is a recorder set up on each one. This man is making continuous rounds taking readings.

MR. EBERSOLE: There is nothing enunciating any change of volume at the moment. You are depending on the personnel observation.

MR. RATHJEN: There is a local alarm, I believe.

MR. ABERCROMBIE: There is a local alarm.

MR. EBERSOLE: Where there is water in it?

MR. ABERCROMBIE: Yes, plus the recorder.

MR. EBERSOLE: Is anybody in there to listen to the local sound?

MR. ABERCROMBIE: He usually makes his rounds within 30 minutes.

MR. EBERSOLE: In a 30-minute interval, what is the opportunity of filling that. Do you know?

MR. ABERCROMBIE: I think to actually fill that volume in 30 minutes, I don't know what catastrophic failure would have to occur. We have not identified any.

MR. EBERSOLE: Have you looked for the possible ways to fill it within the 30-minute interval, like a broken valve that you could not see on the drift?

MR. ABERCROMBIE: I think what we have learned from General Electric about the flow rates on the failures of, say, any seals or any scram valves, but that would not by itself fill the lines.

MR. EBERSOLE: You pick the 30 minutes, then, intentionally, to say that there is nc mechanism that could fill it in that interval, is that right?

MR. ABERCROMBIE: We thought that was a conservative approach.

MR. EBERSOLE: You could have picked two hours or ten minutes or one second, I don't know what. But there was a conscientious examination of the modes of possible fill. Ultimately they are going to be continuous.

MR. ABERCROMBIE: Yes.

MR. EBERSOLE: Right now we are riding on a -- thank you.

MR. ABERCROMBIE: But I would like to say that you certainly identified what we consider the bottom line, and that is that you have to know about water in the volume. Everything else doesn't really matter.

MR. EBERSOLE: Everything else is really gingerbread.

MR. ABERCROMBIE: Convenience.

MR. RATHJEN: I think I have about covered the ground. I don't think there is much point in looking at the other drawings in here. In your handout is simply the floor-by-floor breakdown of the floor plan of the rest of the drain system. I believe that is it.

Are there any further questions?

MR. ZUDANS: Would it be feasible to run a larger than two-inch line from -- is it technically or practically feasible to increase the size of two-inch drain line from east and west side for the SDIV?

MR. RATHJEN: I believe so, and I believe that is one of the considerations of doing that. There are a number of different concepts.

MR. ZUDANS: We will wait.

MR. PLESSET: Why don't we go on, then.

MR. DOMER: Bert Morris is going to cover several agenda items here in the event sequence itself, our evaluations of why the event occurred, investigation items, including the investigation, and he is going to cover corrections that have been made today.

MR. MORRIS: My name is Bert Morris. I work out of the Reactor Engineering Section of the system in Chattanooga. I am basically going through the same general program that G.E. has presented which concerns the sequence of events. I understand some of you may already have seen this presentation, so I may be repetitive to you.

I have some nice visual aids which are available to you, and also their conclusions are basically the same as our own.

On the early morning of June 28th, we were shutting Browns Ferry 3 down for some maintenance. This is normally -- on a manual shutdown like this, we ordinarily run the recirculation valves back to a fairly low power level and then insert some rods so that we manually scram. We were preparing to manually scram the reactor. It is pretty much a full power rod pattern.

We had inserted ten power rods to further reduce the power level from the point that it was scramming.

This next slide here shows the actual rod pattern prior to that first scram. You can see there was a substantial number of rods that were out. We had 185 rods out at Browns Ferry. Of these, 157 rods were pulled out the full way and we had 18 rods in intermediate positions.

Now, on this picture we also show the rod position after that first scram, and we see that there was a substantial number of rods on the east side which failed to go full in. You will notice that every rod actually did move some distance, but we went in and looked at the individual rods and the distance that they went in, and we tried to correlate it in certain ways so that we could install the flow and unique piping configuration on the header itself.

We were unable to really draw any kind of conclusions on individual rods, with the exception of the fact that the faster rods as measured from our own scram timings --

MR. EBERSOLE: I think at this point in time I would like to divert a little bit anyway. The operator on the desk watching this must have had some kind of mental and physical reactions which were extraordinary to see that the rods were not in when he loaded the building.

MR. MORRIS: It is really not very difficult to tell that. Ed was talking about the blue lights before. Also with the rods when you have a scram you really don't have a rod position indication as such. You have what is a green background.

MR. EBERSOLE: But anyhow, he saw that he did not get a scram. Do you have any kind of a record of his physical reaction to this? Did he say to himself consciously, should I trip the turbine, should I engage bypass, should I execute pump trip? Does he, in fact, have an ordered, deliberate procedure for this case?

MR. ABERCROMBIE: Does he now, or did he then?

MR. EBERSOLE: Did he then? I mean here is a case where --

MR. ABERCROMBIE: No, there was nothing explicit such as the procedures that we have in place now for any event such as this.

MR. EBERSOLE: He did not get the signal for automatic pump trip because he did not get a pressure supply, so he surely did the right thing in not tripping the turbine or asking anything to close steam flow. Otherwise, it would have been quite different if he had stopped steam flow, especially if the bypass stuck. But do you think he consciously let steam flow continue, knowing that it was the best thing to do?

MR. ABERCROMBIE: That is difficult for me to really say.

MR. EBERSOLE: Okay. Was the turbine tripped before the rods had all gone in?

MR. ABERCROMBIE: Yes, he tripped the turbine shortly after that. The power levels that existed, he cannot have maintained the turbine on. The bypass system was functioning properly, and he knew he was --

MR. EBERSOLE: So he had bypass, so he tripped.

MR. ABERCROMBIE: Yes.

MR. MORRIS: In the part of the handout I have given you, there was a test breakdown of the actual sequence of things in a little bit more detail than what I have gone through, so you might look through that in a little while. Actually, following this initial scram there were several operator actions and observations and whatever.

The operator actions here were routine things that we normally do after a scram at Browns Ferry. Normally you clear the Scram Discharge Volume, high level and bypass to allow to reset that scram at your first opportunity. This will override your high level scram on your discharge volume instrument volume.

We took the reactor load switch which shut down, which also initiates the scram itself if one had not already occurred through your manual actions. Your low lying, low level neutrons were on in. The operator observed up in the blue lights on the control panel there all the scram valves did indeed open. The accumulators discharged and the APRM instruments or the gross power was all the way downscale.

Other than that other thing as far as pipe configuration, everything seemed pretty normal.

MR. ZUDANS: You say that all accumulators discharged?

MR. MORRIS: Yes, sir.

MR. ZUDANS: Without actually moving the rods in?

MR. MORRIS: All accumulators discharged.

There are a couple more significant points to note. The scram level switches. This was determined in subsequent determinations. High level picked up in 18 seconds compared to normal 40 to 50 seconds to load to pick up those high level switches on the instrument volume, 40 to 50. That was a real consistent number, and it was significant that we got that much water in the instrument volume in such a hurry.

This display here is what the neutron instrumentation, the LPRM readings and our power monitors read following the first scram. Again, this would be your east side of your core. You see comparison with CRDs, and you can see that we had several low readings on the east side and more of what would be the top in the reactor core.

Earlier we referred to the fact that the amount of insertion on the individual rods was correlated against the scram speed. As a visual representation of that, this is the chart of how far, on the average, particular rods got from the rods that were at full out to begin with, position 48 versus the scram insertion time that had been noted previously as far as testing goes.

I see generally the rods with a faster scram insertion time than they probably were before.

On scram number 2, the operator had reset the scram on this time. Resetting the scram will allow the drain valves and the vent valves on that scram discharge system to come back open and you will commence draining the instrument volume. There was about 100 seconds of drain time between the first and the second scram. That is between the time the operator reset the scram and initiated the manual second scram.

Again, the observations were similar to the first scram. All scram valves were indicated open by the blue light. All accumulators discharged. All rods again moved somewhat. There are still 59 rods partially out.

And here is the actual rod positions. You can see they moved about five notches, on the average. Again, particular rods moved farther than some others, and some moved very little. The same scram speed correlation approximately holds for the second and subsequent scrams as well.

The operator basically repeated his actions again. He was convinced that the scram was well under control and was taking positive efforts to get the rest of the rods in and reset the scram again between the second and third scram, about 53 seconds of drain time, and initiated another manual scram. Again the rods moved in in a small way, about three or four notches this time, and we still got 46 total rods out.

MR. ETHERINGTON: Are those times consistent with the estimated drain time? I mean does it assume the boiler has drained away sufficiently to permit a second scram?

MR. MORRIS: We haven't calculated that specifically. We did some approximations, and it seemed like the total number of rods and notches that went in was about proportional to the drain times between the successive scrams.

MR. ETHERINGTON: About proportional, you said?

MR. MORRIS: Yes.

MR. EBERSOLE: In the meantime, the bypass system was --

MR. MORRIS: The bypass and normal feedwater system was maintained in normal conditions. It wasn't what we would have seen that we had in the past.

On scram number four the operator allowed a little more drain time this time between the third and fourth scram, I think about 160 seconds. This time he did not manually scram the reactor. He took his instrument volume bypass switch out of bypass. There was apparently high water still in the instrument volumes as we would expect, and he got an autoscram after he took that bypass switch out of bypass on his intrument volume.

This is roughly 14 minutes after the beginning of the event. All rods went in, and what the operator described as a normal scram.

MR. THEOFANUS: What is his part at this point? He took the bypass off. Was he trying consciously to go in it in some way and do something?

MR. MORRIS: I'm not sure that he was.

MR. ABERCROMBIE: I'm sorry. I did not get all of the question.

MR. MORRIS: He is asking if the operator intended to scram by moving this bypass switch. I don't believe it probably was.

MR. THEOFANUS: Do you know what path he was on at this point? Is it known now what he was trying to do at this point? Presumably your down time -

MR. MORRIS: He pretty much knew what he was trying to do. It would not have made any difference whether he manually scrammed or tripped that bypass. The end result would have been the same.

MR. ABERCROMBIE: It really was a deliberate action. They knew that they had problems with water. That was what they had assumed was stopping the rod movements. In this case his enunciators told him that the scram discharge volume had completely drained. Therefore, he went to the normal position.

It was a deliberate act based on the indications that he had at the time. And then, as we learned later, there are a lot of things that are happening in that Scram Discharge Volume as far as those level switches are concerned, and he still had a high water level in there as soon as he shut the valves, and he scrammed them right out.

MR. THEOFANUS: Let me ask the question another way. I think you can help me with what you said, but one more step. Had the scram not occurred at this point, the automatic scram, what would be his next action?

MR. ABERCROMBIE: He was getting set up to do a manual scram.

MR. THEOFANUS: That is all I wanted. Thank you.

MR. MORRIS: I guess he did manually scram it.

MR. ABERCROMBIE: Yes.

MR. MORRIS: All rods went in shortly thereafter.

MR. ZUDANS: You said that they knew the Scram Discharge Volume was empty by instrument. There are no instruments in the Scram Discharge Volume.

MR. ABERCROMBIE: Yes, on the instrument volume is what he was looking at. All his indications told him the instrument volume was drained, and he went normal.

MR. EBERSOLE: Let me ask a question. Mr. Abercrombie, is there instilled in the operator a feeling, a gut feeling or whatever you want to call it, that the worst thing to do under the circumstances of any kind of stuck rod incident is to turn off free flow of steam; that he is to do everything in his power to keep free flow of steam moving to avoid water collapse when he arrives up to the safety degree pressure?

Is he trained to at all costs keep the turbine rolling, keep the bypass open, keep the MSIVs open, keep the steam moving, because if I don't move it, if I close it I am going to have one collapse and a reactivity spike, which would be hard to cope with?

MR. ABERCROMBIE: I think it is fair to say that maintaining the heat safe under those conditions is instilled.

MR. EBERSOLE: He is going to try to keep the steam flow, and if he could, he would dearly love to bypass MSIV, and he did flip to the -- let's say he was in the run mode and he did the mode switch. He put it in what? He went to -- what is the other?

MR. ABERCROMBIE: Shutdown.

MR. EBERSOLE: Now, that bypassed the whole steam bypass of the MSIV, didn't it?

MR. ABERCROMBIE: Yes.

MR. EBERSOLE: That was good. As a matter of fact, he dearly would love to prop open those MSIVs so they would not close all of them.

MR. MORRIS: That is part of the reason we do move that switch.

MR. EBERSOLE: I often thought that we ought to have a hard iron bypass on that MSIV.

MR. ABERCROMBIE: There is many a time I wish we had had it.

MR. EBERSOLE: Right.

MR. MORRIS: This is the scram that we liked real well. This is self-evident what it will show. This is just a quick summary of the drain times between scrams. I have already given you these numbers. Again, I would like to say that we did do a real simplistic correlation between drain times and the total number of rods that were inserted on such a scram, and they are proportional.

In your handout now you do have a little more detailed sequence of events. I am not sure we really have time to go through it. I just included it in there for your inspection. You may scan it and pick out questions.

These are some of the inspections and checkouts that we did immediately following the incident or shortly thereafter. The hydraulic control units were moved out and perhaps someone went down there and changed some valve lines on each side. It takes you about three or four hours to do something like that.

We sent operators and Ed Edmonson and his men down there immediately, and he blocked the whole system on the east side, verified all of the manual valves on individual hydraulic control units, and indeed, they were in the description. We had two or three people who were just to make sure that those valves were indeed lined up right.

We went in and operated the drain vent valves. From all indications, our operator observations -- or prior to this event they had been trained, and all valves were indeed open, and they were identified in the control room with the lights up there. We went in and calibrated all of the instrument volume switches. All 50-gallon scram switches were successfully calibrated.

We had a little bit of trouble on 3 and 25-gallon switches on the first time that they tried to calibrate them. Calibration procedure was a little different than what you normally expect in a scram. With the slow fill time they can kind of look at some of the flow switches that kept them from picking up on the first attempt to calibrate them.

Operator did verify that the 3-gallon switch picked up during the incident and the 25-gallon switch as a computer point was verified to operate and picked up there, and then during the first scram, and subsequently cleared at the end of the whole event in the correct sequential order, and apparently they are at the 50-gallon switches. So we knew that those switches were working as well during the entire time.

We went back through all of our control rod maintenance malfuctions and modification activities for either the past several months and the past couple of years as far as modifications went. We did not see anything at all that could affect what happened down there. We walked down all of the air lines to the hydraulic control units and the vent-in valves to see if maybe some unauthorized work had gone on inadvertently or something like that that wasn't controlled. Everything was certainly normal.

We pulled all of the CRD temperature logs, and temperature logs will tell you sometimes if you have a successive seal leakage on your CRDs. I think there were a couple of them on the west side that were a little hotter than normal. There were no hot lines at all found on the east side.

We went in and made cuts on all of the vent lines, the two-inch drain line, the scram headers themselves and the instrument volume. We ran a boroscope in there to make sure we had no obstruction in those lines. That is the two-inch long line on the east side. It was cut and rodded out, and then we looked through and nothing was found.

Possibly some big blockage in the sump lines, drain lines was there. So we went down there and looked around the sump for some large object, and nothing was found down there.

Prior to starting back up on the unit 3, we went through the exhaustive CRD test program. We did our friction testing, which is essentially measuring the differential pressure it takes to drive that rod in and out of the core. You notice we measured the stall flow there. The stall flow tells you the shape your seals are in, and also the rod scram time. All these rods and everything were just perfectly normal.

This indicates mechanical integrity of the rods was not impaired in any way. We did some flow and drainage tests on the unit 3 Scram Discharge System. We pumped a bunch of water in there in variations of the drain times, how they open and flow on east and west sides, and we had a lot of things taken there, and we will talk about that a little later.

Ed Edmonson there went in and did a series of testing on the electrical portion of the reactor protection system, and there was nothing wrong there either. The same parallel path he took there. Their CRD hydraulic test unit. They were proceeding on some confirmatory test. By this time it was pretty much decided that there was water in that header which gave us the problem, and we wanted him to go in and put some water in there and have a test modeled out there and demonstrate. A test setup will act the same way as what our rods did.

MR. MORRIS: We were sure there was water in that volume which gave us the problem.

The second point here is, I guess you would say, whether, if you had money or something you could bet on, but there was a restriction -- and that six-inch header comes into the two-inch drain line -- in that scram line there was a restriction of some sort in that two-inch wraparound line on the east side of the CRD models.

However, our subsequent testing indicated that the vent system sort of impedes your drainage from those headers, so we cannot -- we can say that the vent did contribute to the incident.

MR. EBERSOLE: I can't help but look at that slide again and notice that our problem is a common one to the sewage plumbing industry. So I suggest you invoke the plumbers in the future investigations. That is all it is.

MR. MORRIS: We considered a number of causes, and I think we have already addressed some of these that I just went through there. We went down and sat down and think of all of the things possible that could cause the problem and just either eliminate them in a methodical manner or suggestions maybe that are plausible. And these are some of the basic causes that one might hypothesize to give you problem.

One is certainly electrical reactor protection system logic, valve line on the hydraulic flow unit or some total malfunction in the hydraulic control unit that would give a problem. And the mechanical problem on drive system itself would postulate it perhaps. The instrument volume is plugged up and none of the drain switches were a problem with the scram discharge problem proper.

I said that during the same period of time GE was supporting us in San Jose, both analytically and with some test work that they were doing.

Let us look through some of the causes that we considered. First is electrical, and ended with that with a bunch of the reactor protection system logic. I think Ed Edmundson went through a pretty good discussion of why we don't think that is a problem. In fact, the operators always had blue lights which were indicative of the scram valves actually moving to the scram position. Also, all of the rods moved every time, which would be the logical if the scram signal wasn't going. The post-test that they ran showed that the logic wasn't working like it was supposed.

The hydraulic control unit. Checked all of the valves. The accumulators all worked like they were supposed to. A good indication of scram valve positions in the control room. The air system looked like it was working fine. The testing on the modules that we did, scram testing, all such vents looked all fine. Maintenance looked good. I think it would have been a problem in the hydraulic inspection, but it was inspected, and probably on the west bank drives as well. They all responded.

Control rod drive -- I guess the best thing you can say there is that we went back in and mechanically tested all of the east side drives after the event and nothing looked wrong at all.

There seemed to be a lot of interest in the possibility of the instrument volume somehow plugged up and all of this for some reason. The level switches did not work. I think the path problems of the various plants with those level switches at one time or another -- we don't think this is the case because we would not preferentially bother the east side rods which affect both banks. And if that were the case, from all the data that we have all of the switches worked in the proper sequence during the entire event.

This sort of leads you down to the problem out in that discharge volume, particularly the east side. I say again it is sort of significant that the scram level switches tripped in 18 seconds. As I said before, the 40 to 50 seconds was a real number. We went back for X many scrams. Unit 3 hadn't scrammed within the last three weeks. We went back to auto scram in the system, and somehow we got that volume in 18 seconds. We just believe there was a lot of water out there to begin with.

MR. PLESSET: Do you have any speculation as to why there was such differences between the degree of insertion and the various rods? Some of them went in much further than others?

MR. MORRIS: The only thing that we have been able to show there is at the scram speed. That is what we expectd, faster rods to go in further.

MR. ABERCROMBIE: We went back, and Unit 3 had usually come out of a refueling out. We went back and got the scram times, and I think he pretty closely correlated that the rods that were the fastest on scramming in were the ones that went in the furtherest.

MR. PLESSET: So it did correlate?

MR. ABERCROMBIE: Yes.

MR. MORRIS: We showed the figure earlier in the handout which shows this.

MR. WU: Why is there such a drastic difference between the east and the west banks if they are differentially one side -- why the two sides are so drastically different?

MR. MORRIS: I am not sure I know what you are asking.

MR. WU: I understand that there is some difference there.

MR. ABERCROMBIE: In the drain time?

MR. WU: Well, I was referring to the east bank and the west bank. If the west bank scrams were normal and the east bank, the distribution of them in the insertion time.

MR. MORRIS: Are you locking at the figures? Is that why you are asking the question? The west bank problem is not the same distribution scram times. That distribution is pretty much -- that is distributed on both sides.

MR. ABERCROMBIE: We do not believe there was any water in the west header at all. We believe only that the east header had water in it.

MR. EBERSOLE: At this time you think that it may be either due to the improper venting or the flow restriction in the long pipe, is that right?

MR. ABERCROMBIE: Yes. I wish I knew really what caused it.

MR. EBERSOLE: One other parameter that can cause it, if you can dream it up, it is pressure, even though it is drive pressure in that header. Is there any possible way that you can get drive pressure from some unexplained source in that?

MR. ABERCROMBIE: I sure don't know of any.

MR. ZUDANS: I have another question. You mentioned that scram switches drift in 18 seconds instead of the normal 40 to 50. That kind of contradicts or indicates that you had some water sitting in the SDIV already.

MR. MORRIS: Not necessarily. It was in the volume force, not volume pressurizes. You can force a lot of water through that two-inch line in a hurry.

MR. ZUDANS: Was it meant to force the water out of the SDV on the west side because it was a short piece of pipe, but did manage to force out the east side?

MR. MORRIS: What you are saying is true, that water was in the east side. That would have to come from the east side. I imagine though you have a significant volume of water sitting already. Essentially you are trying to shove a whole bunch of more water up there at considerable pressure.

It certainly pressurizes that east side in a hurry and forces a lot of water over there to push on that. Rather in this case, it was just a predrain system like a normal pressurized or pumping that water over into the east bank.

Essentially the drain valves would go slower than the vent valves.

MR. PLESSET: Let me see if I understand. You have tested the insertion rate on individual rods separately. Do they vary all that much, and if they did why would that be?

MR. ABERCROMBIE: There are variations in the scram timing. I don't recall the data and we have, I guess, sort of an onload on the tech specs that the rods have to insert at a certain time. There are rods that because of seal conditions go in faster than others.

MR. PLESSET: So it is just variations in the way that the seals have --

MR. ABERCROMBIE: Yes.

MR. MORRIS: They may vary two seconds or three seconds from --

MR. PLESSET: There's not that much seals.

MR. MORRIS: Like I said, it was seals, there is a certain amount of friction that your rod receives when it goes into the core unit due to the particular channels and things like that.

MR. EBERSOLE: When the nitrogen and accumulators individually bottom out how much pressure is left in them, 500 pounds?

MR. EDMUNSON: 560.

MR. EBERSOLE: Do they have diaphragms to keep them in?

MR. EDMUNSON: Yes. It is a piston.

MR. EBERSOLE: There is no diaphragm seal between the water and the nitrogen?

MR. EDMUNSON: You are asking if there are seals?

MR. EBERSOLE: Is there a nitrogen bladder in the bottom of that?

MR. EDMUNSON: Not a bladder, no. There is a double over-ring seal piston.

MR. EBERSOLE: And when it bottoms out it is at 500 pounds, right?

MR. ABERCROMBIE: In that, yes.

MR. EBERSOLE: If you had boiled over, would that nitrogen have proceeded into the dump tank because the dump tank pressure is a lot less than that?

MR. ABERCROMBIE: Yes. We looked at that a possible mechanism too, but when you look at it, you have nitrogen in the volume, it is going to evacuate just like air.

MR. EBERSOLE: Yes, except that it will take a while.

MR. ABERCROMBIE: Also, preferentially, water will leak into the accumulator because the choice of water pressure is higher.

MR. EBERSOLE: That is before you scram?

MR. ABERCROMBIE: Yes, before we scram. I am saying that that system basically tells us that the seal is intact before the scram and there should not be a mechanism that would cause the seal to just catastrophically fail.

MR. EBERSOLE: You mean as it discharges nitrogen you say you don't allow for seals failing at that time and allowing the nitrogen in the accumulator to go into the dump volume?

MR. ABERCROMBIE: Let me see. Monty, you are still -- the accumulator pressure, the nitrogen pressure will still be lower than the reactor pressure.

MR. EBERSOLE: I know, but it is higher than dump volume prior by a long sum.

MR. ROSS: We can show that during the subsequent scram actuation the control room panel lights show that the accumulators all recharged. It shows that --

MR. EBERSOLE: They all recharge?

MR. ROSS: Yes. It wasn't a seal failure.

MR. EBERSOLE: I see.

MR. CATTON: If you had your option, after looking at all of this, what kind of a diagnostic system would have been helpful?

MR. MORRIS: I did not hear the question.

MR. CATTON: What diagnostics would have been helpful?

MR. PLESSET: That he did not have?

MR. CATTON: That the operator did not have. What would be helpful for him to look at?

MR. MORRIS: Dump volume pressure would not have told you anything because it was draining into the atmosphere.

MR. EBERSOLE: I am talking about after dumping.

MR. CATTON: Let me broaden it then. Before, during and after.

MR. MORRIS: The dump volume pressure will tell you that your volume pressurized a lot sooner, and the operator might see that. I don't know.

MR. ZUDANS: I still am puzzled a little bit with this 18 seconds versus the 40 to 50 seconds. I wonder if that is clear in your own mind why that happened. Where did that water come from? Was it being held in the SDIV, or was it pushed out of SDV, and if so where would that water come from? Because obviously if it tripped in 18 seconds, if it tripped the scram signal, that means that means that it filled something like 50 gallons.

MR. MORRIS: We have some data here that may explain the question for you.

MR. ABERCROMBIE: Well, one thing, GE, I think they have the data that they received from, I believe, Brunswick, where they did install some transducers on a scram discharge volume to see what the pressure transient looked like from the volume. But if you assume you start with an empty volume it takes a definite period of time for that volume to fill and come up to reactor pressure. If you assume that the volume is 90 percent full when you start the scram, then it comes to the reactor pressure much, much faster, which gives you the delta-P to force the water on through the two-inch line into the volume, into the scram discharge instrument volume.

MR. EBERSOLE: Well, at this nitrogen seal I am going to hypothesize when it went on the upstroke and you release the residual 500 pounds into the dump volume, it would assist in pressurizing that, wouldn't it?a

MR. MORRIS: It would come down to the bottom of the piston.

MR. EBERSOLE: It would assist in pressurizing the dump tank.

MR. ABERCROMBIE: Yes.

MR. EBERSOLE: And that can be compounding the problem of the pressure. Is your new canning system for the water inventory, has it been tested against several scrams so you can see -- do you have a signature, I guess you would call it?

MR. ABERCROMBIE: Yes. We have looked at some scrams with that installed, and it is evident what is happening. You can see the west volume drain, then you can see the east volume drain.

MR. EBERSOLE: You were getting a real picture?

MR. ABERCROMBIE: Yes.

MR. PLESSET: You wanted to make a comment? The man from GE. Did you want to make a comment?

MR. ROSS: Yes. As to if the seals did leak again and you are delivering even at that nitrogen to the bottom side of the dry piston, and as I described yesterday, the flow path of the bottom side of the piston isn't up past the drive piston seal, it is up to like the normal cooling water flow path which is on the outside of the drive. So it preferentially enters the vessel, not deliver itself back to the scram discharge volume. And even if it did it is just adding volume in that flow, whether it is compressable air or whether it is the water that normally flows that way. It is not going to add significant amounts of some matter that is going to cause a different signature and pressure.

MR. EBERSOLE: It is typical past the low pressure.

MR. ROSS: Excuse me.

MR. EBERSOLE: Will it tend to go past the outside then?

MR. ROSS: Right.

MR. CATTON: What maintenance are there for the nitrogen volume? Do you check the pressure? Do you check for water leakage periodically so that you can drain water from the nitrogen space?

MR. ABERCROMBIE: Yes. It has an alarm device. It would tell us if we had any water leakage into the nitrogen side.

MR. CATTON: Your comment about the nitrogen is really not true. When you push water through the system, the water is constant volume pretty much, both high pressure and low pressure. When you push that nitrogen from 500 psi into the SDV it is at roughly atmospheric pressure, and you have got a heck of a lot more volume to push out of the system. So it would not act the same. As a matter of fact, it would be significantly different.

MR. ROSS: I guess I am not understanding you.

MR. CATTON: You are decreasing the pressure on the nitrogen by maybe ten atmospheres. All other things being the same, that means the volume is ten times greater that you have got to push out through that two-inch line; whereas, the water, the volume expansion would be small.

MR. PLESSET: Let us let him think a minute. Do you want to respond to that?

MR. ROSS: Yes, I would like to respond if I understand it.

MR. PLESSET: What he is pointing out is that the nitrogen in that chamber is at very high pressure, and it goes into a low pressure region and expands. The pressure is down by tens, and it expands by ten times the volume. That is his point.

So it might have a bigger vent in that low pressure region, isn't that right?

MR. CATTON: His response to Jesse is that the nitrogen doesn't matter.

MR. PLESSET: While they are conferring on that point, can somebody tell us whether there is any evidence of deterioration in the seals?

MR. MORRIS: I am happy to. I have had a substantial number of seal failures, and your enunciation there will tell you if you have a seal failure, if you are leaking with the water.

MR. PLESSET: That would tell you the state of the seal.

MR. EBERSOLE: You mean after you pressurize you would see water.

MR. MORRIS: If in fact we did pressurize and there was water.

MR. EBERSOLE: You now have a record that they did not fail, these seals?

MR. MORRIS: Well, they were recharged, and there was no indication of water.

MR. EBERSOLE: Anyway if that did occur, would one accumulator bled down through your atmospheric 500 psi represent a substantial fill problem in the -- I mean since --

MR. PLESSET: They are working on that.

MR. CATTON: I still don't think I understood your answer about diagnostics. Did you indicate that you felt that there were no further diagnostics that would be needed?

MR. ABERCROMBIE: As far as diagnostics are concerned, the best thing that we could have was an indication that the volume was empty before we ever started. That was the best thing that we could have.

MR. EBERSOLE: And unpressurize?

MR. ABERCROMBIE: Yes.

MR. CATTON: So maybe pressure and your ultrasonic device would be a complete set of instrumentation?

MR. ABERCROMBIE: I think a level indication -- I don't know about the pressure. I really haven't thought that much about it. I am sure that will be discussed when we talk about modifications.

MR. PLESSET: Why don't let him finish his presentation? Are you almost finished? Is that right?

We will let them interrupt them when they come back with their answer.

MR. MORRIS: We are just discussing some of the inspections that we did on the east volume proper Ed Edmunson has already discussed. We inspected the six-inch headers, the two-inch headers. We inspected the six-inch and two-inch headers and looked at the instrument volume, looked in through the drains and verified that the vent lines were not obstructed.

We went out and transited the whole system, benchmarked the reactor building and transited in all of the slope and elevations on the drainage lines and found that it was a positive -- or actually a negative slope, I guess you would say, all the way from the headers to the instrument volumes.

Here is some of the data that GE provided for us that they got on their testing down in San Jose, and this figure has the scram volume pressurization, essentially the rate there, plotted against what one would assume for a seal leakage versus a turbine shear or the volume in their test rates that were available for the scram discharge into.

In other words, I think 3.3 gallons is the nominal volume allowed for a particular drive in the scram discharge volume and have it available to it to discharge into. So on 185, roughly three times 185 on Browns Ferry, this shows that as you start limiting the volume available to you in that scram discharge volume pressurization it works very fast.

MR. CATTON: Is this time to pressurize the reactor pressure?

MR. MORRIS: I think so. It is very close, but not exactly that.

MR. EBERSOLE: 1530?

MR. MORRIS: Here is a couple of points that is not quite clear on the graph there. With the available volume even less, you see the pressurization rate is very, very fast there. They get those on the chart there on those points.

MR. ABERCROMBIE: That particular chart I think GE was using to indicate that we were about 90 percent full on that volume.

MR. MORRIS: I think this shows, this slide here shows that same thing. It says time after the strike --

MR. PLESSET: Will you explain that statement? I did not quite follow you. You say they used this data to indicate that the SDV was 90 percent full about?

MR. ABERCROMBIE: In trying to reconstruct the event, you said, well, I have water in there. Well, how much did I have? And maybe somehow that will lead you to the source. And when GE ran through the testing that they did in San Jose and came up with these curves, I think everything that we saw kept coming back to that volume, of which was about 90 percent on the east side, before the scram.

MR. MORRIS: Also, this graph shows the normally expected scram time to be roughly three seconds on the scram time. So even a substantial volume, at least in that volume, immediately available for the scram, was finally pressurized.

MR. EBERSOLE: It comes to my mind here that just that curve doesn't throw it away. It has some important implications. Will you put it back up again?

Notice the variation in the three curves on the volume. About how fast it can possibly scram. And then the next curve was a -- well, let me ask you this: if I scram and I have a gross seal failure on one rod and in the course of scramming, I will now have extraordinary backfill out of the reactor system, right? On the halfstroke, after the accumulators have done their thing, and you are really scrambling. Is that going to prefill the dump volume?

MR. ABERCROMBIE: Monty?

MR. EBERSOLE: I have a gross seal failure on the rods between the piston and the reactor vessels to contribute to abnormally fast dump volume fill. Is that a mechanism by which you can prematurely fill the volume?

MR. ROSS: No. Remember again that the sizing of the scram discharge volume is based on worst case seal leakage rate.

MR. EBERSOLE: But that is a design seal related to leakage. I am going to take a catastrophic seal failure.

MR. ROSS: The design base is the number 10 GPM, is determined where we move the seals from the stop piston to pilot piston.

MR. EBERSOLE: So it is a catastrophic failure?

MR. ROSS: The seals will crack, the seals will degrade and the seals will not be removed.

MR. EBERSOLE: Can I devise any mechanical way, such as coupling reactor pressure to the dump volume on a mechanical failure before I have rod insertion?

MR. ROSS: The coupling is through the drives, and we limit the flow by the inherent restriction on the drive.

MR. EBERSOLE: If I break a drive or a piston.

MR. ROSS: If you break a drive or piston?

MR. EBERSOLE: Yes. Or piston rod, I should say.

MR. ROSS: Again, the seals are going to remain there, although you might separate a portion of the shaft itself. And the flow path is from the vessel to pass all of the seals.

MR. EBERSOLE: All right. I am just trying to visualize inadvertent coupling of a reactor pressure system to the dump volume prematurely.

MR. ROSS: We will address that in a moment.

MR. MORRIS: As I understand also, Monty, the volume at Browns Ferry is set for 10 GPM times 185 rods.

MR. RATHJEN: 10 GPM for 10 seconds.

MR. MORRIS: I thought times the total number of rods.

MR. ZUDANS: That is what I was going to ask. The GPM indicated here are per rod, but the times, assuming the same condition for all rods.

MR. MORRIS: This is for an individual rod. The design basis is carried over for the 185 rods.

MR. ZUDANS: In other words, you have 1,850 gallons per minute total flow when you indicate the intent?

MR. MORRIS: Of allowed volume for the rod construction.

MR. EBERSOLE: I am going to just mention something. You haven't had a scram for some time. Where would that water come from that you think was in the dump?

MR. ABERCROMBIE: I wish I knew. We just did not come to any conclusions of any source.

MR. EBERSOLE: You don't know where that water came from? But it had to come from someplace.

MR. ABERCROMBIE: If it did remain there from the last scram, then that lends some credibility for some blockage in that two-inch line. And then we developed, or directed pressure in that volume, very quickly on that scram on the 28th, it dislodged what ver was in there.

MR. EBERSOLE: Where does GE think that water came from that was there?

MR. ROSS: You can postulate that many ways the water gets there. On a probabilistic basis, I think that the probability that the water enters the scram discharge volume 1 was leakage.

MR. EBERSOLE: It is supposed to get out of there at a reasonable rate. But this time it didn't get out?

MR. ROSS: Yes.

MR. CATTON: Could the drain valve be closing and you don't know it, or the vent valve had been closed?

MR. ROSS: Even if the water at the bottom.

MR. CATTON: How long before was the previous scram? There was a number of days, wasn't it?

MR. ABERCROMBIE: Three weeks.

MR. CATTON: Three weeks. Even if the vent valve was closed it probably would have drained?

MR. EBERSOLE: Well, I hope so.

MR. ABERCROMBIE: The test data of the drain time showed that the east volume had restabilized at about a half a GPM drain rate. So if you assume that with the vent completely closed and you stabilized, then if you had something that is slightly over a half a GPM coming in there, you would have never drained completely.

MR. CATTON: Is half a GPM an unreasonable leak rate into that SDV on the east side?

MR. ABERCROMBIE: I don't think so. That is not an unreasonable number.

MR. PLESSET: Let us go on.

MR. MORRIS: This figure shows essentially the same thing. It is a level in here. This shows for the various fill volumes in the scram discharge header what your pressurization rate would be. It is significant here to note that your pressurization rate could occur within the timeframe of your scram stroke.

I think it was about 90 percent flow.

MR. EBERSOLE: If you thought you had vented, but you had not vented because the vent valve had stuck, would that by negative pressure affect -- hold that water up in there for an indefinite period?

MR. MORRIS: You said before it will drain but very slowly.

MR. ABERCROMBIE: We did in that test we ran. The east header stabilized at about a half a GPM drain.

MR. EBERSOLE: I am talking about with the vent closed.

MR. ABERCROMBIE: That is what I am talking about.

MR. EBERSOLE: And trying to drain?

MR. ABERCROMBIE: Yes. We closed the vent to determine whether or not we would drain eventually.

MR. EBERSOLE: At a half a GPM. Thank you.

MR. MORRIS: GE also did some calculations for us showing the fill times on the instrument volume. On this particular curve, what you would normally see, it shows that it normally would be about typical of what we see on records, about 50 seconds to pick up those 50-gallon switches. And they contrasted this particular figure. Maybe you will be able to read this better.

GE did some similar calculations, assuming that that east header was full of water and tried to calculate the hydraulic -- how long it would take to put that instrument up. I think this will answer your question.

MR. CATTON: Yes, but I just want to finish up the previous line of questioning. You measure the leak rate into the SDV, don't you, as a standard maintenance type procedure?

MR. ABERCROMBIE: No, that is not a standard thing, although we did do it as a part of the Unit 3 startup. We actually had different plateaus of pressure. Close the drain valves and then determine whether or not we had enough inflow to eventually bring in the three-gallon alarm. We measured the level after an hour at that plateau with ultrasonics and established the leak rate.

MR. CATTON: What was it?

MR. ABERCROMBIE: .03 GPM. It was very, very low. We never did get the three-gallon alarm after one hour even at full reactor pressure.

MR. CATTON: So you have no idea what the leak rate is now, or whether or not it could explain that water being there?

MR. MORRIS: There was no water.

MR. ABERCROMBIE: No, there was no water in the volume then.

MR. CATTON: But you don't know what your leak rate is either?

MR. ABERCROMBIE: That is true.

MR. MORRIS: Here are some of the various sources of water that we might postulate would get into the system. I am going to talk about the outlet scram valve. Already, normally, if your valve is leaking to any extent at all -- I am saying leakage normally. If the outlet scram valves are leaking to any extent at all, you are going to end up with a hot rod. We did check the CRD temperature logs prior to venting and there were none.

As Herb was just saying, after we restarted at Browns Ferry 3, we indeed checked the leakage into the system by closing the drain valve and roughly, in intervals of 200 psi, and then pressurization after, on restart, after they have vented. I think it was something there like two gallons per hour, was the leakage into the system.

MR. CATTON: That is at present?

MR. MORRIS: That was after the restart. I don't know what it is right now.

MR. ABERCROMBIE: The only way we have to determine if there is any substantial leakage into the volume would be by indications on the control rod, the hot rod. But we have no established method of determining at any period what that end leakage is to all of the rods.

MR. CATTON: In other words, you just can't close that drain and measure --

MR. ABERCROMBIE: We could.

MR. CATTON: You have two levels?

MR. ABERCROMBIE: Yes. We could. But I am saying that right now we do not have --

MR. CATTON: Do you think it would be worthwhile to do that?

MR. ABERCROMBIE: I really don't, you know to me you still go back to the bottom line is ensuring that the volume is empty when you need it.

MR. CATTON: I would agree with that.

MR. ABERCROMBIE: Knowing what the total leakage is into the system really doesn't do you any good. The only thing that will do you any good is if you have a rod that is giving you trouble. You need to know that so you can replace the rod.

MR. CATTON: I would agree with that. I also would have thought that people would calculate things like time to drain too and find that they didn't. That is why I ask the question.

MR. MORRIS: One could postulate that upon previous scrams we had those levels never came out. We had blockage in the drain line, created the activity, and you would not know about it. And then the vent was closed off and you had substantial leakage, a half gallon a minute. Essentially, you would say that you had volume in that header. I believe a half gallon of that would be a pretty substantial leakage into that.

It would be pretty unusual, I think, to have that much scram valves that is going to get you that kind of number.

The introduction of water from the vent drain systems, de discuss those together basically, since they both tie into the same system.

As I said, that is a free drainage system that doesn't really look like much of a path for water to come down that or to get back up into the scram system itself.

The flow rates in the system are not very large. We did check the sump activity prior to the period, initially, through the Browns Ferry 3 event, and the sump level, which would indicate how much safe flow you have going into the system. It was not any greater than usual.

Just graphically, or elevation-wise, it was very difficult to postulate getting water back into that system from that drainage bed. Then getting your instrument volume, picking it up, the instrument switches are somehow running it uphill into the vent system.

We don't think we picked up water from that drainage system. Someone else will talk about some modifications and try to improve that system to make sure that we sort of discharge the scram discharge system to some extent, flushing connections. They are all used during outages, and we put hoses on them and then run water through them to the discharge headers to wash out some of the contamination. And they are normally not connected nor were they at the time.

MR. CATTON: What is your best guess?

MR. MORRIS: To that vent I bet on blockage. I can't tell you.

MR. ZUDANS: Even if you are blocked you would have to get water from someplace.

MR. MORRIS: Blockage, like I say, you can postulate. I am sure there is some leakage past the scram discharge valve, even though it is a small amount. And over a long period of time, say three weeks, you could probably fill that volume.

MR. ZUDANS: But with a half a gallon discharge from the SDIV --

MR. CATTON: That is gravity, not blockage, gravity without a vent.

MR. ZUDANS: I understand.

MR. EBERSOLE: I have a picture here in my hand,

and following up GE's observation about no leakage paths, I can easily with this picture envision a trap as a sleeve that will give me prodigious flows to fill the dump volume at the precise time I need to scram.

MR. WIESENBURG: What we are going to do here is Mr. Ross has a slide, a picture that you have in your hand --

MR. EBERSOLE: I am just thinking of it mechanically.

MR. WIESENBURG: Mr. Morris is done that. Mr. Ross will cover that.

MR. MORRIS: Here is a summary of some of the flow testing at Unit 3.

MR. ABERCROMBIE: Can I go back just a moment? One thing that, one possible source of water on those flush connections, and I don't know if you really notice those, but when we put those flush connections on, they were intended to be used during shutdown and they did require an external source of water to them and some valves if you like to open them up. But as best we can determine there were no hoses or were no -- there was no flushing at all going on at that time. But that was a potential source of water.

MR. MORRIS: This is a summary of some of the drain testing we did on the Browns Ferry 3. We actually brought water into the flushing mechanism, and we actually filled the whole system solid, and there is some variations of drain times of the vents, open and closed. The data presented here is the drain times of the system, with both the drains open. It shows you west side, the short side, drained considerably faster than the east side.

Again, what you mentioned, after the west sides drains down, I believe this instrument, the level switch indication, the east side still has another 15 minutes of drain time associated with it.

MR. CATTON: Yesterday we discussed a little bit the interface between the NSSS vendor and the A&E. And you are on the A&E. Maybe I can ask you the question. Who is responsible for making those kinds of calculations for a system when it is to be installed, or does anybody make those kinds of calculations?

MR. ABERCROMBIE: Monty might be able to address that because GE did make a change in the volume required in the early 1970's.

MR. CATTON: But I am referring to these -- he built the hydraulic instrument, and yet it seems to me that the calculations to check out the instrument were much less -- pre-op testing was never done.

MR. ABERCROMBIE: There was a test, obtained during the pre-op testing, based on scram and when the high-level alarm cleared, when it came in.

MR. CATTON: Then the pre-op testing was incomplete. If you look at this diagram and you consider the drain time of the instrument volume, the drain time of the the east header, your instrument is not telling you at all what is going on in the east header.

Now, those are very simple calculations to make. And I am wondering where it fell down the crack, the fact that they were never made.

MR. MORRIS: I think the instrument volume, the original design will tell you that that valve was closed. And we had blockage of the drain line on the basis that it was done normally. It doesn't in theory make any difference, the fact that it takes only five minutes to drain. I know it doesn't look very good, but normally you never care about that, because after a scram you have usually several hours where you don't expect to have to use that scram system again.

MR. EBERSOLE: Isn't there a third party besides GE and TVA called Control Associates?

MR. ABERCROMBIE: Reactor Controls.

MR. EBERSOLE: Now, does GE subcontract to that subcontractor to take care of this problem?

MR. ABERCROMBIE: The contract with Reactor Controls was with TVA.

MR. EBERSOLE: Oh, it was with TVA.

MR. ABERCROMBIE: Right.

MR. EBERSOLE: That was a subcontracting job from TVA. GE doesn't do it?

MR. METCALF: The Reactor Controls contract was actually with TVA.

MR. EBERSOLE: So they did that.

MR. METCALF: Right.

MR. EBERSOLE: Interfacing with GE.

MR. METCALF: Their design and their supply was based on the design criteria and guidelines supplied by GE for the basic design.

MR. EBERSOLE: TVA deliberately stayed away from that part of the design and installation.

MR. MORRIS: I might add a couple of points here that are not on the chart. With the vent closed, the east side, as we already said, would take the drains at roughly a half gpm. With the vent closed on the west side, it is a little bit harder to measure that. I think we set the test up it has to be three or four gpm on the west side when the vent closed. It was a shorter path and there was no way for the air to sneak back up in there.

Let me go over real quickly some of the stuff that we have done since that time. We discussed the pre-flow test. And we brought all of our people and we brought the design down to GE in Chattanooga and we were trying to fix it down there. As I said, we have to take a lot better appreciation of how that system operates. We really know how about to fix it so we make sure it won't happen again. I think the system is basically a reliable system, when it has worked three hundred times or four, several times at other facilities.

And what we are saying, we have gone down and looked at it, I believe we can further improve it considerably. We have done all of the 8017 tests and we have scrambled each unit and just testing all the -- we monitored the discharge header itself. All of them seem to be working fine. Some interim changes were made to the system, and so far we have had UT monitors on both the east and west side headers and continuously coordinating them, we beam ultrasonic -- we have used this UT quite a bit during the Unit 3 testing. We did it also the 8017 scram test and had a lot of confidence in that testing. We have positive vents on both the east and west headers, as Mr. Rathjen explained earlier.

Of course, procedures and training goes, there are several operating instructions have been changed to be a little more explicit and telling the operator what to do if by chance we should detect water within these instrument volumes. And also, as part of the information and dissemination program that we have, we inform all of our operators about the TVA, about what is going on and this incident, where we are at right now.

We are starting to converge on what we think our final modifications would be to the system. We believe we can eliminate possible reoccurrence of this event and overall increase the general reliability of the system.

MR. CATTON: Do you have any requirements on time to drain for SDV?

MR. MORRIS: In theory it doesn't make any difference.

MR. CATTON: Well, in theory it does, but it is -- if it isn't, you will be in trouble.

MR. MORRIS: Our modifications certainly improved the drain time of that system.

MR. CATTON: There is also do you have any requirements on the amount of flow capacity it would have to have, getting back to some of the questions that have been raised by Mr. Ebersole.

MR. MORRIS: I don't think that there is really not a specific requirement, as long as it will drain any kind of a reasonable time period, say, an hour, something of that nature. I don't see that you can really say that that is a real hard criteria.

MR. CATTON: I wasn't trying to; I was asking.

MR. MORRIS: It would fall out of our modification procedures.

And that is all I have.

MR. PLESSET: I think that Mr. Ebersole would like to get his point discussed. Right?

MR. EBERSOLE: I thought they were going to do it later.

MR. WIESENBURG: I would like to have Mr. Ross address both of these questions -- on what happens to nitrogen given leak by an accumulator, and address Mr. Ebersole's question.

MR. PLESSET: Fine.

MR. WIESENBURG: The catastrophic failures of the control rod itself.

MR. ROSS: First, to the nitrogen question: as I understand it, the concern is what happens if we get nitrogen across the piston of the accumulator and it is trained in the flow going to the underside of the drive.

We have a schematic of the drive. It would make it easier to understand the flow path through the drive.

The water from the accumulator is going to enter into the drive water insert path, here, the underside of the drive piston. The flow path, the normal cooling water flow path, is the path not shown here, but it comes through the flange of the drive and it goes up this permashield region of the drive to the vessel, that way. The communication path that potential nitrogen train of flow would have, then, is one up through the drive piston, past these shields, and as I said, there is on the order of like a dozen shields and bushings, through that flow path, up past the outside of the drive piston, through a like number of shields here, which then communicates again with the vessel pressure; and from that flow path, from this flow path on the outside of the drive piston, it then has to go past more shields on the collet piston shields to get again to the exhaust flow path to the scram discharge volume.

I guess the bottom line on this discussion is that if you were to get nitrogen train, it has a tough time getting to the scram discharge volumes, to preferentially discharge through the vessel instead.

I guess another point, going back to the earlier diagram, is that it is tough to imagine that the nitrogen does make it across the piston itself. Again, when you get the scram injection and discharge valves open up and the accumulator pushes the pressurized water to the accumulators to the underside of the drive piston, at the point where the accumulator pressure equals the vessel pressure, the -- we have a ball check of the drive piston moves up and plugs that flow path, and therefore you are not going to have any communication from that point on with the accumulator.

MR. EBERSOLE: Because that goes to the reactor pressure then, doesn't it?

MR. ROSS: Right. It equals out at reactor pressure.

Now, the potential effect that would have is, once -- well, let us assume that we did get nitrogen to the scram discharge volume. Its consequence would be one of it would modify the pressurization form of the trace, the pressurizing of the scram discharge volume. However, the rods would insert and in time, when the nitrogen would take the volume of nitrogen assumed to be training at tank zero, the water that it displaced at scram discharge volume is that which is initially on the top of the drive piston, so that the volume of nitrogen would have to traverse the full length of the insert line and at the time that the rod is fully inserted it has probably just made it to the underside of the drive, let alone communicated clear back to the scram discharge volume.

The next question was that of the consequences of potential breaks or for reaching inside the drive itself. I don't know, I look at it and I can hardly see a mechanism which would give you a full communication path between the vessel and the scram discharge volume through the type of structure that we have. But even if it did occur on a drive, the flow would still be limited by the discharge area of the withdrawal line, and a critical mass flux rate would be somewhere around 8000 pounds mass per square foot per second. On an individual rod, where you have a withdrawal line, it is a three-quarter-inch line; that would give you a discharge of somewhere around 40 to 50 pounds per second. Appreciating that the rods are fully inserted on the order of three seconds, the contribution of this one rod would only give you a gallon or two more of discharge to the discharge volume which is shared by all of the rods. So its potential consequence is, again, small.

MR. EBERSOLE: There is no structural failure that you can envision in the piston rod or the cylindrical shell within which it works that can cross-couple reactor fluid pressure to the dump volume at a rapid rate prior to actual calling for a scram signal and have it prefilled and subsequently, in a matter of a few seconds, demand a scram and not get it?

MR. ROSS: Certainly not prior to a scram. If you have the breach of the piston occur prior to scram, the scram valve is shut; there is no communication between the vessel and the scram discharge volume.

MR. EBERSOLE: Well, out in the withdrawal lines it is closed, the withdrawal valve is closed?

MR. ROSS: Yes.

MR. EBERSOLE: So that would preclude the insertion of water from the dump volume from the cracked piston or whatever?

MR. ROSS: Right. So prior to the time of the scram there is no communication; this valve is shut. You could have the cracked piston jumping in communication so its only contribution is that which occurs during the time the rod is broken.

MR. EBERSOLE: Now comes the question of whether the fact that the mechanical failure could prefill the dump volume during execution of the scram stroke. And you're saying there is not time enough, right, because of constrictions in the flow path?

MR. ROSS: Yes.

MR. EBERSOLE: It sounds like a good argument to me.

MR. ZUDANS: Except that the closing time volume, the discharge, because of the scram, also goes to the same vent, through the same path. You can't scram: there is competition for the outlet.

MR. ROSS: It may affect that one drive.

MR. EBERSOLE: That one drive is adequately taken care of.

MR. ROSS: Maybe we might have a short break, a ten-minute recess.

(A brief recess was taken.)

MR. PLESSET: Let us go on.

MR. WIESENBURG: We are ready. We have to address some corrections and modifications, et cetera, that are under consideration in the future. And Mr. Metcalf will discuss that.

MR. METCALF: My name is Pelar Metcalf. And I am with the engineering design. And I would like to discuss some of the things that we have looked at in regard to making modifications to the CRD system and make it more reliable and more effective. And some of these modifications I think you probably heard before, because there are some somewhat similar to some of the recommendations that GE is looking at.

And one of the things, our primary objective, I think, in looking at these is like Jesse hit it earlier, that the safety aspects of the system is to ensure that you have a scram volume such that when you want to scram you have an effective volume space to scram. The drain system per se is not a safety system. You want to have a drain system and you want it to be reliable such as you can drain the water out. But what you really are looking for is to making sure that the scram discharge volume along with the scram discharge headers are empty of water when you want to scram.

So one of the things that we have looked at from the standpoint of the scram discharge instrument volume are putting separate instrument volumes on both of the east and west scram discharge headers. Each one of these headers would be directly tied to the east scram discharge header in the west with a six-inch line. There would be no pipe size reduction from the header to the instrument volume.

And this is very similar to what is being done now in the BRW sixes, because each one of the headers now have separate instrument volume on BWRC sixes. The drain lines from the scram discharge instrument volume would be an individual line from each volume to the CRW system. They would not cross-tie together; there would be a separate line to the CRW system, the current CRW system at Browns Ferry.

Also, each scram discharge instrument volume would basically have the same controls that are now on the individual header, the instrument volume. So it would have alarms for three-gallon alarm. There would be an inhibiting control rod withdrawal, which is the 25-gallon. And there would be a scram signal based on the 50-gallon alarm.

This suggests a kind of a pictorial view of what the next system we'll look at looked like, and these lines are not direct routings, it is just an idea of what would be done. But you have a six-inch line coming into each one of the instrument volumes. There would be a separate drain line into the CRW system, so that any leakage into here would go directly into here, because it would not be a two-inch line, would be eliminated. Both the long line now and also the two-inch line, which this line here is probably a two-inch line, that would be changed to a six-inch line.

MR. ZUDANS: Why do you maintain still that that will maintain --

MR. METCALF: Let me go into that a little later. It is a little further on.

One of the things that is being considered, it is a cross, I guess, of two things that you would like to see, is you would like to make sure that the instrument volume drains quickly, if after a scram, even though it is not a safety requirement, and also you would like to have some fairly close indication of what kind of leakage you may be getting into the system. So one thing that has been considered is maybe having a small line coming out of the bottom such as you can detect leakage which would be somewhere in the three-gallon alarm, would be the low, the larger drain line going into the CRW system. This is the drain valve such that larger volumes of water would drain out quickly, and you would not rely on a smal line coming out of the bottom, it would be your primary drain if the volume was full of water. So that is being considered.

Or there is also a possibility that the drain line to the CRW could be increased to three inches or four inches. Of course, when you do that you are effectively draining water out quicker, but you also m ybe lose a closer indication of what kind of leakage you may be having in the volume.

Is there any questions? I am now going into the scram discharge header vent. Now, is there any questions maybe on just the instrument volume itself?

MR. EBERSOLE. I guess this is as good a time as any to make an observation here. I think this is a classical case of a philosophy that permeates the whole business to the detriment of safety. And that is, such tight control is maintained over very minor radioactive movements, that here the philosophy has been that it is more important to close the dump volume and not let any of that back leakage get someplace where it shouldn't than it is to be sure that it is open so you can dump water into the dump volume. And an inversion of that principle would be to say, "I will have large open valves on the dump volume leading to an appropriate fluid sink, and I will never close it until I have guaranteed my rods have seated and then I will close it." Right now the philosophy is: close them and then -- in that -- and then work hard to make sure that you have plenty of room having closed them.

It is an inversion principle here which is a detriment to safety, and I think you ought to look at the real root logic as to why it would not have been far better to have had a volume clearly open, I don't care to where, the dry well or the torus or whatever, and never close it until I have got the rods home, and then close it to erase the minor problem which is a little bit of leakage back by-passing to the shields. It is a philosophical problem, but I think it is right here and all we are doing is patching it up.

MR. METCALF: I don't disagree with that. I think the problem is actually that looking at closing such as you don't have radiation and your possibility as long as you've got an open space, keep it open until you get everything in.

MR. WIESENBURG: There is one other design consideration that enters into this. And that is: given a scram, the scram discharge system itself becomes an extension of the reactor pressure vessel pressure boundary, and it is not just a strict guard against radioactive leakage; it is a strict guard against --

MR. EBERSOLE: It is new boundary; however, it is rather tightly sealed by those strictures, and if it were introduced into a safe area it would not matter. I mean, it is a fundamental philosophy that contradicts safety.

MR. PLESSET: I disagree slightly with Mr.

Ebersole about their being a little bit looser with the radioactivity. However, if you regard this scram discharge volume, the instrument volume, as an extension of the reactor vessel, why isn't it all safety grade? Why isn't it all safety grade? I mean, it doesn't seem to follow. I will accept your logic that it is an extension of the primary vessel, which it is. But why isn't it, then, safety grade all throughout? Why hasn't it been? And why will it not be?

MR. METCALF: The system is safety grade up through the vent valves and the drain valves. The instrument volume, it is safety grade up through the vent valves and the drain valves.

MR. CATTON: Is the air system safety grade? And that is part of your square system.

MR. ABERCROMBIE: It is fail-safe.

MR. METCALF: I really could not answer that question. The aspect of the valves, once the air is taken off, then that part is now back, the other part, if you lose your air, then you are going to scram.

MR. PLESSET: You are telling me that it has the same seismic qualification as any other safety grade and it is throughout?

MR. WIESENBURG: The discharge volume system itself. Yes.

MR. PLESSET: And the instrument volume?

MR. METCALF: That is correct.

MR. PLESSET: It has always been that way?

MR. EBERSOLE: Well, the pipe back to the torus could also be safety grade. If you wanted to open the system, on the open there would be no degradation of the reactivity, it would be the same, if you adopted the open logic rather than the closed logic.

MR. WIESENBURG: Your point is well taken. All we were trying to insert in the discussion was that there is more consideration to this aspect.

MR. EBERSOLE: Time and again you will see safety degraded by the apparent need, which is a political one, to forbid the escape of the slightest amount of radioactivity. It impacts on the safety function everywhere you turn.

MR. CATTON: How do you rationalize the relief valves emptying into the torus? Is that different? Is it a different philosophy in your relief valve than for your scram system?

MR. METCALF: I think that from the aspect of what --

MR. PLESSET: If this is all safety grade, why does it stop at that valve? Because, as I understand it, at Hatch they pulled out all of the hangers and the whole thing got all torn up. Is that right?

MR. METCALF: I didn't understand your question.

MR. PLESSET: It is safety grade all the way down to the clean rad waste.

MR. WIESENBURG: Safety grade until the drain valve.

MR. PLESSET: But it has beyond that valve, is where this pipe tore out of the wall and affected the rest of the system, presumably set a water hammer back into it, is that right?

MS. ZUKOR: I don't know at Hatch. I don't have all that information.

MR. PLESSET: Well, it was Brunswick that set a water hammer back through the system and crushed the level indicators in the instrument volume. I still don't think that it is safety grade in the sense that I am thinking of it. Is yours safety grade, then, in that same sense? I don't think it is. You say it stopped at the valves.

MR. WIESENBURG: It stops at the valves because the valve would be the pressure boundary.

MR. PLESSET: So if you had a water hammer just beyond the valve or back into the system and it crushed the floats, you would be in trouble -- just as they were at Brunswick. I mean, I don't follow the argument.

MR. EBERSOLE: It is safety grade, you say, up to and including the valve, the vent and drain valves of the dump volume.

MR. WIESENBURG: Yes, sir.

MR. PLESSET: Beyond that they are not, I believe.

MR. WIESENBURG: Yes, sir.

MR. PANCIERA: I am from the NRC staff. Clarification on the point of safety grade. At our regional meetings, indicated that in all cases there is a benign seismic load; in most cases this was a static type analysis.

Point number two: we found at least one case where it was -- in one case we felt that it was ASME Section 3, Class 2. In many cases it was ASME B 31-1. In this I am talking about the piping within the boundaries of the vent and drain valve. So I am really at this point not sure just what we have overall generically.

MR. PLESSET: Okay. That helps. Thank you.

Well, I think we have tried to make a point. Maybe yours is all --

MR. METCALF: Well, going back to ours, I'm not sure exactly. I think ours was to be 31-1. Of course, when this was designed it wasn't basically a Section 3 requirement. And I think what we really are saying is that within the confines of the isolation valve, of the -- not the isolation, the drain valve and the vent valve, that there was a seismic analysis done at some time, and from that standpoint on the requirements were less because of the fact that you were going into the CRW system and really your requirement, like I said earlier, is the fact that you want to ensure that you have got volume to scram, it is within those confines of those two valves that back into the scram valves back to the vessel.

MR. EBERSOLE: Are those stainless?

MR. METCALF: I believe everything is stainless except for the scram discharge headers and maybe the drain lines themselves. The withdrawal lines and things are stainless. The small-diameter lines coming in from the control units.

MR. EBERSOLE: But the big headers are?

MR. METCALF: Are not. They are carbon steel.

A little discussion now with regard to the scram discharge header vents. And like I said earlier, the primary interest is to make sure that you don't have water in the scram headers or in the instrument volume. The header vents and ensuring the vent and drain as quick as possible are two things to do, but they are not the safety aspects of the system.

Some of the things that we have looked and are considering in regard to improving the vent and drain system is cross-tying the vents from each of the scram headers. This cross-tie would be before the vent valves there would be a cross-tie with an isolation valve between such closing and can put it back into the configuration that it is in now. This is just to ensure that one of the vent valves failed to open, that you would have a path that you could vent back through the other vent valve, and just an additional means for it.

We are also evaluating the vent valve design and configuration. Currently it is a float valve. Maybe it should be another type of valve. Maybe it should in a vertical run as opposed to a horizontal run of pipe. These are things that are being considered currently.

Also we are looking into where this scram discharge header vent should be run: should it be continually run to the CRW system, or possibly look at other ways to have a more positive vent arrangement, such as going to the DPW system or tying somehow into the APAC system. And all of this is really to make sure that you have a vent and for some reason that vent is available such that you can ensure that you can drain from the instrument volume.

This sketch shows how the vent cross-tie would be before each one of the vent valves. This is one configuration which is being considered. And this is currently each one of the vent lines come back in to a CRW line, which is right above the floor elevation. One thing that is being considered is to come up with a four-inch line and tie in at a high elevation and then take a small-diameter line being straight to the HVAC system. This is to help ensure that you have a positive vent. That is one thing that is being looked at currently.

Another item and with regard to the vent that we are considering is taking the vent now to the DRW system, rather than to the clean rad waste system. And we are also looking at the possibility of putting two vent valves, as opposed to one; and these would basically just be to ensure that these valves close on scram. You basically would have -- they would be the same type of valves, but it would just be two valves.

But really, from our standpoint, we really haven't made -- I guess we are a lot closer to making a decision as to actually what we are going to do with the instrument volume, as opposed to what we are going to do with the vent system. And I think part of this is getting back to the aspect of trying to make the vent more positive.

MR. EBERSOLE: Mr. Metcalf, I guess this is a good time to observe we have been rightly accused of putting Band-Aids on bad problems all over the place, and that is exactly what we are doing here: we are Band-Aiding the daylights out of what is a closed system to make it open and close on schedule and to make it an instrument totally acceptable for all operations. So shortly we are operating all sorts of Band-Aids to close the system when it is needed, as against the idea of having an open system which doesn't need any instruments, it is just open and it will dump, and then, having executed the prime function, you will close it to prevent follow-on of a somewhat modest problem, the leakage of seals.

All we are doing here is stacking all sorts of garbage on top of garbage to make it work, rather than going back to the root concept of evaluating that. And I would suggest that you do that: you go back to the roots, not just patch.

MR. METCALF: I don't disagree. And I think that we have looked at other things. And I guess, from the aspect of the vent itself, we are not completely satisfied with what we want to do with it. And I think this part we are more, because that gives you a positive indication that you have got water and you don't have water, and if you don't have water, you can scram. So this is a lot more straightforward than from the aspect of the vent, because that, I agree, is an area where it is really no clear thought way to do it and solve all of your problems or maybe create other problems by doing it different.

MR. EBERSOLE: You have to build on the fundamental stake that it is beginning to make it work.

MR. ZUDANS: Would you consider that this is an interim solution to make sure that you don't have any further problems and you will continue thinking along the lines that Jesse is talking about?

MR. METCALF: This that we are talking about here is our plans in looking at a long-term solution. The interim solution and detection of water, making sure that you don't have water in the system, is being done by our UT network. But this would be the long-term modification. It would be an interim fix.

MR. ZUDANS: Do you feel, do you need any vents in this modification at all?

MR. METCALF: Yes. You have to have some type of vent if you are going to drain water out. And that goes back to, I think, to what Herb said earlier: with the valves closed you only get a certain amount of drainage. So you would have to have some type of vent. Exactly how that vent was configured is debatable.

MR. ETHERINGTON: That arrangement of the vent that you have over there looks more like an overflow arrangement than a vent.

MR. METCALF: An overflow?

MR. ETHERINGTON: Yes. You have it going down into a funnel. I agree this is fine for when it does overflow, but don't you want a connection to the vent system as well? You've got an open pipe there.

MR. METCALF: The basis of this discussion, I guess, in regard to -- you see, DRW system is an open system; it is not a closed system like the DRW systems. The arrangement is to make sure that -- I'm not sure there'd be a funnel arrangement, but the intent is to make sure that you have a positive vent to the atmosphere, but also some type of configuration such that if you had any water or steam condensation that it would go down into your drain.

MR. ETHERINGTON: Yes. But I would have thought that you would have wanted to make another connection to the vent system rather than just let it get out into the building.

MR. METCALF: Well, this design would be made such that that would be the intent, because you would make sure you have a positive vent, plus any steam condensation would go into the drain system rather than going out into the room.

MR. ETHERINGTON: Yes. But your previous slide showed both a vent and a drain from the top of the --

MR. METCALF: You are talking with regard to the vent back into the HVAC system?

MR. ETHERINGTON: The previous made more sense to me than this one did. There you have an off-take for gas and an off-take for condensation of water.

MR. METCALF: Well, there is drawbacks on both ways. I guess this one you are venting into the HVA system and if there's a possibility of steam you don't want particularly steam going into the HVAC system. So, like I say, it is being evaluated which would be the preferred way to go, and I think there is drawbacks both ways.

MR. EBERSOLE: Mr. Metcalf, having endorsed an open system, I'm going to get to the other part of the problem. If I invoked a single failure on your venting system and say that it stays open prior to a scram, and I have somewhat messed up the reactive order by fuel failure or whatever, then I've got an open path through that funnel that we just saw all out into everywhere and I've got a big mess on my hands -- right into the machinery rooms which must mitigate the accident which I started with.

So how are you going to ensure as a prescram function that, in fact, I did stop it up? Although I'd much rather you did not do it at all. Do you understand?

MR. METCALF: I don't disagree with you. I think that is one of the problems that we are having coming up with a definite recommendation on regard to the vent system. But that is one of the reasons why we were looking at the possibility of having two valves if we go to an open system like the DRW, such that you would, hopefully, ensure that, number one, the valves would close if you needed them closed and you were open.

Are there any other questions?

MR. PLESSET: That one there looks like you can get some radioactivity into the ventilating system. Is that right?

MR. METCALF: That is a possibility.

MR. PLESSET: That doesn't sound very appealing to me.

MR. METCALF: Of course, there is monitors on the ventilation system such that if there is radiation they isolate. You can also on the stand-by.

MR. ZUDANS: But it doesn't do much good. They only tell you, not a number, but you can't fix it.

MR. EBERSOLE: They tell you it already happened, but you can't go in and fix it.

MR. CATTON: The suppression pool is looking better and better.

MR. METCALF: I would say that we have looked into, we have looked, considered the fact of putting the vent into the torus. The problem is, I guess, there was questions then when you might need to isolate that line. But that has been --

MR. ZUDANS: Why not drain in the torus?

MR. METCALF: You are saying looking at the possibility of running the drain itself into the torus?

MR. ZUDANS: Right. You started out with six-inch line and you will cut it off at that point and run it straight through the suppression pool, just put one valve in there, get all your instrument; you don't need any complementary vent lines; it is a perfect system, that is what Jesse is talking about.

MR. EBERSOLE: Leave it open.

MR. ZUDANS: Leave it open and shut the valve when you want to, to prevent it from leaking. All your level sensors are your two-inch lines.

MR. EBERSOLE: It just disappears.

MR. ZUDANS: There's no reason to change the headers and banks. They can stay there all right. The question is can you find a place to run such a line. It doesn't have to be six inches.

MR. METCALF: I agree. It is worth consideration.

MR. CATTON: Have you considered the use of the suppression pool seriously?

MR. METCALF: Not seriously. We have looked at the aspect of taking the vent back to the torus area. We haven't really looked at bringing the drain line itself into the suppression area.

MR. CATTON: When one of the relief valves is actuated, how much mass are you putting into the suppression pool? How does it compare with the amount of water associated with the scram?

MR. METCALF: I don't know the exact amount, but there'd be no comparison.

MR. EBERSOLE: It is infinitely greater.

MR. METCALF: There's just no comparison.

MR. PLESSET: I would like to shut off all of this discussion up here. But let us do it. Are you finished?

MR. METCALF: Yes.

MR. PLESSET: Let us go on.

MR. DOMER: That takes us down to the last of the agenda items. And that will be handled by Hank Pfefferlen of GE.

MR. PLESSET: I should say that we would have to stop in five minutes to twelve. Some people have to catch the airport bus.

MR. PFEFFERLEN: I have a short presentation. I will present what I have, then we will open it to questions.

MR. PLESSET: That will be fine.

MR. PFEFFERLEN: My name is Hank Pfferferlen. I am manager of the BWR licensing programs for GE. And my purpose here today is to discuss with you the results of the GE evaluation into possible implications of the Browns Ferry partial scram.

GE has performed some analysis in an attempt to shed some light on the questions that were asked by the NRC and by the ACRS, questions that are of the "what if" character, what if we had this event concurrent with a transient of some sort for full power. I will say that GE has done this evaluation and we have concluded that given the existing BWR configuration, that had the Browns Ferry initial scram attempt occurred under these conditions, that the operator had the capability to safely shut the plant down.

Given that we have come to that conclusion, we still treat this event in a very serious -- we feel it is very important. To that end, GE has devoted significant resources to investigating and evaluating the occurrence. I think some of the activities were alluded to earlier. And before I go into the results of our evaluation, I would like to just very briefly put it into perspective of what the total effort that we have done in understanding the problem.

Right after the Browns Ferry event, right after the Browns Ferry event, we established communications with the site; we set up a task force to interface Browns Ferry with other units; we did send a team of individuals knowledgeable on the scram system to the site, to try to understand what was happening; and we activated a 24-hour communication center. Those first four bullets really represent the data accumulation and dissemination activity. This was then used in a structured problem analysis effort to try and understand just what went wrong, and I think the results of this effort was presented already.

We also performed some analytical work to look at the scram system performance. This was coupled with some tests that were run in San Jose. And again this was discussed previously.

What I would like to get into now are some of the analytical efforts that we did in support of the answer to one of the questions. These were: to answer our own questions, to respond to I&E bulletins, and to respond to NRC staff questions.

Given this input, I would like to summarize for you just what we found.

Our evaluation was, first of all, based on the generic plant that was assessed in the ATWS report that was submitted to the staff in December of last year. We took that plan and we considered in terms of an isolation event. We did a, first of all, a core power calculation and determined that given the rod motion that occurred after the first scram attempt at Browns Ferry and taking that from an end-of-cycle all-rods-out configuration, that we would drop, probably power drop to less than 10 percent. This is considerably evaluated, given that the initial power was at 100 percent, as I indicated, at the Browns Ferry rod motion, we had recirculation pumps tripped in our case and we assumed it happened someplace in the first 30 seconds. And as I indicated, rods would be inserted from all-out, end-of-cycle all-rods-out configuration.

MR. EBERSOLE: Is that a manual recirculation pump trip that you envision in 30 seconds?

MR. PFEFFERLEN: Our assessment in the 30 seconds in the eventuality if we had this event we would get an automatically pump trip. The important thing that is in the time scale, we had up to 30 seconds. So for a plant that perhaps did not have ATWS RPT there would be time to take some action. We believe that in reality the ATWS pump trip would cause us to occur in a much shorter time.

MR. EBERSOLE: What would trip the pumps? Where is the signal that would trip it?

MR. PFEFFERLEN: We are starting isolation from 100 percent power. No, we are not talking about what happened at Browns Ferry.

MR. EBERSOLE: You propose --

MR. PFEFFERLEN: It is 100 percent and then the rods scram in the same manner that was observed after the first attempt at Browns Ferry.

In attaining this we had iterate between our REDY code and a 3-D BWR core simulator, in order to establish power. Once establishing this power, we used the REDY, again the same code that we used in our ATWS assessment, to look at the plant response. And I have broken that down into two categories: first of all, the short-term response, and then the suppression pool, which would be the long-term.

MR. CATTON: There's a REDY code that replaced the old code?

MR. PFEFFERLEN: No. ODYN has replaced REDY. In our ATWS assessment we have done a comparison between the REDY and ODYN codes to assure ourselves that the two are predicting the similar results and it is termed that REDY is conservative for these ATWS tests.

At any rate, this is, then, an extension of our ATWS extension.

MR. CATTON: I thought that the comparison between that code did not quite predict the pressure peaks that it should and that the new code did a good job and that a lapped --

MR. PFEFFERLEN: As I understand it, it is primarily related to the scram. It is more the timing.

MR. CATTON: The REDY code underpredicted the pressures.

MR. PFEFFERLEN: With scram there is a problem with timing, where the scram occurs relative to the pressurization. It is not a problem in ATWS, since we are not scramming.

So what we would do is, we are cutting off the peak, and depending on where you cut it off, the slope of that peak makes quite a bit of difference. But then, I say, we did compare ODYN and REDY in the ATWS context and we found that, indeed, REDY was predicting conservatively. They were very, very close, but REDY was somewhat conservative.

MR. CATTON: All right. I will just accept that for the moment.

MR. PFEFFERLEN: What we found, that in the short-term, because of the drop to the lower power, the rapid vessel pressure stayed within the off-set limits.

MR. EBERSOLE: What pressure was that, please?

MR. PFEFFERLEN: It was on the order of 1250, I believe.

MR. EBERSOLE: And all valves were relieved? Or did you take one stuck?

MR. PFEFFERLEN: No, we had all valves available.

MR. EBERSOLE: So you did not take a stuck safety relief, you used them all?

MR. PFEFFERLEN: I'm not sure that all were called upon at the power level. I could not answer that. We did not assume a stuck valve. I'm not sure that all of them were relieved. They all were available to relieve. I'm not just quite sure what the actual response was.

MR. EBERSOLE: The pressure was 1250?

MR. PFEFFERLEN: Yes.

MR. PFEFFERSON: We both maintain an acceptable level, and the fluid control and the level were well above that calculated in the full ATWS.

MR. EBERSOLE: The fluid is just boiling flow, so that wouldn't matter. But the level is something else. You have lost main feedwater?

MR. PFEFFERSON: Yes.

MR. EBERSOLE: And you were operating at what percent power?

MR. PFEFFERSON: 10 percent.

MR. EBERSOLE: And you have had water compression?

MR. PFEFFERSON: Yes.

MR. EBERSOLE: At what point in time did you have to call upon the turbine driven aux feedwater, so-called -- what do you call it?

MR. PFEFFERSON: HPCI. I believe that is on the order of one to two minutes into the event.

MR. EBERSOLE: And you call upon it at the time --

MR. PFEFFERSON: -- of level 2.

MR. EBERSOLE: You were sitting then at 1250 pounds?

MR. PFEFFERSON: No, no, the pressure --

MR. EBERSOLE: It would be --

MR. PFEFFERSON: With recirculation pumps, the pressure would come back down.

MR. EBERSOLE: Oh, it would come down. What is the power level after you have tripped the pumps then?

MR. PFEFFERSON: Well, that is when you get down to the 10 percent.

MR. EBERSOLE: Okay. Now having got down to 10 percent and tripped the pumps, what is going to make the --

MR. PFEFFERSON: The level is moving down.

MR. EBERSOLE: The level is moving down, the pressure is holding at 1250?

MR. PFEFFERSON: The pressure is back down to below the low set point.

MR. EBERSOLE: Is it?

MR. PFEFFERSON: It comes back down, yes, and --

MR. EBERSOLE: But anyway, you are at the relief set point --

MR. PFEFFERSON: Yes.

MR. EBERSOLE: -- of the first valve?

MR. PFEFFERSON: Yes.

MR. EBERSOLE: Now you are going to ask HPCI to turn on under that condition?

MR. PFEFFERSON: That is correct.

MR. EBERSOLE: And of course they are notoriously allergic to turning on the high pressure because they have all these big trips which pumps it even at normal pressure.

So I guess I am going to get around to the fact that you didn't get the HPCI pump eventually.

MR. PFEFFERSON: Well, we get down and at level 2 we would call for HPCI pump, which is what we have done in a full ATWS and, you know, the same area.

MR. EBERSOLE: Yes, I know.

MR. PFEFFERSON: My point here is that in a full ATWS, if the level continues down, the flow will reduce further. But in this case, because of the lower power, the HPCI is not able to correct the situation and maintain our level within the range of the normal operation.

Now you are right, it is going to presume failure in the HPCI. We have a --

MR. EBERSOLE: A problem?

MR. PFEFFERSON: We then have RCIC, which at the lower power levels could provide some flow, and in fact we believe that even a full ATWS, that while the level will go very, very low, that eventually the RCIC would not -- and we have not run this analysis. I am concluding -- --

MR. EBERSOLE: I know, but I know RCIC wouldn't even cope with that for quite a while.

I guess now I would like to point a question to TVA. I want you to notice your writing on HPCI. You have got a lot of practical experience with HPCI and its reliability or unreliability at normal pressures and conditions. Here you are asking it to start on an absolutely guaranteed requirement that it work at abnormal high pressures. How do you feel about it? It had better work quick too, no delay, no fiddling around.

MR. PFEFFERSON: I don't really know how to answer you, other than that I think we have all looked at the reliability of the data on HPCI's and we have made an awful lot of improvements on the units at Browns Ferry. I think we have improved reliability and, you know, if you think that HPCI is not going to go you may as well as hang it up.

MR. EBERSOLE: You may as well hang up Browns Ferry if HPCI doesn't work.

MR. PFEFFERSON: Or anywhere else.

MR. EBERSOLE: HPCI is a critical matter here.

MR. PFEFFERSON: Again, the point I am trying to make, and I must qualify that it is not the result of rigorous analysis, but it is our technical people's opinion that if we were to go through a HPCI loss, that other sources of water would eventually maintain the cooling through that core. It's a difficult thing to analyze, though.

MR. EBERSOLE: I guess I object to the word "eventually," because it doesn't connote anything to me. When you say eventually you will get cool, I don't know whether that is after --

MR. PFEFFERSON: Well, no, I am sorry. Let me clarify that.

What will happen is the level in the reactor will continue to drop. At some point HPCI stabilizes and brings the level back up, and the flow is then proportional to the levels and natural circulation flow. If we were to lose HPCI our level would continue to drop to a much lower level. The core flow would reduce to a much lower level. It would continue to maintain core flow at some very low level. The power will then also -- and I think it is an important point -- the power will continue down, and we would reach a point where the RCIC closed would be equivalent to the power system, which would maintain cooling.

MR. EBERSOLE: I would like at this point to ask a question to you, GE, that has been asked internally but we have made no progress on it.

It seems that the boiler has perhaps an attractive features which is not exploited if you get to these dire straits. Suppose I tell the operator at this time to execute SAR and boil the reactor down to 100 pounds or whatever to enable foam or froth cooling and get a void fraction which is extremely high.

Would I get then a power reduction rate which I could deal with with RCIC for example?

MR. PFEFFERSON: If you depressurize.

MR. EBERSOLE: Without burning the core?

MR. PFEFFERSON: If you depressurize, I think that would be the case, but then you would bring on the low pressure systems on cold water, which you would have to --

MR. EBERSOLE: Then I would get back in trouble again?

MR. PFEFFERSON: You would get back in trouble again.

MR. EBERSOLE: So I would have to intercede?

MR. PFEFFERSON: That is correct. Now we are back to --

MR. EBERSOLE: Now we are cut two. We don't want to pull that far down, to 400 pounds. But it does seem that there is some possibility that you can void the core and control the reactivity problem which has not been exploited.

MR. PFEFFERSON: Well, in essence I think that is what I was saying here, that as the level goes down we in essence accomplish --

MR. EBERSOLE: Some of that, yes.

MR. PFEFFERSON: And it is not as strong as what you have suggested, but the mechanism is certainly there.

MR. EBERSOLE: Well, what I am arguing is that I will increase the void volume, that I will reduce the void -- in other words, I will reduce the void so that they individually carry away fewer BTU's, so I have got to have more of them, and that means I am going to reduce reactivity.

MR. PFEFFERSON: You are absolutely right, and we have been thinking about this, and I think our problem is that we are not able today with our analytical models to handle a critical core during a blowdown. Now we are looking at this. You are absolutely right. I think it is an area that deserves exploration.

MR. EBERSOLE: Great.

MR. ABERCROMBIE: But you have got to know what you are doing now.

MR. PFEFFERSON: Maybe we can't answer it. We have to make some --

MR. ABERCROMBIE: They would have to know what they doing.

MR. EBERSOLE: Oh, yes, but when your back is to the wall you do whatever you can.

MR. ABERCROMBIE: Yes, that is really what you have to go to.

MR. PFEFFERSON: Okay, the point I am trying to make here is that in the short term the response would perhaps vary so that the scram pattern is rounded conservatively.

If we turn our attention now to the longer term suppression pool temperature, we look at the timing necessary to just keep the temperature within the acceptable limits. It turns out that if the SLC were initiated in 30 minutes, that our peak pool temperature, will stay within 186 or below 186 degrees, which we feel is acceptable.

This is using the existing SLC system, the single pump rather than the two pumps that are being discussed in terms of ATWS. And the RHR was initiated at 10 minutes.

So I think though that the point I am trying to make here is that while we expect the operator could take actions well before this, that if he waited for 30 minutes to initiate the SLC, the existing system, single pump, that the pool temperature would be acceptable.

I think there was a question from the ACRS on loss of offsite power, and we believe that, in looking through the consequences of the loss of offsite power, that what I have said here would apply also to loss of offsite power, since one of the very early things that would happen would be the closure of the SLC.

We would trickle off the heat water, the recirc pumps named earlier, and in some cases we would be in an even better situation.

The point, I guess that I am making here, this is my conclusion, and this is all that I had planned to present, is that given the low power that we attained following the Browns Ferry scram, the effectiveness of that portion of the scram, it is highly necessary for the operator to initiate the boron system coupled with the capability of the existing system. We believe that a plant could survive a safety shutdown given the Browns Ferry today.

MR. EBERSOLE: Right, that is assuming that a lots of things work like you think they are going to work.

MR. PFEFFERSON: That is correct.

MR. EBERSOLE: Let me compound the problem a little bit. When you upset the safety reliefs -- by the way, the whole plants have tail pipes on the reliefs now or do some of them dump it --

MR. PFEFFERSON: Still on pipe.

MR. EBERSOLE: So you would get a high level pressure for those?

MR. PFEFFERSON: Yes.

MR. EBERSOLE: Okay. Now I am going to make things a little more messy by picking up another problem that we have, which is sticky safety reliefs. And now you have continued discharge at low pressure, or rather at low power, such that eventually your pressure will fall to a point at which the ECCS systems will do their great thing, which is dump water by the tons into the system.

How is your boron injection system going to cope with the flooding process that occurs?

MR. PFEFFERSON: We have to keep the low pressure system from flooding the vessel.

MR. EBERSOLE: How are you going to do that?

MR. PFEFFERSON: The operator will have to prevent the low pressure systems from --

MR. EBERSOLE: I am afraid he is locked out, he can't. Can you?

I have gone to low pressure in the primary loop below 400 pounds. I have got high level pressure and all my big pumps are going to, against all efforts I think that you make, are going to flush out all the boron you put in.

MR. PFEFFERSON: Well, I think you have to tie two or three things together here. First, on the safety relief valves that I have mentioned, since we have changed to state valves we have not had a blowdown.

MR. EBERSOLE: So they are more reliable.

MR. PFEFFERSON: The reliability of the valves is tremendous.

MR. EBERSOLE: Okay.

MR. PFEFFERSON: Secondly, in flooding the core, where you have normal levels, for example, the work that we have done, the order through the Emergency Procedures Subgroup, we do instruct the operator to hold out the low pressure systems if he has a normal level.

MR. EBERSOLE: And he can --

MR. PFEFFERSON: We would not let them start.

MR. EBERSOLE: He can stop those motors in the presence of any signal?

MR. PFEFFERSON: He can override.

MR. EBERSOLE: He has overrides.

MR. PFEFFERSON: Yes.

MR. EBERSOLE: I remember, yes, he has got forcible overrides.

MR. PFEFFERSON: But to keep pouring in, if he has his reactor water level normal, within normal limits, he would not allow those pumps to flood.

MR. EBERSOLE: He would turn them off. They are on automatic power?

MR. PFEFFERSON: Yes.

MR. EBERSOLE: But would he go off and turn them off?

MR. PFEFFERSON: That is what we have in our procedures now. The thing you can in on, under all circumstances, is you got a normal level.

MR. EBERSOLE: Yes. And didn't you have that procedure prior to this?

MR. PFEFFERSON: Yes. We did that work in the aftermath of TMI, the boards -- General Electric and all the utilities working together.

MR. EBERSOLE: So you are already aware of the boron washout potential?

MR. PFEFFERSON: I don't think, we do not directly couple the operator actions with any problem on SLC.

MR. EBERSOLE: Oh, it just came about as a back --

MR. PFEFFERSON: Yes. I understand at that point you have to put two or three things together to kind of figure out what might be happening to the operator.

MR. EBERSOLE: Do you regard it as advantageous that he has to manually put boron in because he will remember he better keep it in rather than automate its insertion?

Suppose I automated its insertion. Would he remember that he has got to keep it in?

MR. PFEFFERSON: Yes, I think so.

MR. EBERSOLE: In other words, you would favor manual insertion?

MR. PFEFFERSON: I favor manual insertion for the boron.

MR. EBERSOLE: At least it would make him remember he had better keep it.

Thank you.

MR. PLESSET: Well, thank you. I think we had better kind of draw things to a close. h[illegible] e a five minute to 12:00 deadline for some people. Do you want to make some closing remarks? We will give you just a couple of minutes.

MR. DORMER: The only thing I was going to say is that I hope we covered everything you wanted us to cover.

MR. ZUDANS: Mr. Chairman, could I ask a very quick question?

MR. PLESSET: Very. Just one short one.

MR. ZUDANS: Yes, one short question. Why are all the drives on one side, and why don't they crisscross from one to the other? Wouldn't that then be a better end result if it did?

MR. ROSS: In retrospect, yes, I would consider it would. I guess the design basis of that system was that it wasn't required because we provided instrumentations to monitor the potential accumulation of water in that volume that designs itself.

MR. PLESSET: A plumber's nightmare. Let's leave it at that. I am sorry. Let's make it simple and say it is a plumber's nightmare.

The only other comment I was going to make, you have got an impression that some of the people up here like the idea of draining down into the suppression pool. I want to tell you it is not unanimous up here. But I like your viewing this whole SDV and the instrument volume, drain and vent lines as part of the primary vessel. But I would like you to include that drain valve, because this Brunswick thing, there is a possibility that that drain valve is what caused the destruction of the instrumentation and the instrument volume.

So if you go just a little bit farther, you would make me happy. That may not be your objective, but it is a thought.

I don't think there is any disagreement with having this high class installation all the way to the bitter end, downstream of the valve.

Well, I thank you all, and I think there will be some further discussion on September 3rd on some aspects of this in Washington. There is this Safety Philosophies Subcommittee meeting in Washington September 3rd, and some of you might wish to be in touch with that subcommittee agenda in case there are things of interest to you.

With that I thank you again. You responded very well, I think, on short notice, and we appreciate it. So the meeting is adjourned.

(Whereupon, at 12:00 p.m., the meeting was adjourned.)

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NUCLEAR REGULATORY COMMISSION

This is to certify that the attached proceedings before the

ACRS SUBCOMMITTEE MEETING ON FLUID DYNAMICS

in the matter of:

Date of Proceeding: 20 AUG 80

Docket Number: 

Place of Proceeding: INGLEWOOD, CA

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

JAM' , HIGGINS

Official Reporter (Typed)

James Higgins

Official Reporter (Signature)

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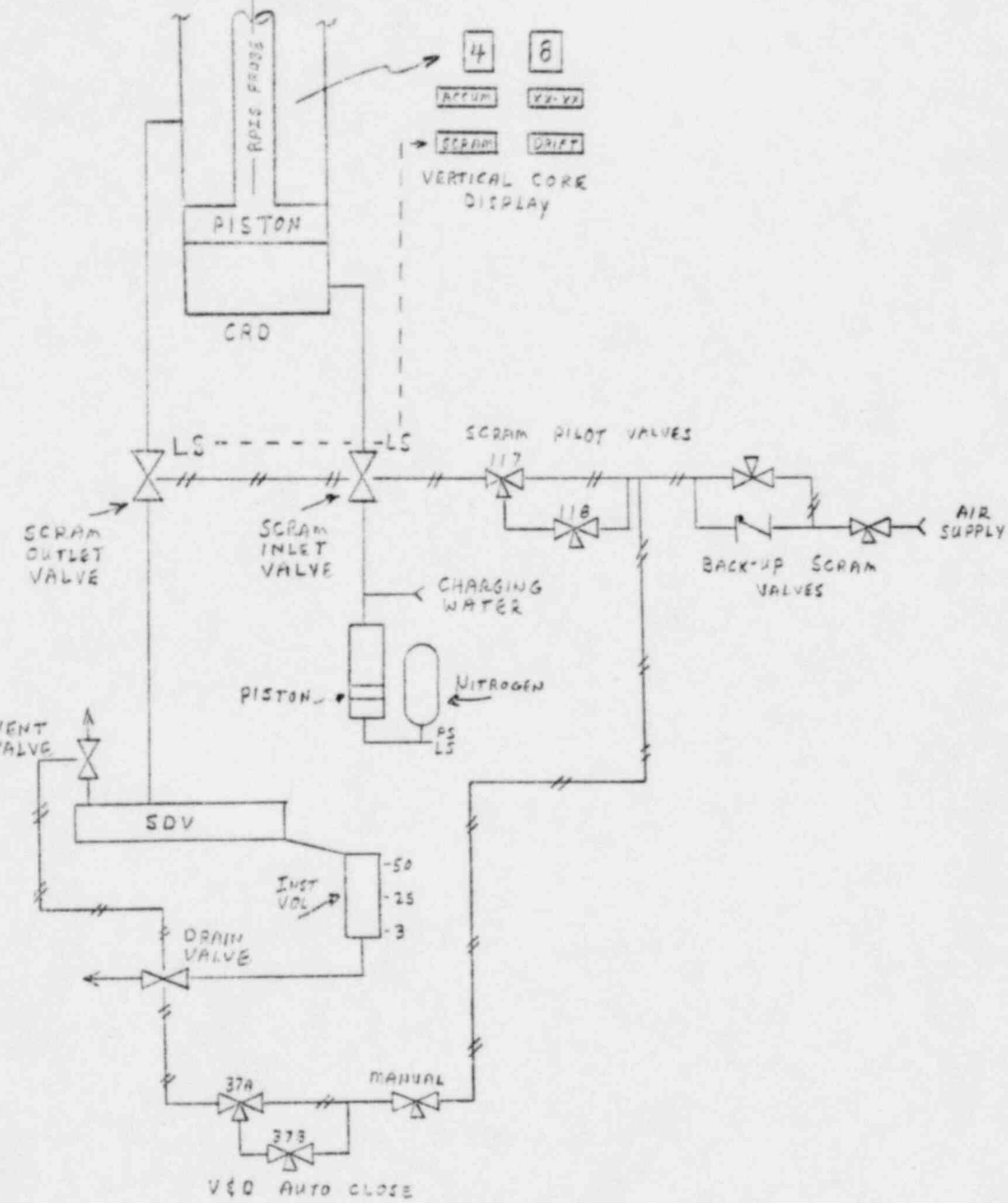


PISTON
CRD
4
8
ACCUM
XX-XX
SCRAM
DRIFT
VERTICAL CORE
DISPLAY
LS
LS
SCRAM PILOT VALVES
117
118
SCRAM
OUTLET
VALVE
SCRAM
INLET
VALVE
CHARGING
WATER
AIR
SUPPLY
BACK-UP SCRAM
VALVES
PISTON
NITROGEN
PS
LS
VENT
VALVE
SDV
INST
VOL
-50
-25
-3
DRAIN
VALVE
37A
37B
MANUAL
V&D AUTO CLOSE

Subject: INCOMPLETE CONTROL ROD INSERTION FOLLOWING UNIT THREE SCRAM - REVIEW TO SUPPORT PROPER ELECTRICAL OPERATION OF THE REACTOR PROTECTION SYSTEM

During a planned shutdown of unit 3, hydraulic control units on the east side of the reactor failed to fully insert control rods until after several attempts. The following analysis supports proper electrical operation of the reactor protection system.

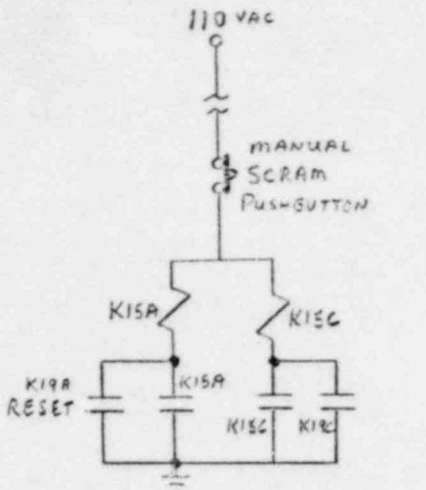
Operators verified blue scram lights illuminated on the main control panel while partially inserted control rods held steady at recognizable intermediate positions. Closure of limit switches mounted on each scram valve are required for blue scram light illumination and this is positive indication that both scram valves were open.

Response times required for the scram actuators to fully de-energize were verified to be acceptable and each rod scram group was verified to be electrically independent.

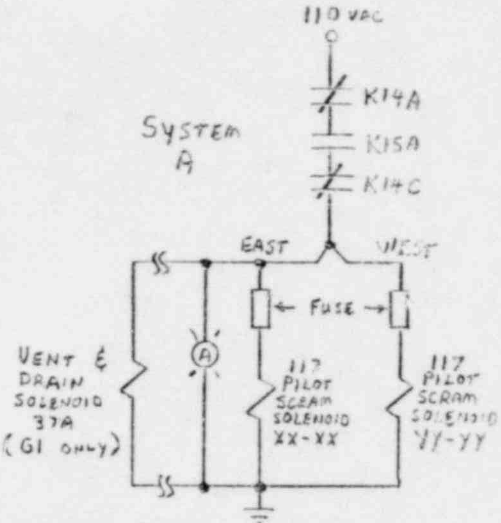
Hydraulic control units from each of the four rod scram groups were verified to be randomly positioned on both sides of the reactor. It is then reasonable to observe typical electrical response from only two sets of four if each of the hydraulic control units are directly adjacent and one is from each rod scram group. Hydraulic control units 18-03, 22-03, 26-03, 30-03, 30-07, 34-07, 38-07, and 42-07 were selected because their control rod drives are also directly adjacent and located in the same core proximity.

The second set of four hydraulic control units which share the west side scram discharge volume all inserted rods properly. Since west side hydraulic control units inserted rods properly the manual scram actuators which are common to each side of the reactor must have operated properly and the pilot scram valve solenoids on both the east and west sides of the reactor must have de-energized. Rod movement to position 02 following scram is a relatively common occurrence and the failure of rod 30-23 to fully insert on the first attempt is not considered relevant.

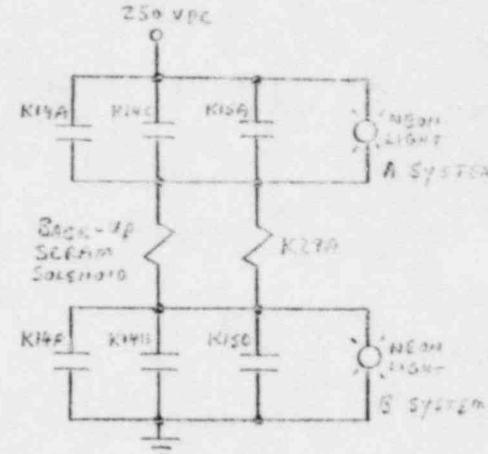
Based on this analysis, the failure of rods to fully insert was not caused by any electrical malfunction in the reactor protection system trip logic.



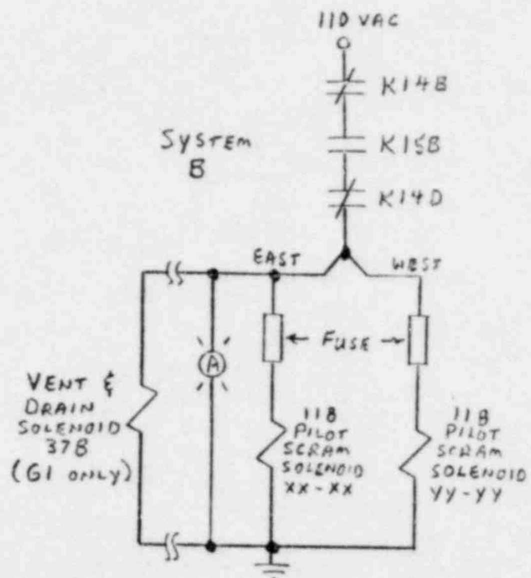

MANUAL SCRAM CIRCUIT
TYPICAL FOR A & B CHANNELS



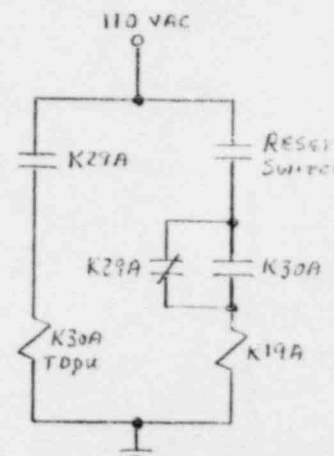

GROUP SCRAM VALVE SOLENOIDS
TYPICAL OF 4 GROUPS




BACK-UP SCRAM VALVE CIRCUIT
TYPICAL OF 2




GROUP SCRAM VALVE SOLENOIDS
TYPICAL OF 4 GROUPS




RESET CIRCUIT
TYPICAL

REVISION 1

# PROPOSED SCHEDULE FOR ACRS FLUID DYNAMICS SUBCOMMITTEE MEETING AUGUST 19-20, 1980

## TUESDAY, AUGUST 19, 1980

| | |
|---|---|
| I. EXECUTIVE SESSION - Opening Comments - M. Plesset | 8:30 am |
| (A) Discussion with ACRS Fellows on Their Report | |
| BREAK | 11:00 am |
| II. INTRODUCTORY COMMENTS - NRC Staff | 11:15 am |
| III. DESCRIPTION OF BWR CONTROL ROD DRIVE MECHANISM AND SCRAM SYSTEM GE SCOPE OF DESIGN AND INTERFACE REQUIREMENT FOR A.E. - GE | 11:30 am |
| LUNCH | 1:00 pm |
| IV. BRUNSWICK AND HATCH EVENTS RESULTING IN DAMAGE TO LEVEL SWITCHES | 2:00 pm |
| (A) System Design | |
| (B) Normal System Operation | |
| (C) Event Sequence | |
| (D) Course of the Event | |
| (1) Actions Taken to Investigate | |
| (2) Conclusions Reached | |
| (E) Possible Consequences if all Instruments had Failed | |
| (1) How Long Would it Take to Accumulate Enough Water to Prevent Scram | |
| V. QUESTIONS RAISED BY COMMITTEE MEMBERS (List provided to Staff) | 3:30 pm |
| RECESS | 5:00 pm |

WEDNESDAY, AUGUST 20, 1980

VI. BROWNS FERRY 3 EVENT OF JUNE 28, 1980 8:30 am

(A) As Built Design of the Scram System Scram Discharge, Piping, Valves, Instrumentation, Drain Tanks, etc.

(B) Description of the Normal Operation of the System

(C) Event Sequence of June 28, 1980

(D) Why did Event Occur

(1) Actions Taken to Investigate Event
(2) Conclusions Reached

(E) Corrections Taken or Planned

(F) Possible Outcome of Event Under Slightly Different Conditions, i.e., Scram from 100% Power, Scram from Loss of Offsite Power

VII. NRC RESPONSE TO EVENTS 10:30 am

(A) Immediate NRC Actions Through I&E Bulletin 80-14 and 8-17

(B) Results of Testing at Other BWRs

(C) Immediate Modifications Required to Vent the Scram Discharge Volume

(D) NRC Regional Meetings with Licensee's to discuss as Built Conditions

(E) Long Term NRC Actions Underway

(F) Implications with Regard to ATWS

VIII. GENERAL DISCUSSION 12:30 pm

ADJOURN 1:00 pm

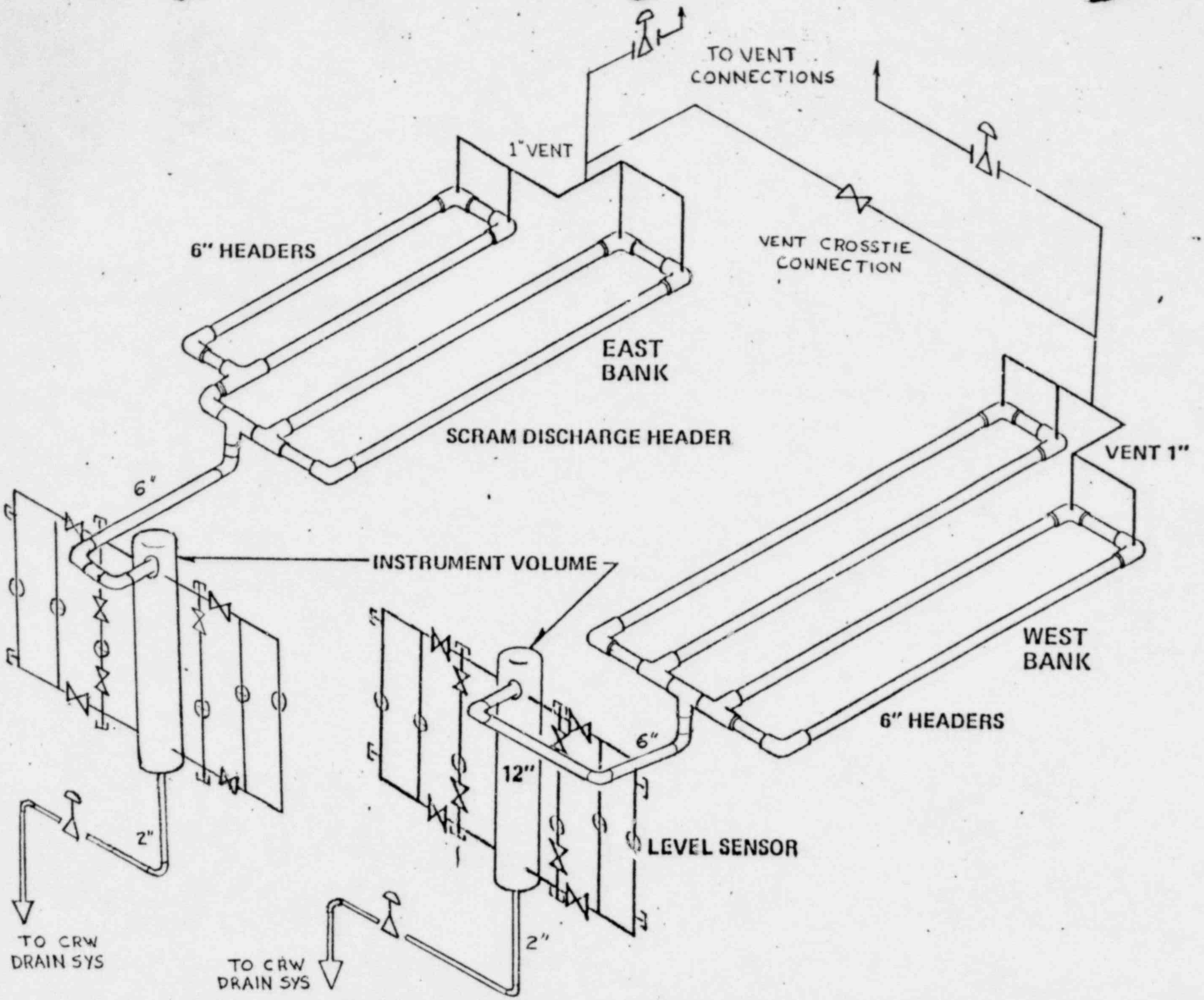
17

## SCRAM DISCHARGE HEADER VENT

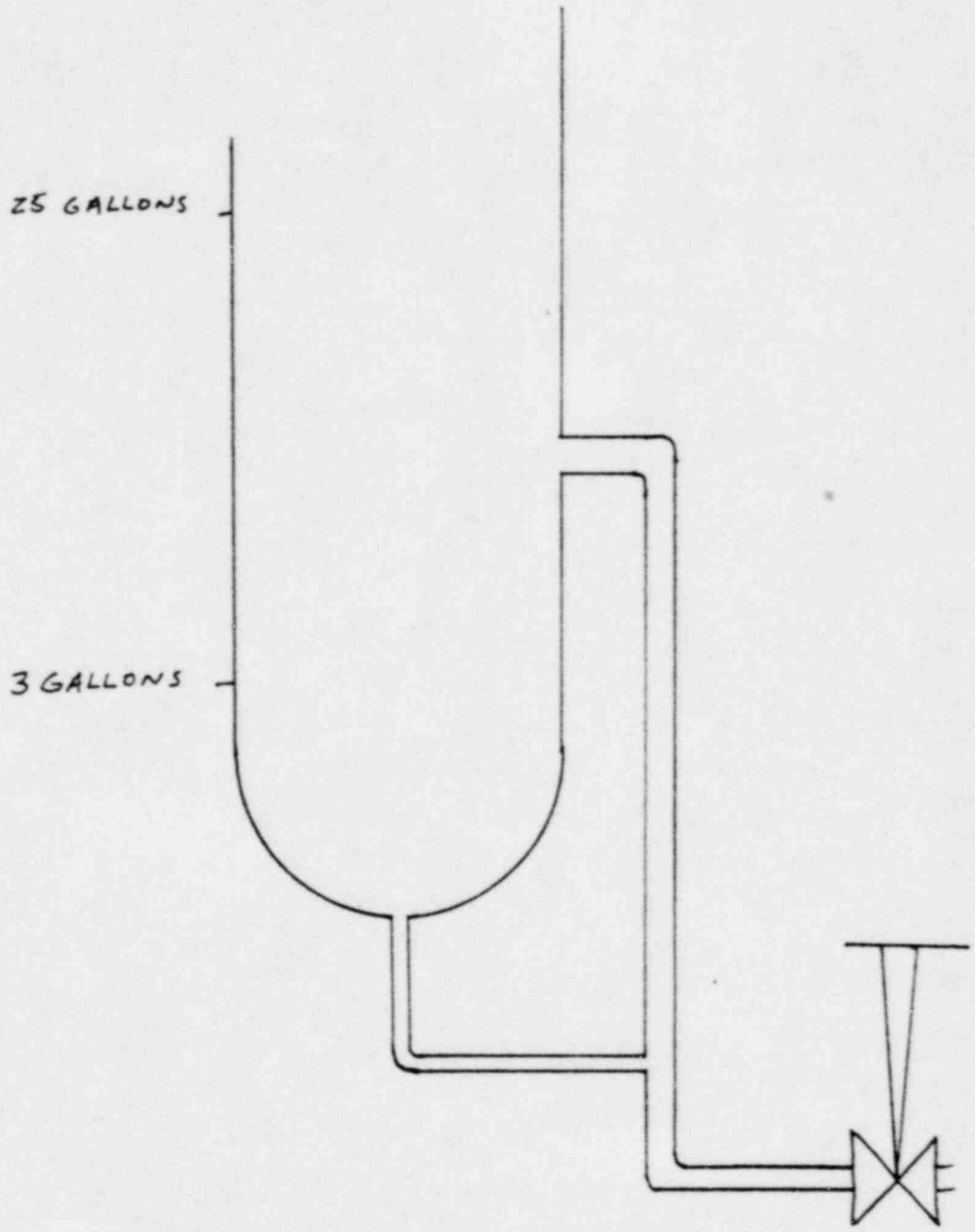
- Crosstie vents from each scram header
- Evaluate vent valve design and configuration
- Each scram header vented to CRW system
- Positive vent arrangement

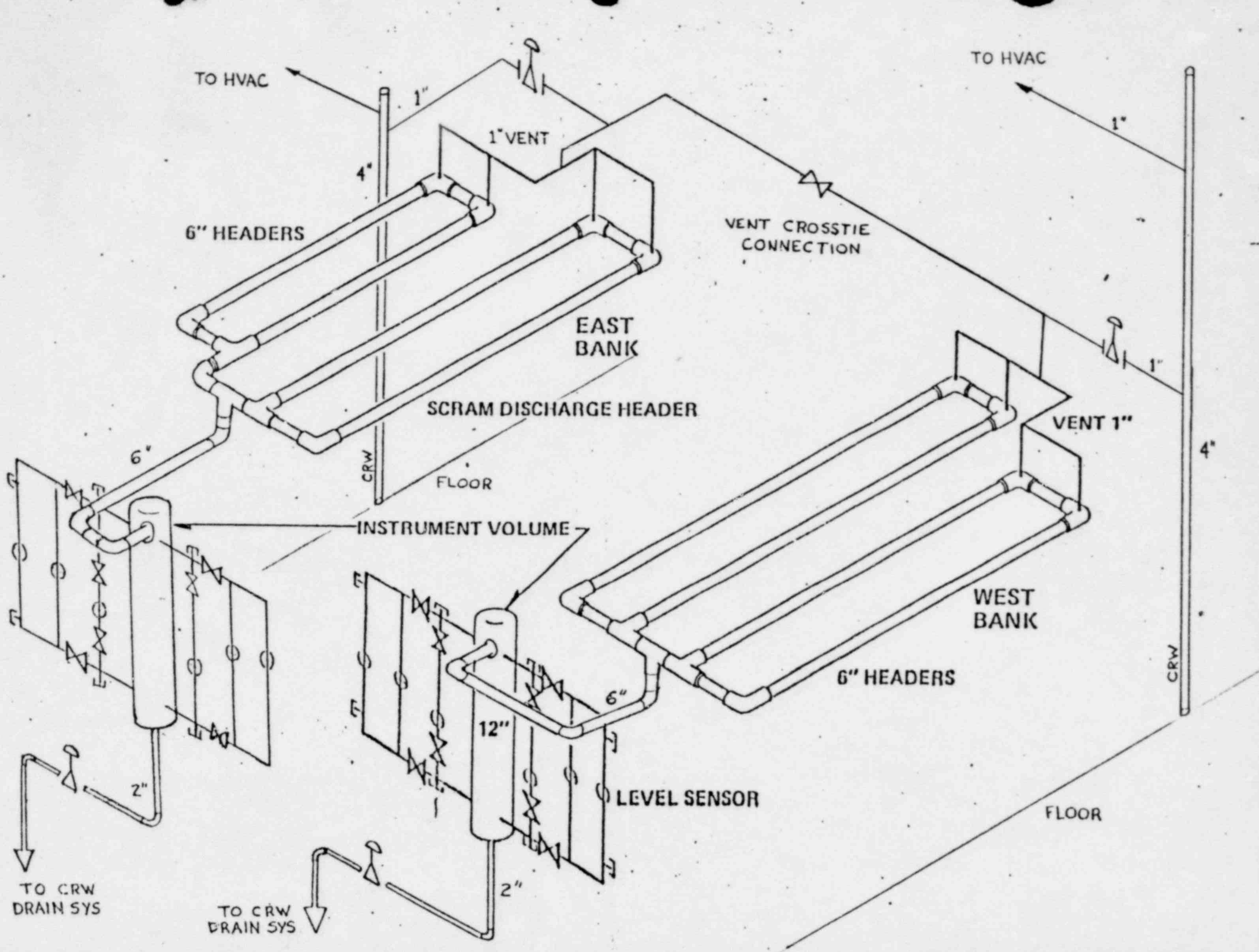
## SCRAM DISCHARGE INSTRUMENT VOLUME

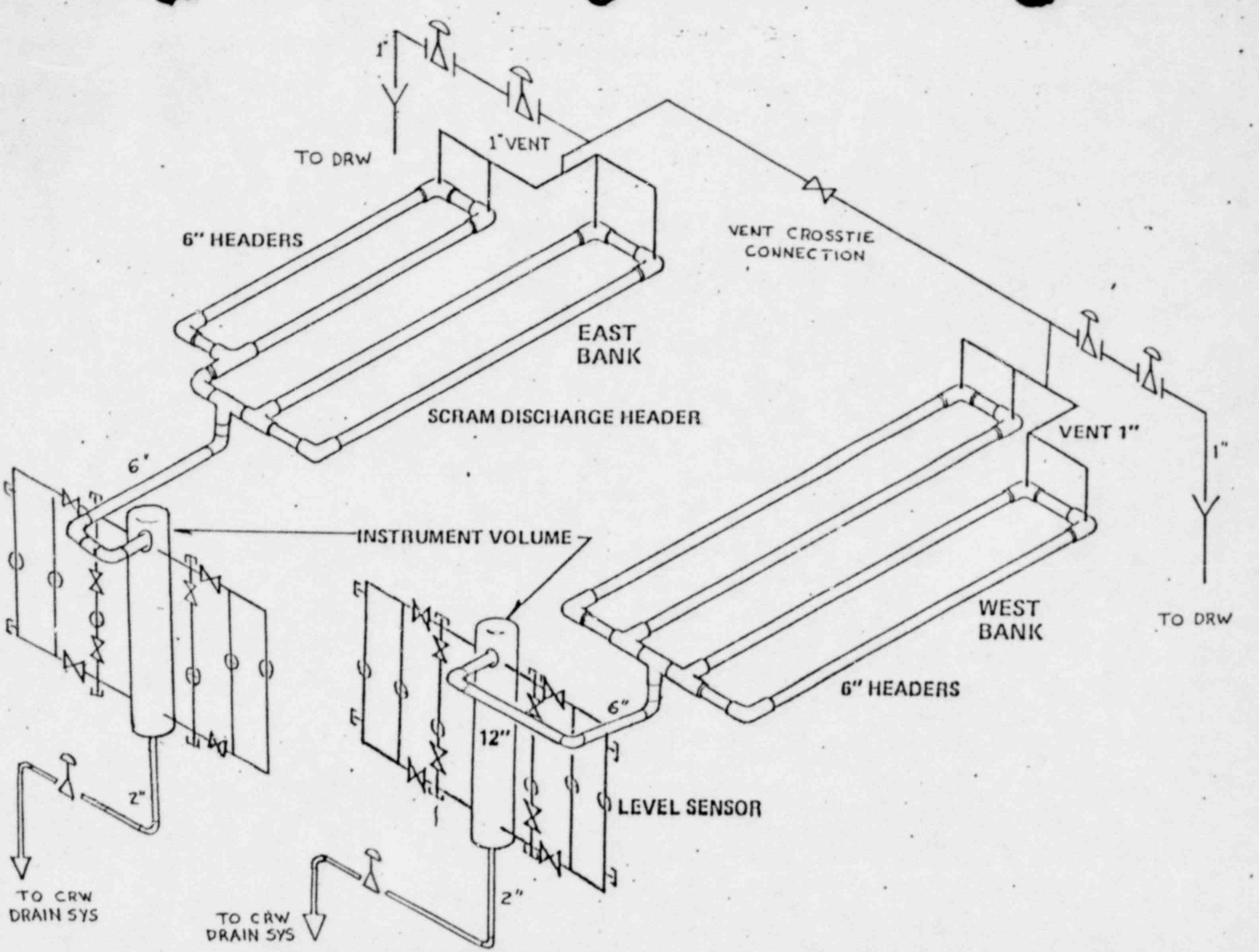
- Separate SDIV's for the east and west scram discharge headers.
- Six inch diameter pipe from scram header to SDIV
- Drain line to CRW system
- Either SDIV will alarm, inhibit control rod withdrawal, and scram


TO VENT CONNECTIONS
1"VENT
6" HEADERS
VENT CROSSTIE CONNECTION
EAST BANK
SCRAM DISCHARGE HEADER
VENT 1"
6"
INSTRUMENT VOLUME
WEST BANK
6" HEADERS
6"
12"
LEVEL SENSOR
2"
2"
TO CRW DRAIN SYS
TO CRW DRAIN SYS

01873-3


25 GALLONS
3 GALLONS


TO HVAC
1"
1" VENT
4"
6" HEADERS
EAST
BANK
SCRAM DISCHARGE HEADER
6"
CRW
FLOOR
INSTRUMENT VOLUME
TO HVAC
1"
VENT CROSSTIE
CONNECTION
1"
VENT 1"
4"
WEST
BANK
6" HEADERS
CRW
6"
12"
LEVEL SENSOR
FLOOR
2"
2"
TO CRW
DRAIN SYS
TO CRW
DRAIN SYS


1"
TO DRW
1" VENT
6" HEADERS
VENT CROSSTIE
CONNECTION
EAST
BANK
SCRAM DISCHARGE HEADER
VENT 1"
1"
6"
INSTRUMENT VOLUME
WEST
BANK
TO DRW
12"
6"
6" HEADERS
2"
2"
LEVEL SENSOR
TO CRW
DRAIN SYS
TO CRW
DRAIN SYS

GENERAL ELECTRIC

PRESENTATION TO THE

ACRS ON

BROWNS FERRY 3 EVENT

AUGUST 20, 1980

HCP
8/18/80 (MM/1539)

## PURPOSE

PRESENT RESPONSE TO QUESTIONS ON BROWNS FERRY PARTIAL SCRAM WITH ESCALATED ASSUMPTIONS

HCP (1)
8/15/80 (MM/1793)

18

## GE ACTIONS

- o ESTABLISH DIRECT PHONE CONVERSATION WITH BROWNS FERRY SITE
- o ESTABLISHED SAN JOSE TASK FORCE TO COORDINATE SUPPORT FOR BROWNS FERRY 3 AND DIRECT EFFORTS FOR OTHER UNITS
- o DISPATCHED TEAM OF SIX SENIOR PERSONNEL TO BROWNS FERRY SITE
- o ACTIVATED A 24-HOUR COMMUNICATION CENTER FOR DIRECT COMMUNICATIONS WITH OPERATING UNITS
- o PERFORMED STRUCTURED PROBLEM ANALYSIS AND IDENTIFIED POTENTIAL IMPROVEMENTS
- o PERFORMED ANALYTICAL ASSESSMENTS
  - SUPPORT INTERNAL EVALUATIONS
  - RESPOND TO I&E BULLETIN
  - RESPOND TO NRC STAFF QUESTIONS

## PARTIAL SCRAM EVALUATION

- o EVALUATION BASED ON RESPONSE OF GENERIC BWR/4 PLANT USED IN ATWS REPORT TO ISOLATION EVENT

- o CORE POWER CALCULATED TO DROP BELOW 10%

  - INITIAL POWER AT 100%
  - BROWNS FERRY PARTIAL SCRAM ROD MOTION
  - RECIRCULATION PUMPS TRIP WITHIN 30 SEC.
  - RODS INSERTED FROM EOC ALL RODS OUT CONDITION

- o PLANT RESPONSE TO ISOLATION (SHORT TERM)

  - REACTOR VESSEL PRESSURE WTHIN "UPSET" LIMITS
  - CORE COOLANT LEVEL/FLOW MAINTAINED AT ACCEPTABLE LEVELS
  - CORE RESPONSE CONSERVATIVELY BOUNDED BY ATWS EVALUATIONS

- o SUPPRESSION POOL TEMPERATURE MAINTAINED WITHIN ACCEPTABLE LIMITS

  - PEAK POOL TEMPERATURE IS 186°F
  - EXISTING (SINGLE PUMP) SLC UTILIZED
  - SLC INITIATED AT 30 MINUTES (MANUALLY)
  - RHR INITIATED AT 10 MINUTES

- o ISOLATION EVENT EVALUATED CONSISTENT WITH LOSS OF OFFSITE POWER EVENT

HCP
8/18/80 (MM/1540)

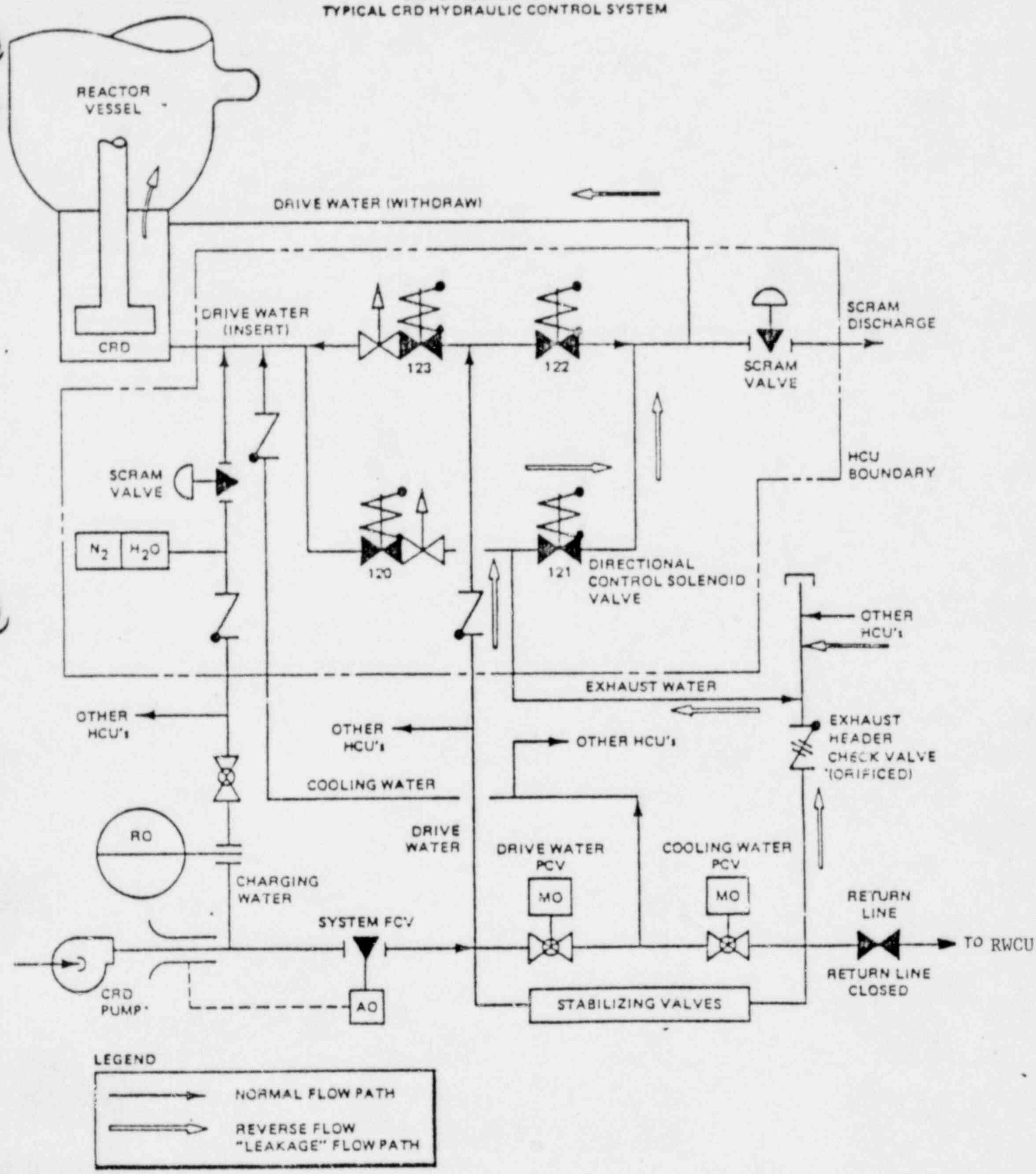
## CONCLUSIONS

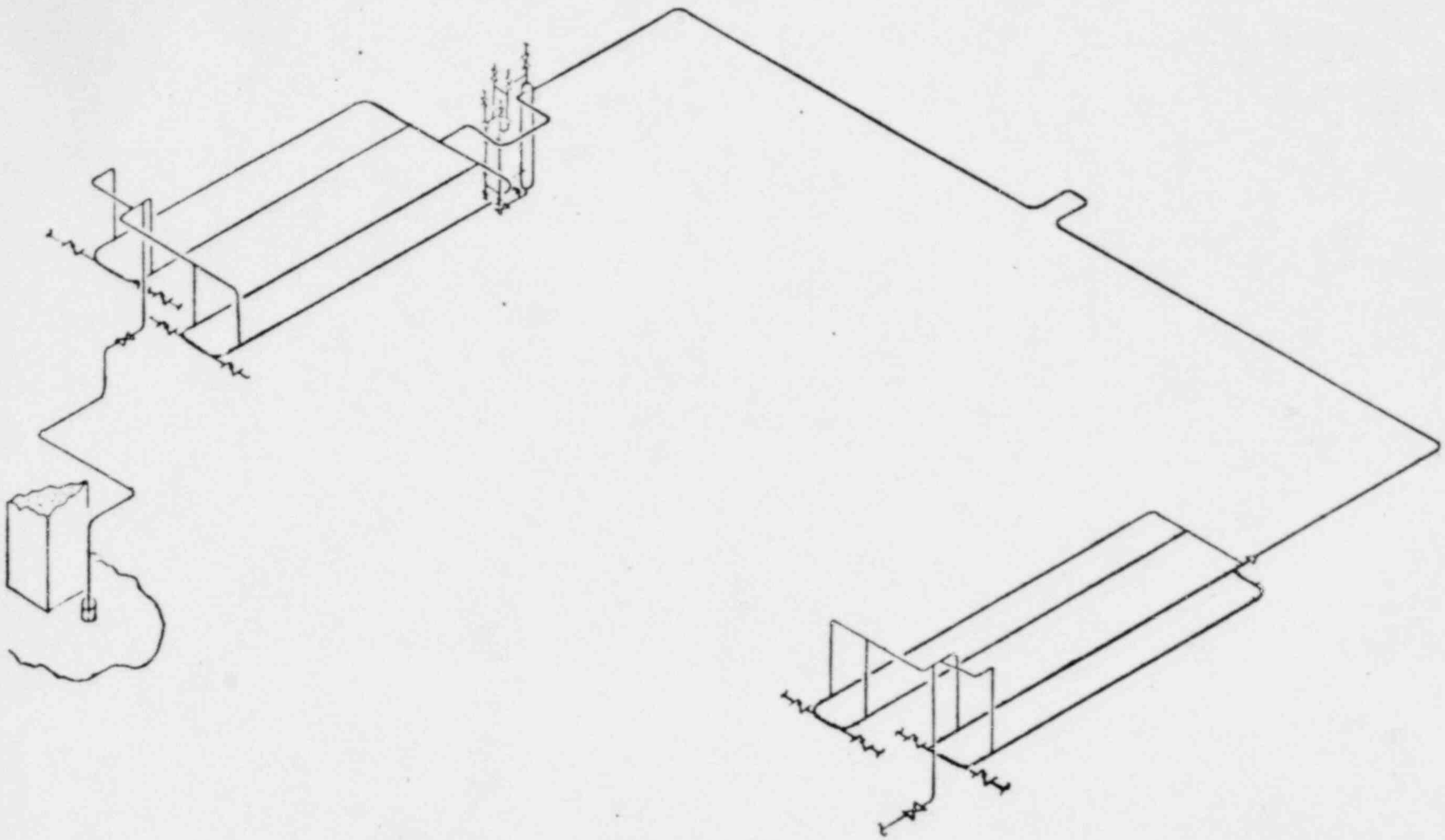
EXISTING PLANT DESIGN CAPABLE OF ACCOMMODATING BROWNS FERRY PARTIAL SCRAM SHOULD IT HAVE RESULTED FROM A TRANSIENT AT FULL POWER

# OUTLINE

| | | |
|---|---|---|
| I. | DESCRIPTION OF HANDOUTS AND FULL-SIZE DRAWINGS AVAILABLE | |
| II. | SIMPLIFIED CRD HYDRAULIC CONTROL SYSTEM | FIG. 1 |
| | BASIC ISOMETRIC OF SCRAM DISCHARGE SYSTEM (SIMILAR TO DISPLAY MODEL) | FIG. 2 |
| | DETAILS OF SCRAM INSTRUMENT VOLUME TANK AND LEVEL SWITCH | FIG. 3 |
| | AS-BUILT ISOMETRIC OF SCRAM DISCHARGE SYSTEM | FIG. 4 |
| | AS-BUILT ISOMETRIC OF UNITS 1 AND 2 VARIATIONS | FIG. 5 |
| III. | FLOW DIAGRAM OF CLEAN RADWASTE DRAINAGE SYSTEM | FIG. 6 |
| | TABULATION OF CRW INTERFACES WITH SCRAM DISCHARGE SYSTEM | FIG. 7A THRU 7C |
| | AS-BUILT PLAN VIEWS OF CRW PIPING BY ELEVATIONS: | |
| | EL. 565-0 | FIG. 8 |
| | EL. 593-0 | FIG. 9 |
| | EL. 621-3 | FIG. 10 |
| | EL. 639-0 | FIG. 11 |

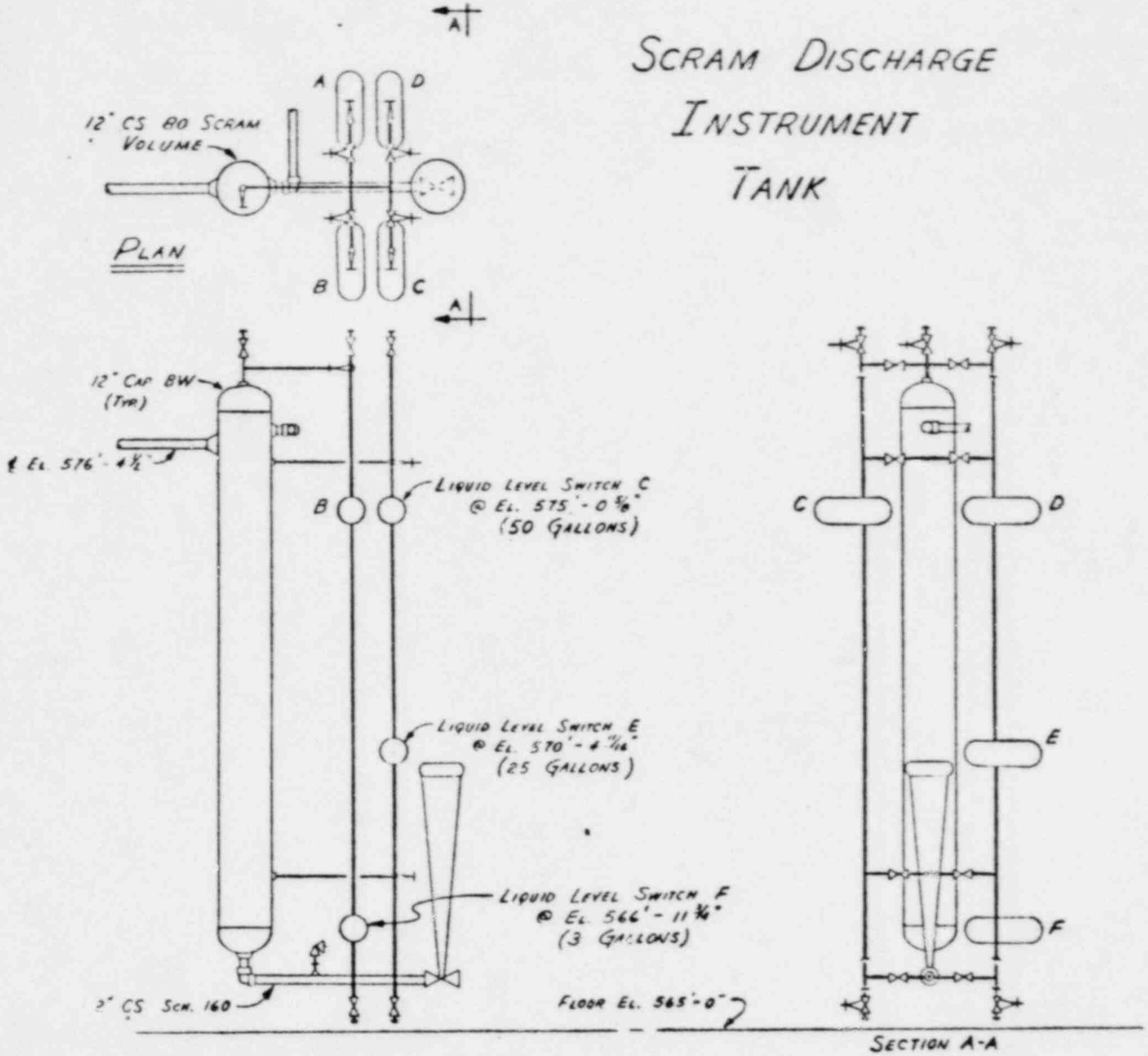
SIMPLIFIED SCHEMATIC
TYPICAL CRD HYDRAULIC CONTROL SYSTEM

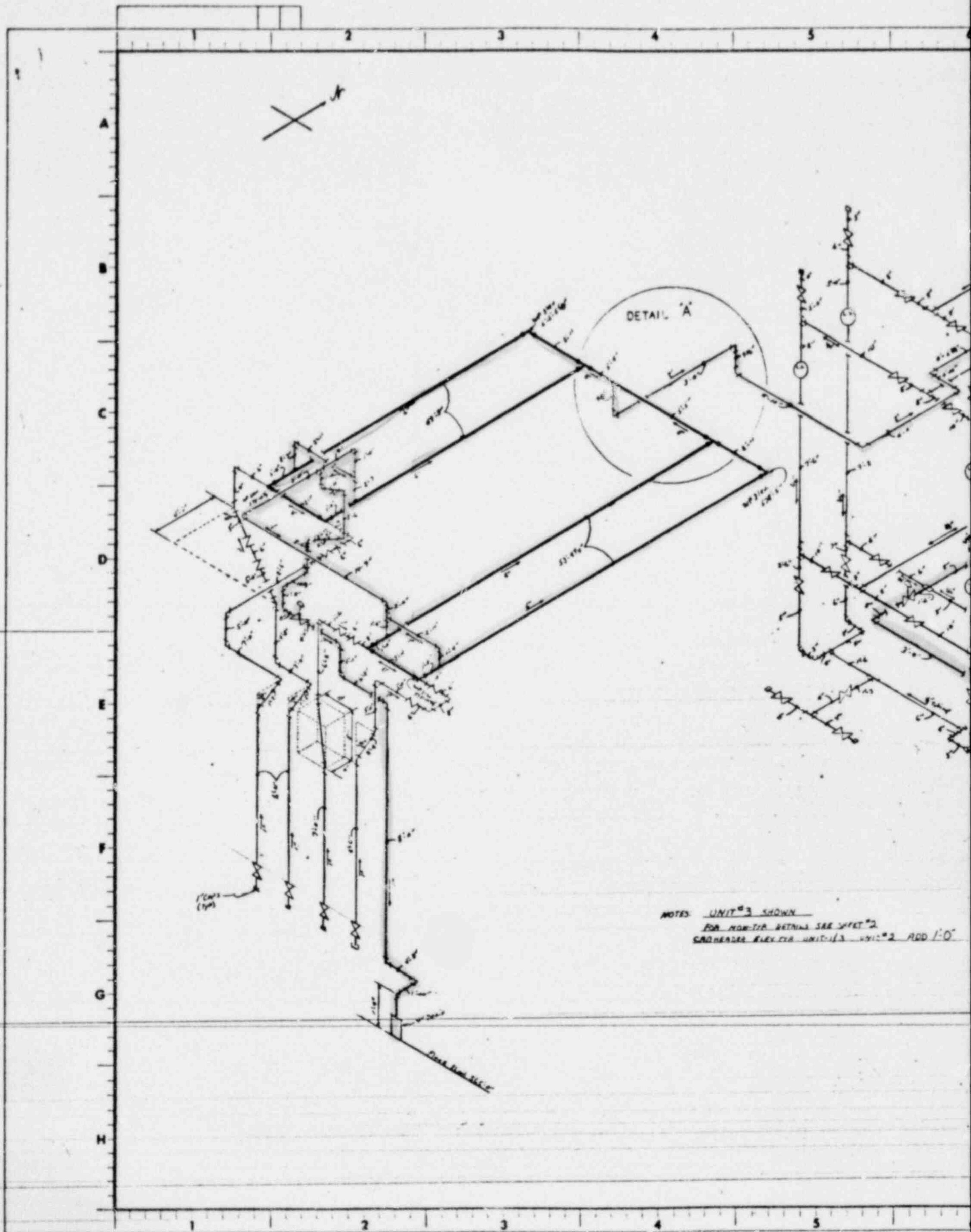




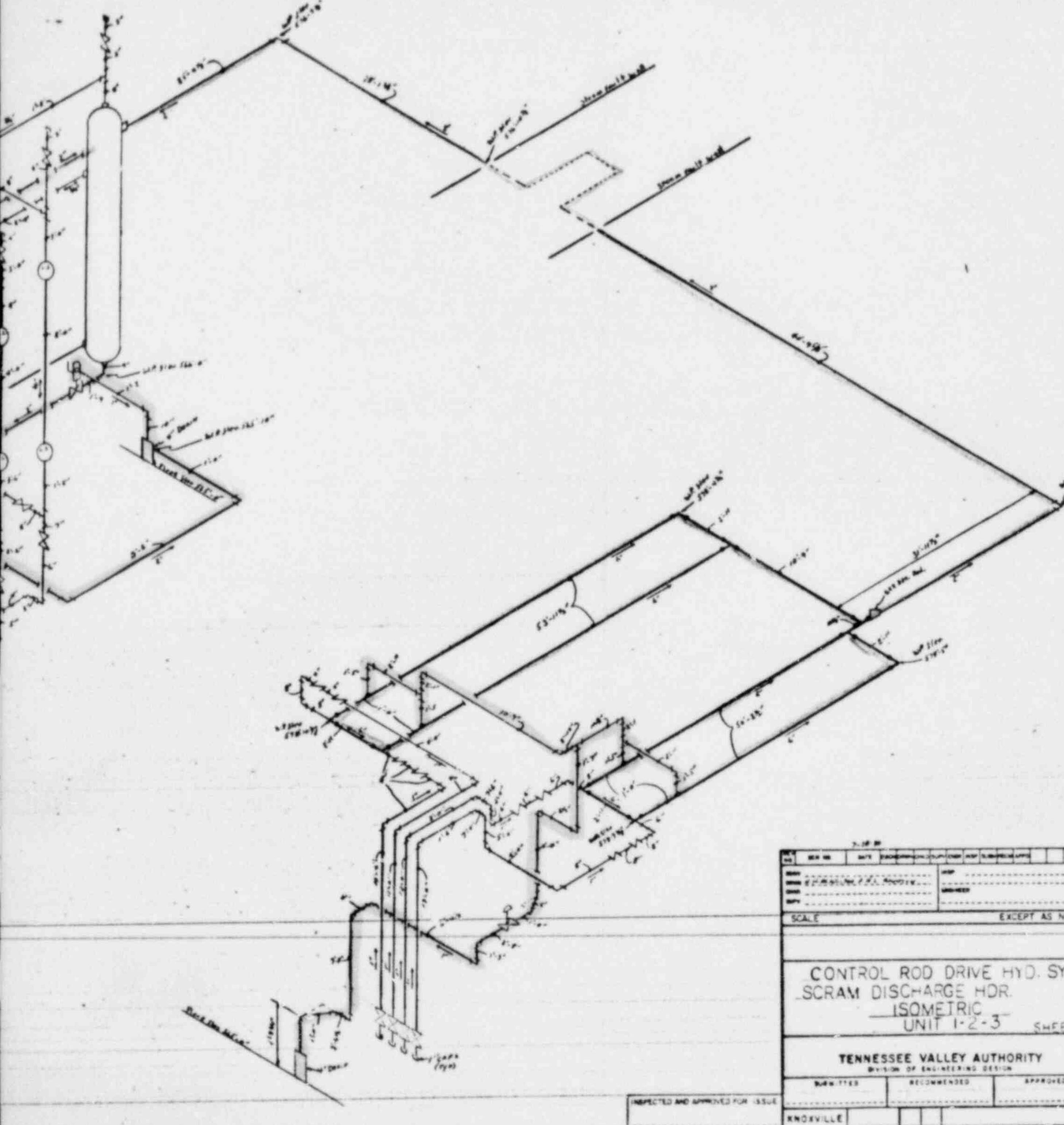
CRD SCRAM DISCHARGE HEADER ISOMETRIC
BROWNS FERRY NUCLEAR PLANT

# Scram Discharge Instrument Tank





DETAIL "A"
NOTES: UNIT #3 SHOWN
1
2
3
4
5
A
B
C
D
E
F
G
H



SCALE EXCEPT AS NOTED

CONTROL ROD DRIVE HYD. SYS.
SCRAM DISCHARGE HDR.
ISOMETRIC
UNIT 1-2-3 SHEET #1

TENNESSEE VALLEY AUTHORITY
DIVISION OF ENGINEERING DESIGN

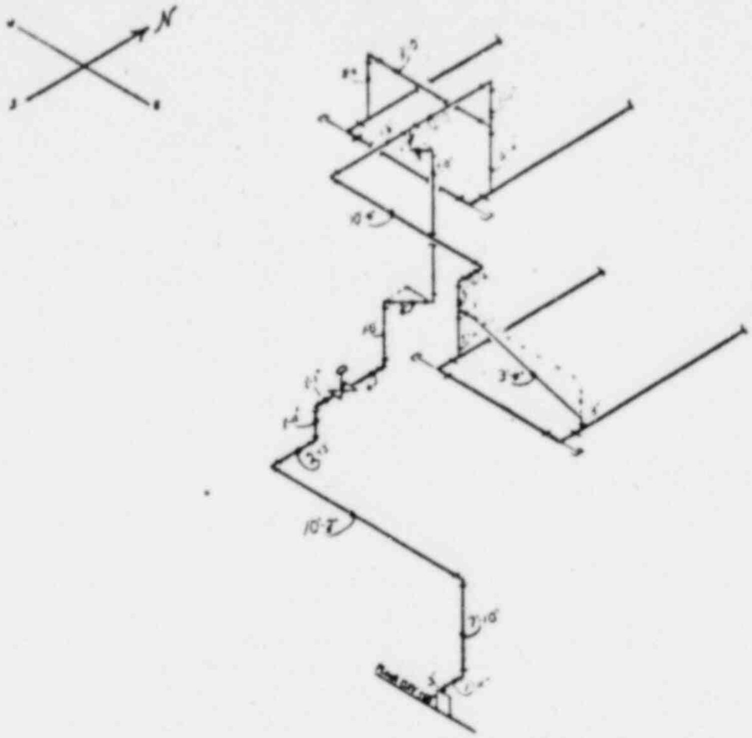
| SUBMITTED | RECOMMENDED | APPROVED |
|---|---|---|
| | | |

INSPECTED AND APPROVED FOR ISSUE

KNOXVILLE

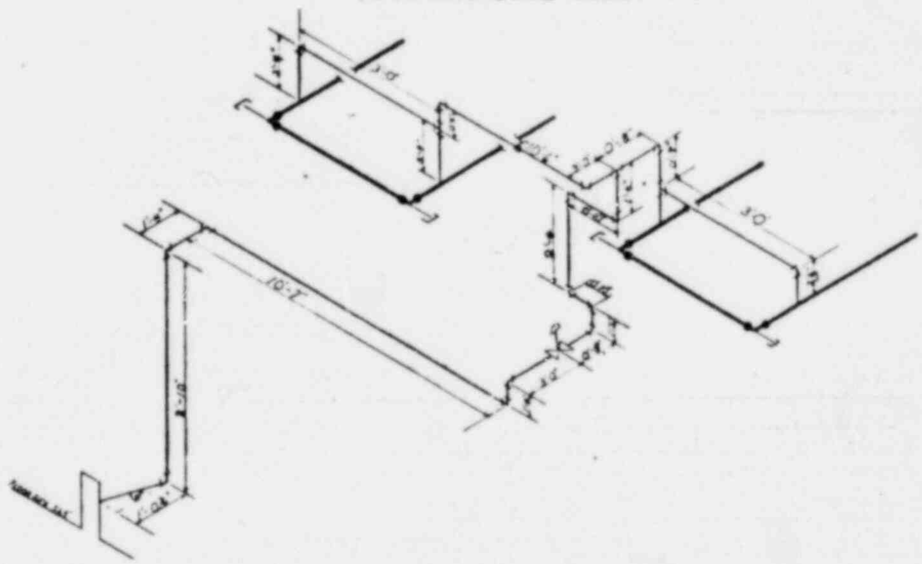
AS CONSTRUCTED

4



WEST CRD SCRAM HEADER VENT

UNIT #2

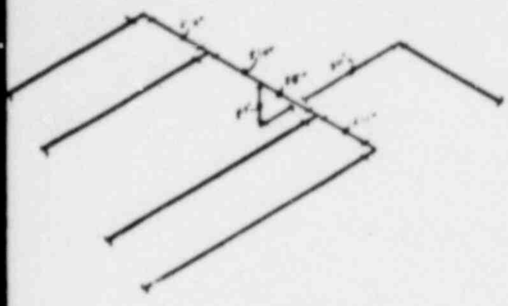


EAST CRD SCRAM HEADER VENT

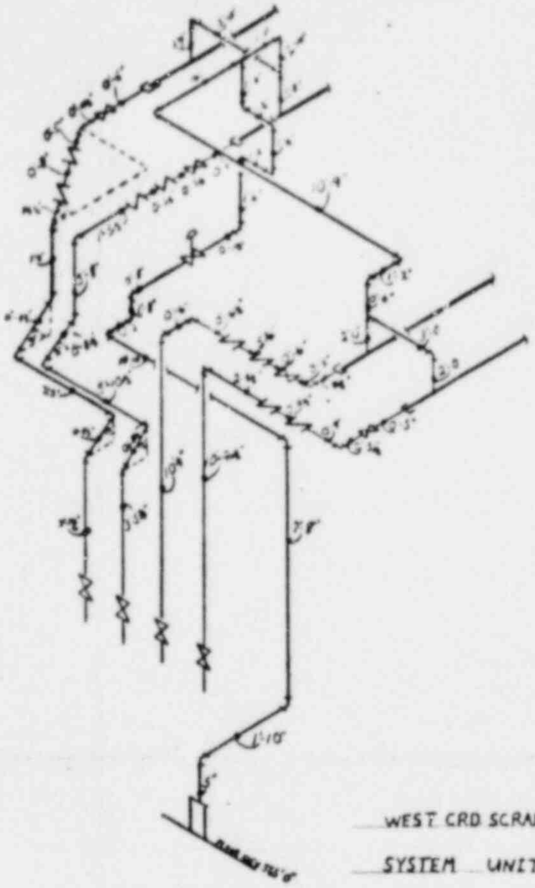
UNIT #2

NOTES: UNIT #2 HAS NO FLUSHING LINES

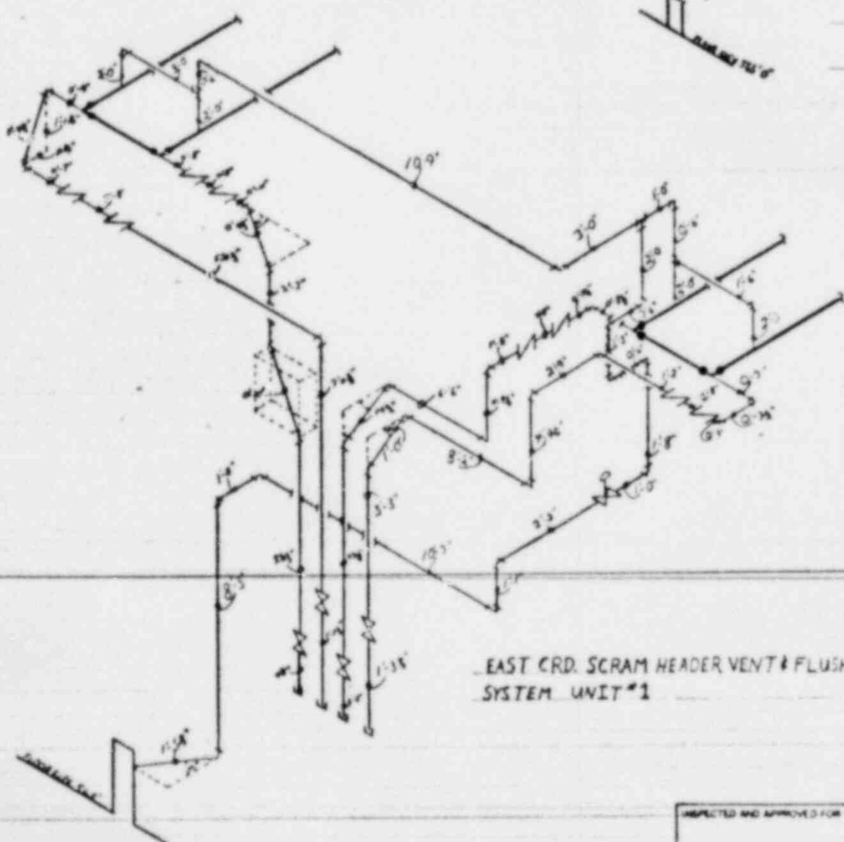
14



DETAIL-A units 1&2



WEST CRD SCRAM HEADER VENT & FLUSHING SYSTEM UNIT #1



EAST CRD. SCRAM HEADER VENT & FLUSHING SYSTEM UNIT #1

SCALE EXCEPT AS NOTED

CONTROL ROD DRIVE HYD. SYS.
SCRAM DISCHARGE HGR
ISOMETRIC
UNIT 1-2-3 SHEET # 2

TENNESSEE VALLEY AUTHORITY
DIVISION OF ENGINEERING DESIGN

| SUBMITTED | RECOMMENDED | APPROVED |
| --- | --- | --- |
| | | |

INSPECTED AND APPROVED FOR ISSUE

KNOXVILLE

AS CONSTRUCTED

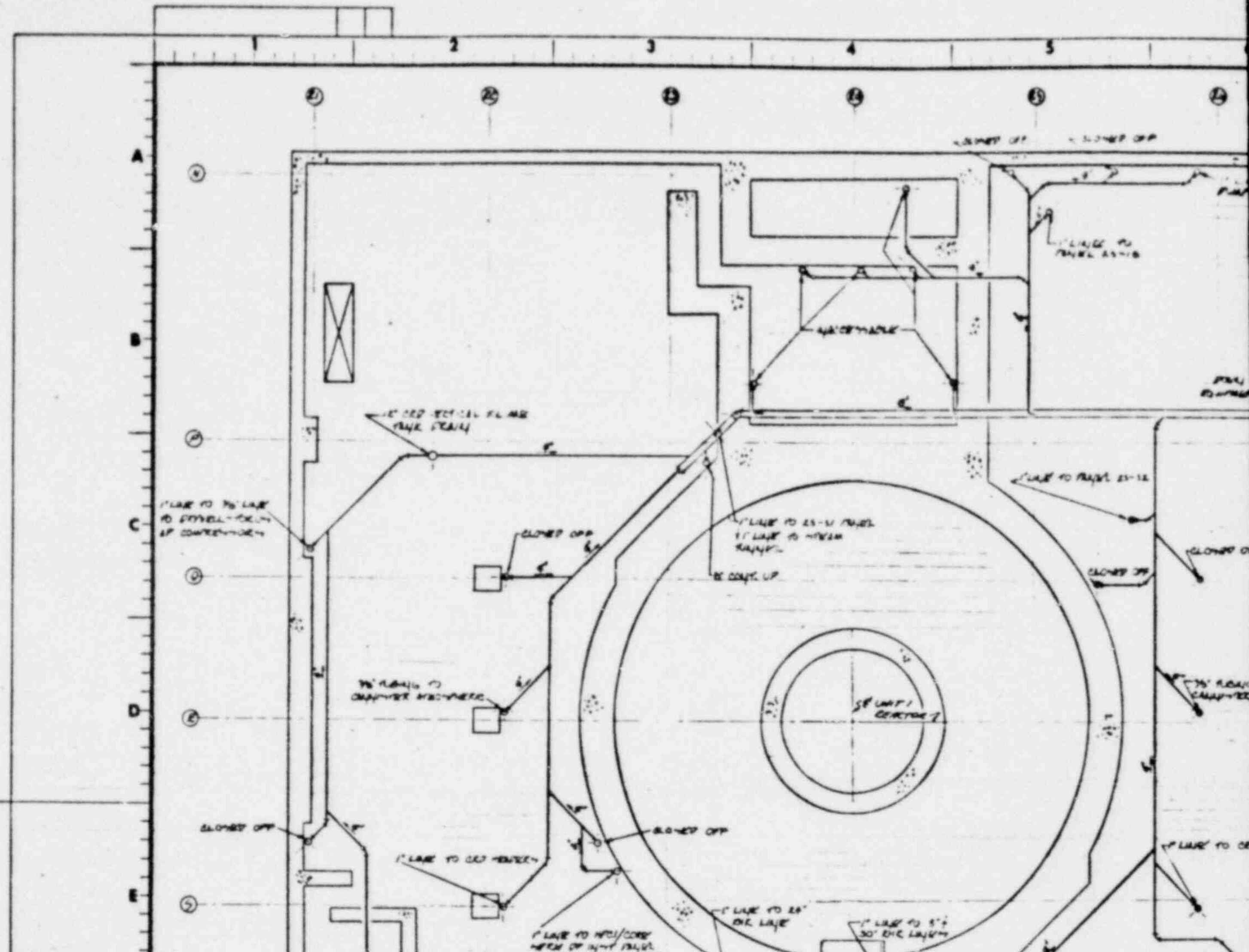
5

TABULATION OF CRW INTERFACES WITH SCRAM DISCHARGE SYSTEM

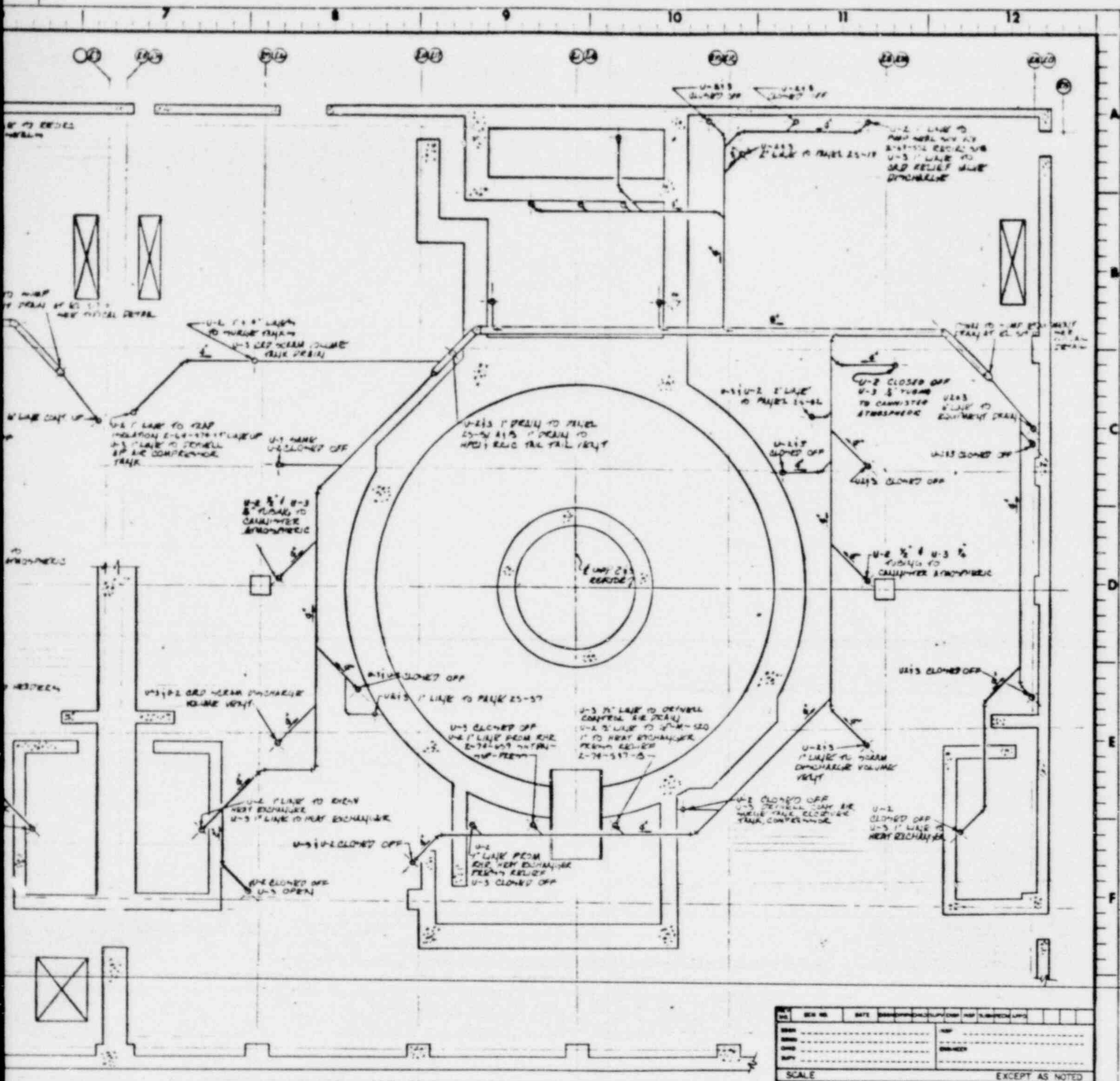
| FLOW DIAGRAM REF. NO. | LINE DESCRIPTION | LOCATION |
|---|---|---|
| 1 | Lower end of 8" unlimited access equipment Drain Hdr. (in R.B. equipment Dr. sump) | El. 509'-0" |
| 2 | Vertical run of 8" header from sump. | To El. 547'-6" |
| 3 | Vertical run of 8" header from sump (continued). | To El. 560'-4" |
| 4 | 90° El. for horiz. run of 8" header to<br>Stub-ups thru the 565'-0 floor slab: | El. 561'-4"<br>El. 565'-0" |
| 5 | Train 1 (For all units unless indicated)<br>1 ea panel 25-52 dr<br>* 1 ea U2 capped and U3 atmospheric filter vent (CAPPED)<br>2 ea CRW dr. capped<br>* 1 ea atmospheric vent (CAPPED)<br>* 1 ea CRD header vent (CAPPED)<br>1 ea RHR heat exchanger dr. (shell side) (unit 1 only)<br>1 ea panel 27-217 dr.<br>U2 capped<br>U3 D.W. control air surge Tk. dr.<br>2 ea RHR shutdown cooling dr.<br>U3 capped<br>1 ea RHR supply dr.<br>U3 capped<br>1 ea panel 25-196 dr.<br>U2 and U3 capped | El. 565'-0" |
| | Train 1A (U2 and U3 only)<br>2 ea CRW dr. capped<br>1 ea CRW dr. capped (U2)<br>1 ea RHR heat exchanger dr. (U3) | El. 565'-0" |
| 6 | Train 2<br>1 ea panel 25-18 dr.<br>2 ea CRW dr. capped<br>1 ea Recvrc Pmp seal dr.<br>U3 CRD relief vlv. disch. dr.<br>4 ea CRW dr. (inaccessible) | El. 565'-0" |
| 8 | Train 3<br>* 1 ea scram instr. vol. dr.<br>1 ea Dp comp. separator dr.<br>U2 line trap dr.<br>1 ea CRW dr. capped off-U1<br>1 ea RHR heat exchanger dr. shell side -U1 | El. 565'-0" |

| FLOW DIAGRAM REF. NO. | LINE DESCRIPTION | LOCATION |
|---|---|---|
| 7 Train 4 | 1 ea CRW dr (inaccessible) | El. 565-'0" |
| | 1 ea panel 25-51 dr. and dr. from steam tunnel | |
| | 2 ea CRW dr. capped | |
| | * 1 ea atmospheric vent (CAPPED) | |
| | * 1 ea scram hdr. vent (CAPPED) | |
| | 1 ea panel 25-57 dr. U2 and U3 only | |
| | 1 ea RHR heat exchanger dr. | |
| | 1 ea CRW dr. capped | |
| 9 | 6" header from 8" header to | El. 565'-0" |
| 10 | stub -ups in the 593' floor: | El. 593'-0" |
| | 2 ea CRW dr. capped (U1) | |
| | 1 ea RBCCW panel 25-8 dr. | |
| | A/C dr | |
| | RBCCW receiver dr. | |
| | "B" isolation tank dr. | |
| | Vertical line to RBCCW dr. | |
| | Receiving Tr. dr. | |
| | RBCCW dryer dr. | |
| | (U3 blanked) | |
| | 1 ea panel 25-5 A and B and 25-5-00 dr. | |
| | 1 ea RWCU panel 25-2 dr. | |
| | 1 ea panel 25-6-001 dr. (U2 and U3) | |
| | 1 ea panel 25-6 A and B dr. (U2 and U3) | |
| | 1 ea CRW dr. blanked (U2 and U3) | |
| 11 | 6" header to stub-ups | El. 593'-0" |
| | in 621'-3" floor: | El. 621'-3" |
| | Unit 1 only | |
| | 1 ea A/C unit bd. rm dr. | |
| | 1 ea D.W. pool Htx. dr. | |
| | 1 ea T's to D.W. and FPC pipe dr. | |
| | 2 ea T's to vent sys and fuel pool Ht Exch. dr. | |
| | 2 ea fuel pool cool PMP dr | |
| | to vent sys | |
| | to FPC pipe dr. | |
| | 2 ea to 14" pipe dr. | |
| | 1 ea RWCU precoat PMP dr. | |
| | RWCU precoat Tk dr. | |
| | to tank overflow dr. (VENTED TO ATMOSPHERE) | |
| | to backwash inlet dr. | |
| | precoat outlet dr. | |
| | 1 ea to precoat inlet A dr. | |
| | to precoat outlet B dr. | |
| | to RWCU holding PMP 1B dr. | |
| | to backwash line dr. | |
| | to precoat PMP disch. dr. | |
| | to precoat outlet dr. | |

| FLOW DIAGRAM REF. NO. | LINE DESCRIPTION | LOCATION |
|---|---|---|
| 11 (cont'd) | 1 ea spare blank | |
| | 1 ea to RWCU holding PMP 1A dr | |
| | to precoat inlet A dr. | |
| | to precoat inlet B dr. | |
| | Unit 2 and Unit 3 | |
| | 1 ea panel 25-36 A and B and 25-187 dr. | El. 621'-3" |
| | 1 ea holding PMP dr. | |
| | 1 ea RWCU station dr. | |
| | U2 precoat backwash intake dr. | |
| | 1 ea pump 2A dr. | |
| | U3 PMP disch dr. | |
| | U3 PMP 3B dr. | |
| | U3 backwash air pipe dr. | |
| | 1 ea PMP 2A dr. | |
| | to backwash air line dr. | |
| | U3 blank | |
| | 1 ea U2 blank | |
| | U3 precoat overflow dr. | |
| | 1 ea to conds. s and s pipe dr. | |
| | to 6" RHP pipe dr. | |
| | 1 ea FPC pipe dr. | |
| | 1 ea PMP A and B dr. | |
| | FPC pipe dr. | |
| | U3 FPC PMP dr. A and B | |
| | 1 ea FPC pipe dr. for U2 add | |
| | PMP A and B dr. | |
| | 2 ea FPC Ht. Exch. dr. | |
| | U3 FPC Ht. Exch. dr. | |
| | 1 ea panel 43-674 and 673 dr. | |
| | U3 sample station dr. | |
| | 1 ea eq. dr. | |
| 12 | 6" header to stub-ups in the 639'-0" floor: | El. 639'-0" |
| | 4 ea air duct dr. | |
| | 4 ea blank (5 ea for U2 and U3) | |
| 13 14 | 4" line from 8" header to Stub-ups in the 593'-0" floor: | El. 561'-4" to El. 593'-0" |
| | 2 ea CRW dr. | |
| | 1 ea instru. panel dr. | |
| 15 | 2" line from 4" line to stub-ups in 621'-3" floor: | El. 593'-0" to El. 621'-3" |
| | 1 ea fuel pool vent duct dr. | |



1
2
3
4
5
6
A
B
C
D
E
F
G
H
CLOSED OFF
UNIT 1
TYPICAL EQUIP SUMP DRAIN



PLAN @ ELEV 565.0

UNIT 2&3

SCALE EXCEPT AS NOTED

POWERHOUSE
REACTOR BUILDING _ UNITS 1-3

CRW

UNLIMITED ACCESS @ EL 565.0

UNIT NO1
UNIT NO2
UNIT NO3

AS CONSTRUCTED

TENNESSEE VALLEY AUTHORITY
DIVISION OF ENGINEERING DESIGN

| SUBMITTED | RECOMMENDED | APPROVED |
| --- | --- | --- |
| | | |

INSPECTED AND APPROVED FOR ISSUE

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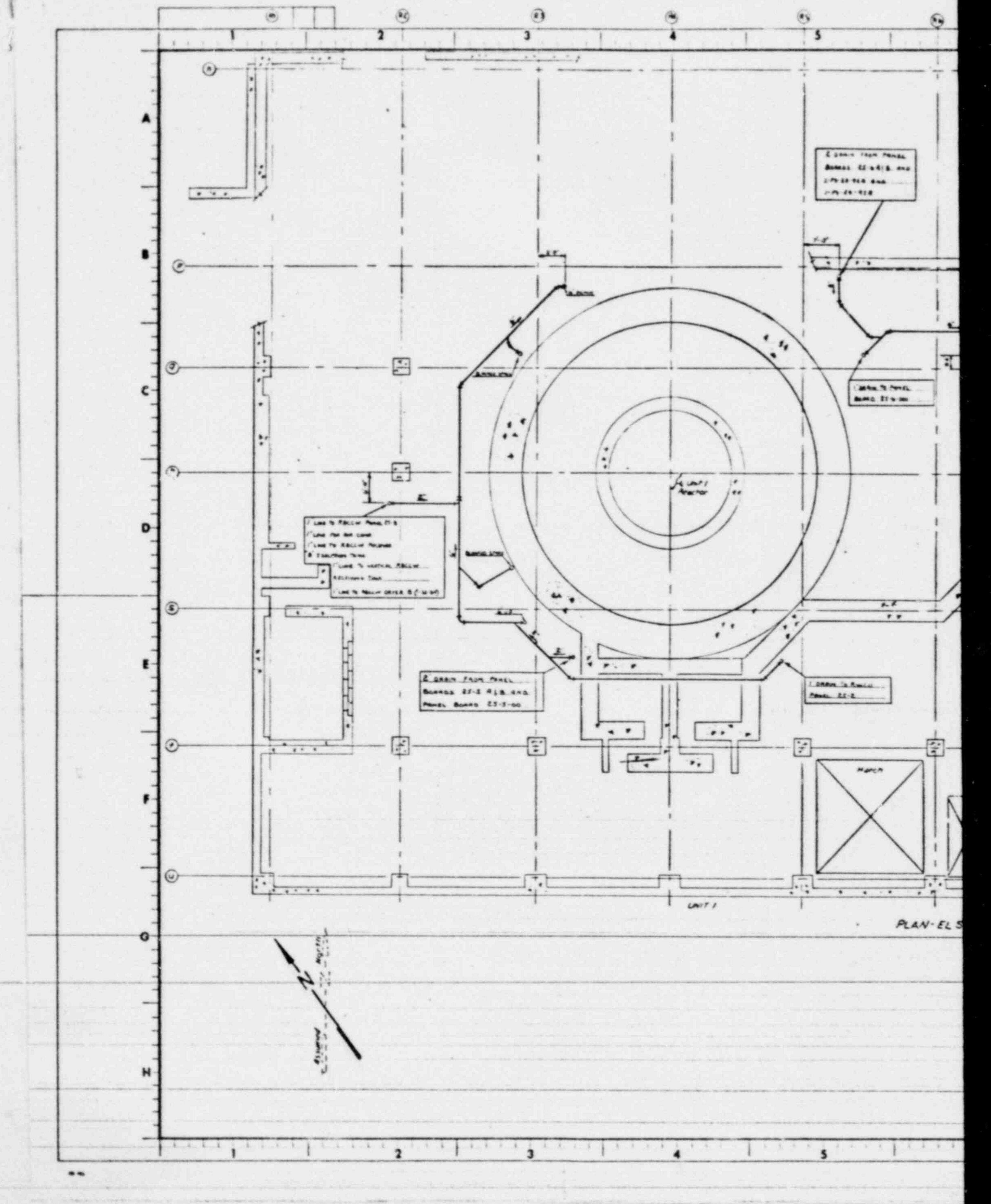
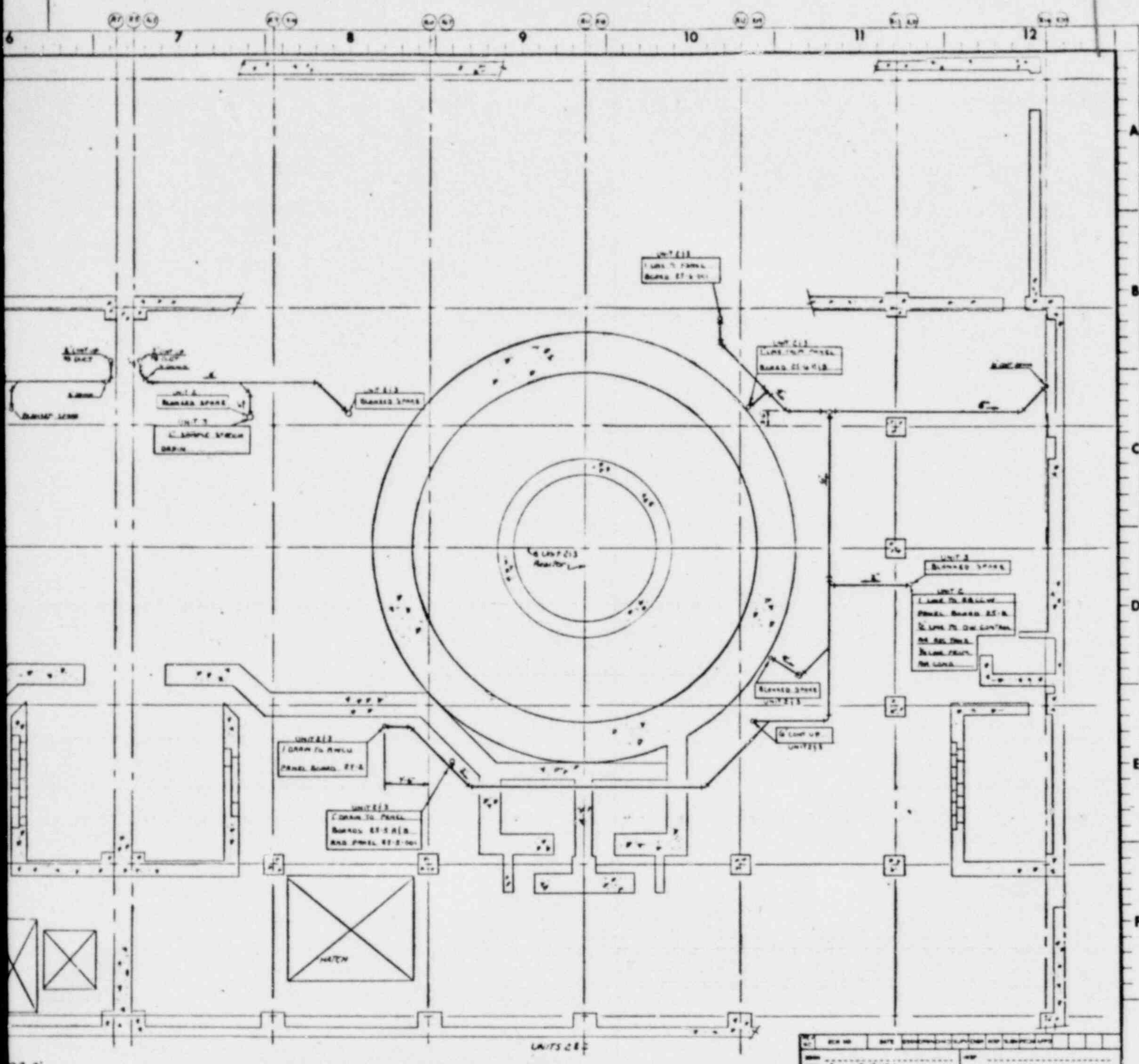


1
2
3
4
5
A
B
C
D
E
F
G
H
Hatch
UNIT 1
PLAN-EL S




UNIT NO 1.

UNIT NO 2.

UNIT NO 3.

**AS CONSTRUCTED**

SCALE EXCEPT AS NOTED

POWERHOUSE
REACTOR BLDG. UNITS 1-3

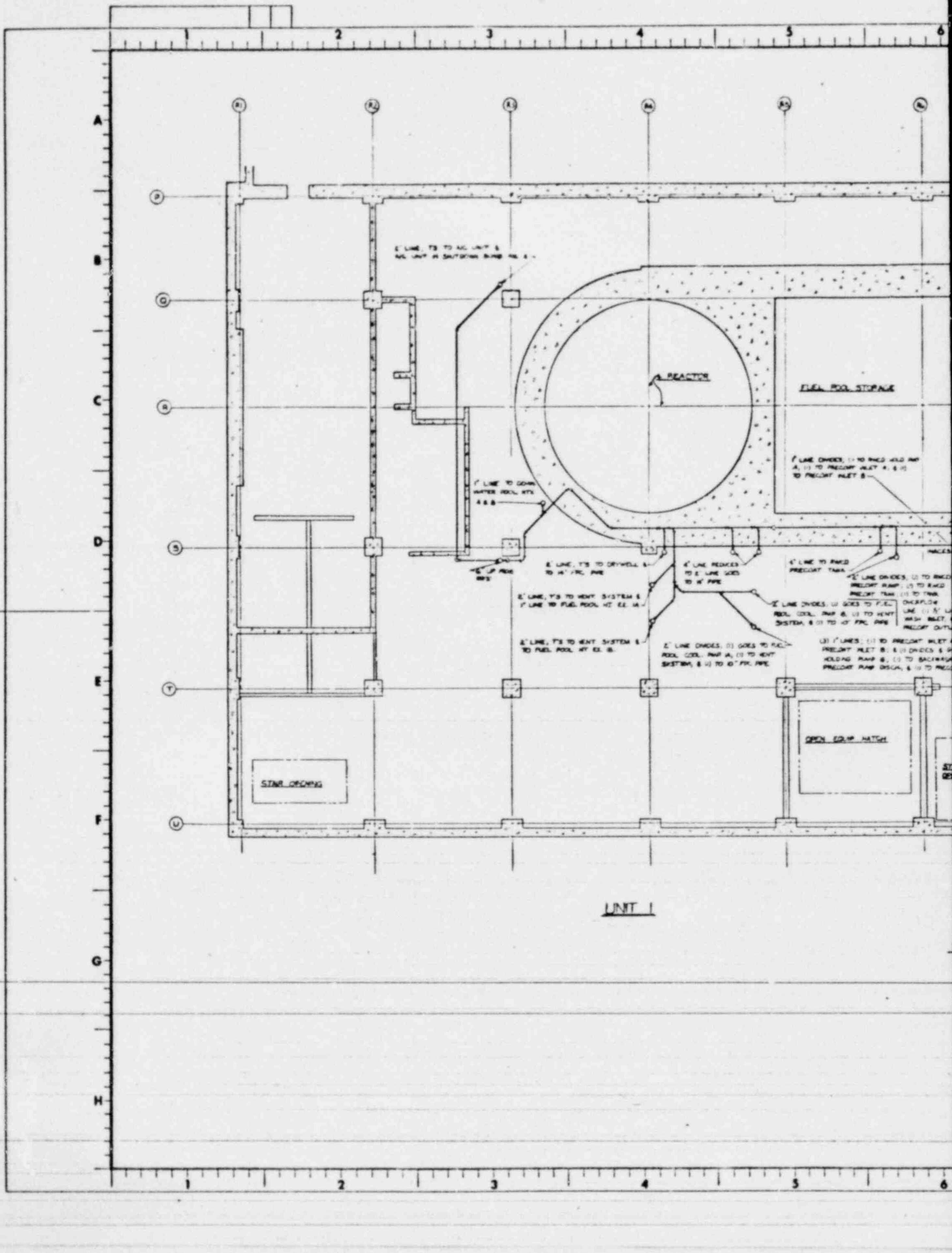
CRW
UNLIMITED ACCESS
ELEV 593.0'

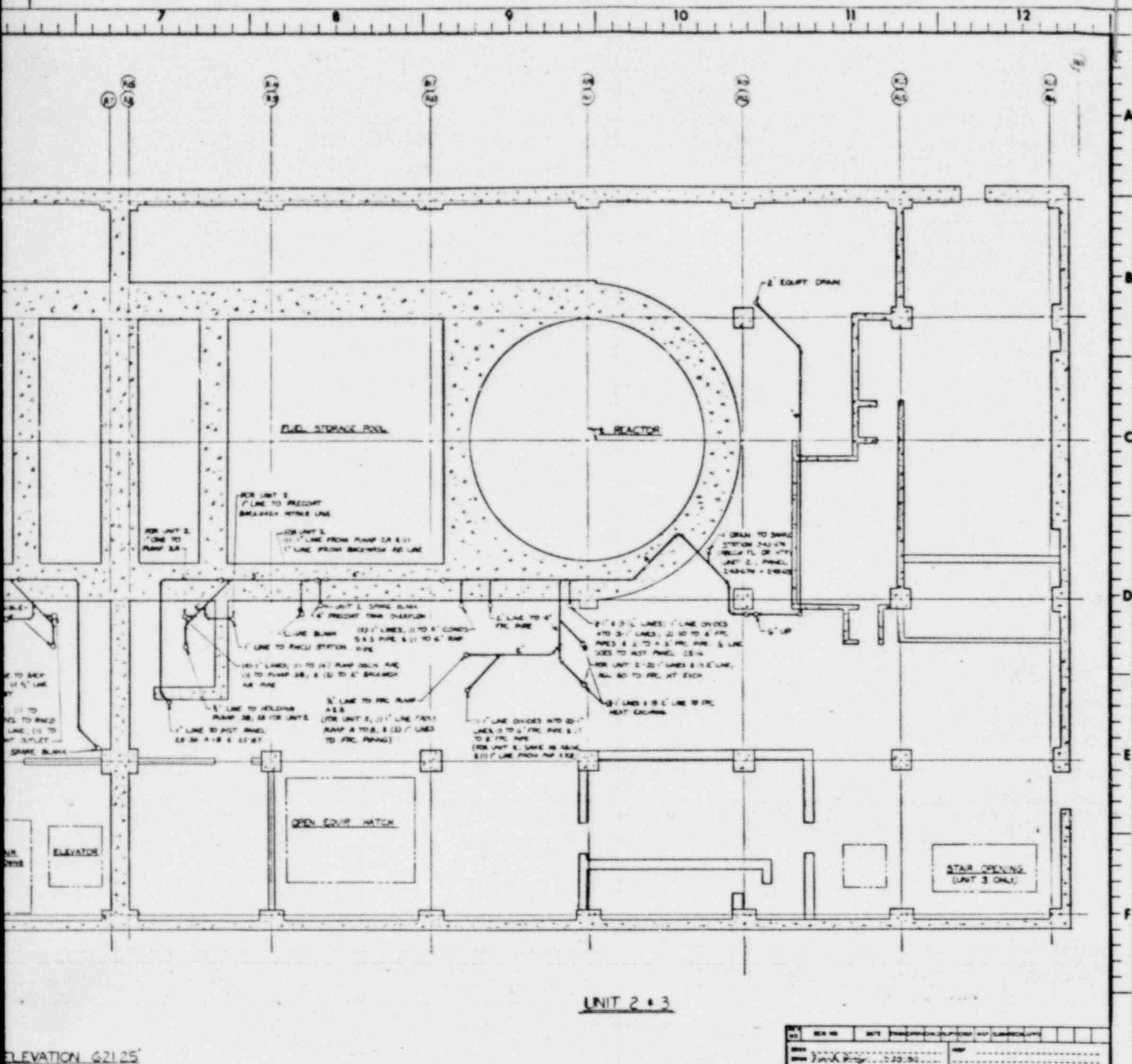
TENNESSEE VALLEY AUTHORITY
DIVISION OF ENGINEERING DESIGN

| SUBMITTED | RECOMMENDED | APPROVED |
|---|---|---|

KNOXVILLE

INSPECTED AND APPROVED FOR ISSUE


REACTOR
FUEL POOL STORAGE
OPEN EQUIP HATCH
STAIR OPENING
UNIT 1




UNIT 1
UNIT 2
UNIT 3

**AS CONSTRUCTED**

SCALE EXCEPT AS NOTED

6' UNLIMITED ACESS
@ ELEV 621.25'

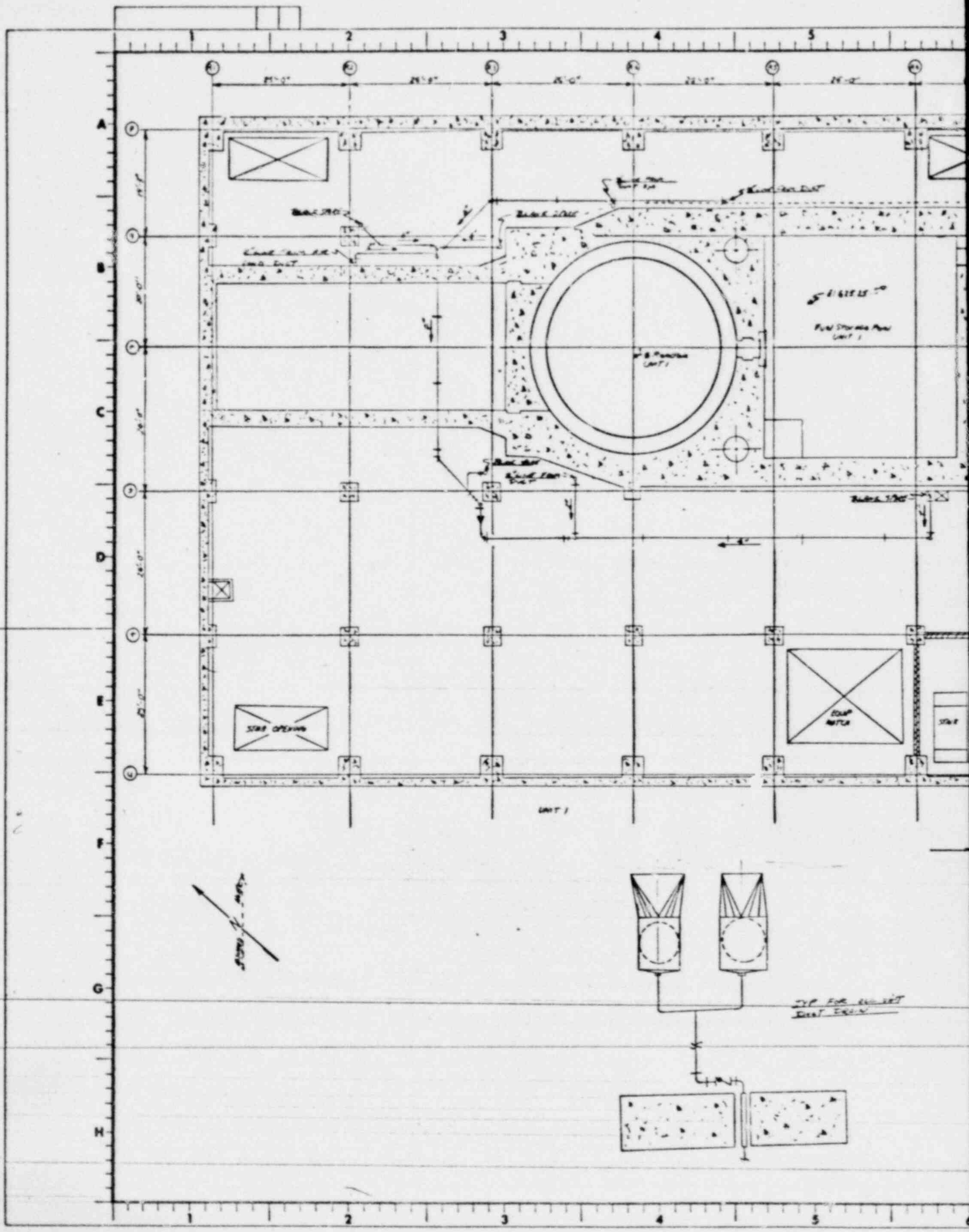
TENNESSEE VALLEY AUTHORITY
DIVISION OF ENGINEERING DESIGN

SUBMITTED | RECOMMENDED | APPROVED

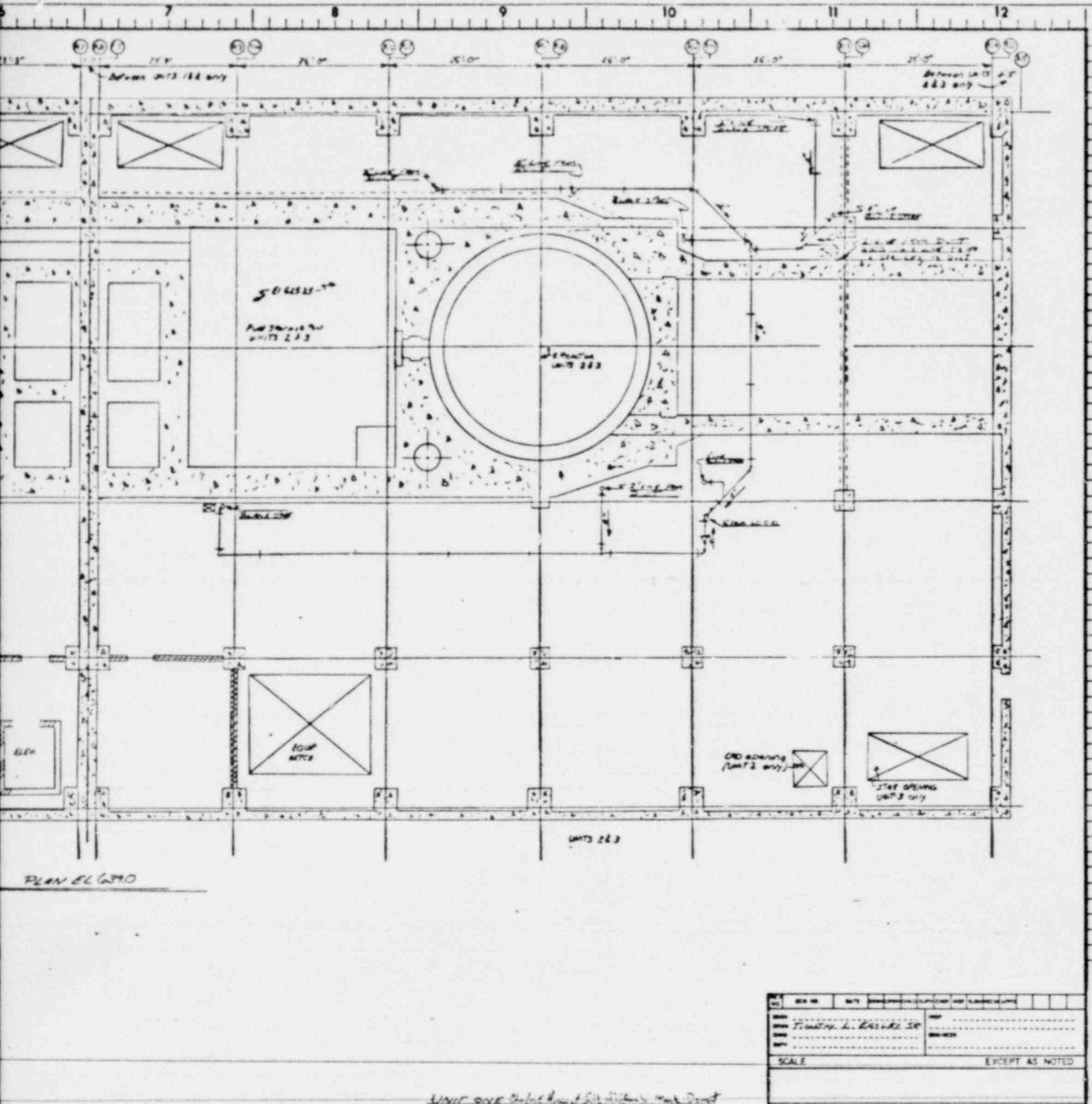
INSPECTED AND APPROVED FOR ISSUE

KNOXVILLE

10



A
B
C
D
E
F
G
H
1
2
3
4
5
Fuel Storage Pool
Unit 1
STAIR OPENING
EQUIP HATCH
UNIT 1




UNIT ONE
UNIT TWO
UNIT THREE

AS CONSTRUCTED

Timothy L. Kasuke Sr

SCALE EXCEPT AS NOTED

CRW 6" UNLIMITED ACCESS
EL 639.0'

TENNESSEE VALLEY AUTHORITY
DIVISION OF ENGINEERING DESIGN

| SUBMITTED | RECOMMENDED | APPROVED |
| --- | --- | --- |
| | | |

INSPECTED AND APPROVED FOR ISSUE

KNOXVILLE

14

## PRIOR TO INITIAL SCRAM

- POWER LEVEL REDUCED TO 36% BY:
  - REDUCED RECIRCULATION FLOW
  - SELECTED CRD INSERTION
- NORMAL SHUTDOWN COMPLETED BY MANUAL SCRAM

14

## PRIOR TO SCRAM #1

| | 02 | 06 | 10 | 14 | 18 | 22 | 26 | 30 | 34 | 38 | 42 | 46 | 50 | 54 | 58 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 59 | | | | | 48 | 48 | 48 | 48 | 48 | 48 | 48 | | | | |
| 55 | | | | 48 | 48 | 48 | 42 | 48 | 42 | 48 | 48 | 48 | | | |
| 51 | | | 48 | 48 | 48 | 48 | 48 | 48 | 48 | 48 | 48 | 48 | 48 | | |
| 47 | | 48 | 12 | 48 | 0 | 48 | 8 | 48 | 8 | 48 | 0 | 48 | 12 | 48 | |
| 43 | 48 | 48 | 48 | 48 | 48 | 48 | 48 | 48 | 48 | 48 | 48 | 48 | 48 | 48 | 48 |
| 39 | 38 | 48 | 48 | 48 | 0 | 48 | 48 | 48 | 48 | 48 | 0 | 48 | 48 | 48 | 38 |
| 35 | 48 | 48 | 48 | 48 | 48 | 48 | 48 | 48 | 48 | 48 | 48 | 48 | 48 | 48 | 48 |
| 31 | 48 | 48 | 0 | 48 | 48 | 48 | 48 | 48 | 48 | 48 | 48 | 48 | 0 | 48 | 48 |
| 27 | 48 | 48 | 48 | 48 | 48 | 48 | 48 | 48 | 48 | 48 | 48 | 48 | 48 | 48 | 48 |
| 23 | 38 | 48 | 48 | 48 | 0 | 48 | 48 | 48 | 48 | 48 | 0 | 48 | 48 | 48 | 38 |
| 19 | 48 | 48 | 48 | 48 | 48 | 48 | 48 | 48 | 48 | 48 | 48 | 48 | 48 | 48 | 48 |
| 15 | | 48 | 12 | 48 | 0 | 48 | 8 | 48 | 8 | 48 | 0 | 48 | 12 | 48 | |
| 11 | | | 48 | 48 | 48 | 48 | 48 | 48 | 48 | 48 | 48 | 48 | 48 | | |
| 07 | | | | 48 | 48 | 48 | 42 | 48 | 42 | 48 | 48 | 48 | | | |
| 03 | | | | | 48 | 48 | 48 | 48 | 48 | 48 | 48 | | | | |

## AFTER SCRAM #1

Blank Indicate Rod Full In

| | 02 | 06 | 10 | 14 | 18 | 22 | 26 | 30 | 34 | 38 | 42 | 46 | 50 | 54 | 58 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 59 | | | | | 40 | 4 | 36 | 42 | | | | | | | |
| 55 | | | | 36 | 46 | 38 | 2 | | | | | | | | |
| 51 | | | 36 | 34 | | 36 | 42 | 10 | | | | | | | |
| 47 | | 42 | | 20 | | 24 | | | | | | | | | |
| 43 | 12 | 40 | 44 | | 30 | 28 | 40 | 38 | | | | | | | |
| 39 | 24 | | 40 | | | 34 | 32 | | | | | | | | |
| 35 | 30 | 4 | 38 | | 18 | 8 | 34 | 30 | | | | | | | |
| 31 | 22 | 10 | | 34 | 28 | 2 | | | | | | | | | |
| 27 | 42 | 36 | 30 | 14 | 26 | 28 | 36 | 24 | | | | | | | |
| 23 | 8 | | 38 | 32 | | 12 | 36 | 2 | | | | | | | |
| 19 | 34 | 42 | 34 | 20 | 10 | 28 | 22 | 26 | | | | | | | |
| 15 | | 40 | | 36 | | 38 | | | | | | | | | |
| 11 | | | 26 | 6 | 14 | 40 | 40 | 24 | | | | | | | |
| 07 | | | | | 40 | 2 | | | | | | | | | |
| 03 | | | | | 28 | 42 | 42 | 30 | | | | | | | |

0131

ATTACHMENT (1)

CONTROL ROD POSITIONS

## Following Initial Scram

- Operator Actions
  - Scram Discharge Volume High Level Scram Bypassed
  - Placed Reactor Mode Switch in Shutdown
  - IRM's and SRM's Inserted
  - Scram Reset 4 min 27 secs

- Operator Observes
  - All Scram Valves Open
  - All Accumulators Discharged
  - Many CRD's on East Side Not Fully Inserted
  - APRM Readings Downscale
  - Other Plant Parameters Normal

- Other Significant Information
  - Scram Level Switches Tripped in 18 Seconds vs. Normal 40 to 50 secs
  - Several Low Scale LPPM Readings on East Side
  - 76 CRDs Did Not Fully Insert

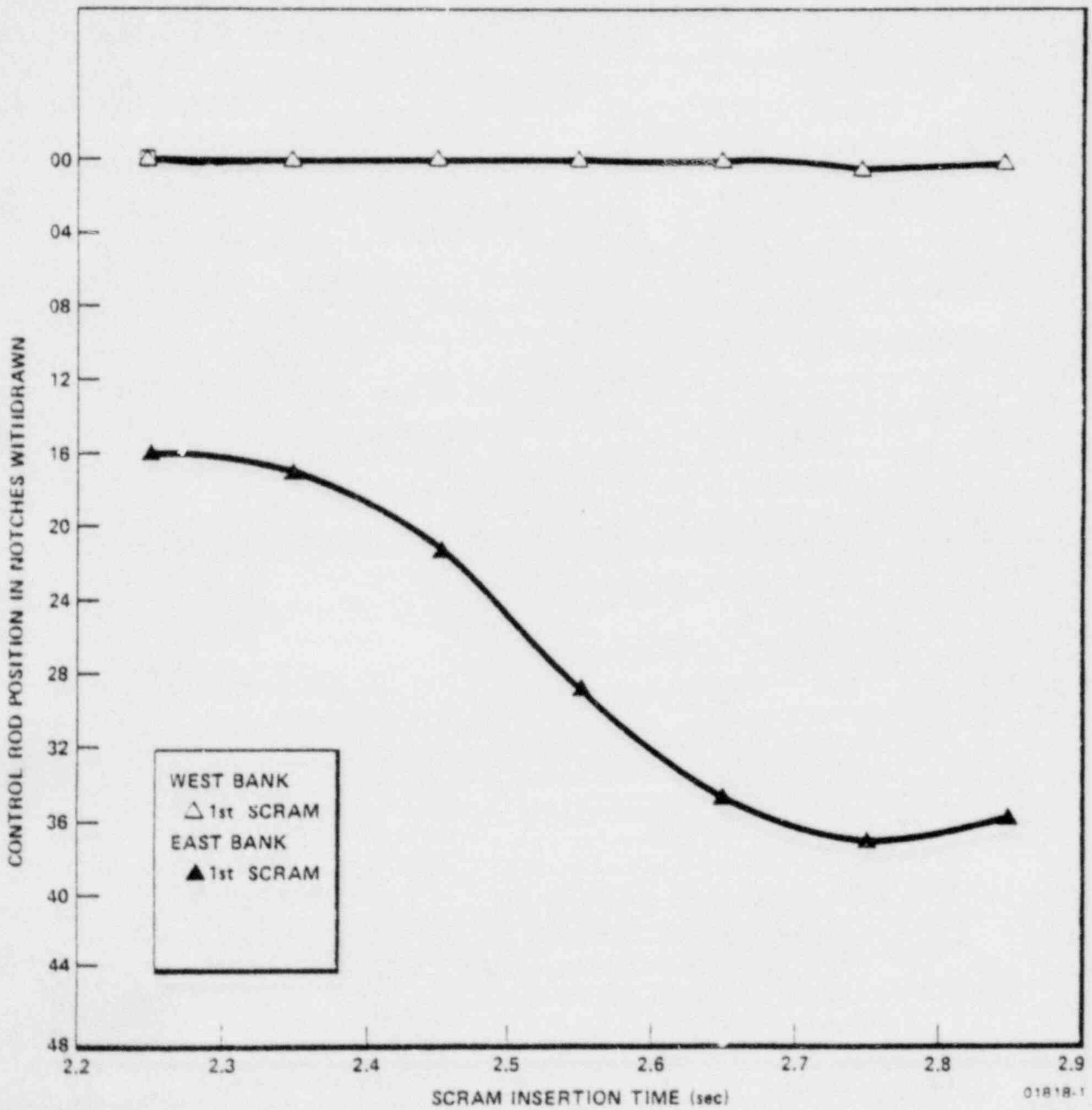
14

| | | 08 | 16 | 24 | 32 | 40 | 48 | 56 |
|---|---|---|---|---|---|---|---|---|
| 57 | | | 2 | 2 | 0 | 0 | | |
| | | | 0 | 0 | 0 | 20* | | |
| | | | 0 | 0 | 0 | 0 | | |
| | | | 0 | 0 | 0 | 0 | | |
| 49 | | 2 | 4 | 4 | 0 | 0 | 0 | |
| | | 0 | 2 | 0 | 0 | 0 | 0 | |
| | | 0 | 0 | 0 | 0 | 0 | 0 | |
| | | 0 | 0 | 0 | 0 | 0 | 0 | |
| 41 | | 3 | 3 | 6 | 0 | 0 | 0 | 0 |
| | | 2 | 2 | 6 | 0 | 0 | 0 | 0 |
| | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 33 | | 6 | 8 | 3 | 0 | 0 | 0 | 0 |
| | | 3 | 4 | 2 | 0 | 0 | 0 | 0 |
| | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 25 | | 9 | 10 | 9 | 2 | 0 | 0 | 0 |
| | | >0 | 0 | 4 | 0 | 0 | 0 | 0 |
| | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 17 | | >0 | 10 | 7 | 2 | 0 | 0 | 0 |
| | | 6 | 6 | 4 | 0 | 0 | 0 | 0 |
| | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 09 | D | | 4 | 4 | 0 | 0 | 0 | |
| | C | | 0 | 2 | 0 | 0 | 0 | |
| | B | | 0 | 0 | 0 | 0 | 0 | |
| | A | | 0 | 0 | 0 | 0 | 0 | |

*Failed

LPRM READINGS FOLLOWING SCRAM #1

# CONTROL ROD POSITION
## vs
## SCRAM INSERTION TIME




7/29/80
32

## Second Scram

- Operator Actions

  - Manual Scram 6 Min 04 Secs After Initial scram
  - Reset Scram 7 Min 03 Secs After Initial Scram

- Operator Observes

  - All Scram Valves Open
  - All Accumulators Discharged
  - Some Rod Movement
  - Other Plant Parameters Normal

- Other Significant Information

| | | |
|---|---|---|
| - | Rods Full Out | 0 |
| - | Rods Partially In | 59 |
| - | Rods Full In | 126 |

PRIOR TO SCRAM #2

0131

| | 02 | 06 | 10 | 14 | 18 | 22 | 26 | 30 | 34 | 38 | 42 | 46 | 50 | 54 | 58 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 59 | | | | | 40 | 4 | 36 | 42 | | | | | | | |
| 55 | | | | 36 | 46 | 38 | 2 | | | | | | | | |
| 51 | | | 36 | 34 | | 36 | 42 | 10 | | | | | | | |
| 47 | | 47 | | 20 | | 24 | | | | | | | | | |
| 43 | 12 | 40 | 44 | | 30 | 28 | 40 | 38 | | | | | | | |
| 39 | 24 | | 40 | | | 34 | 32 | | | | | | | | |
| 35 | 30 | 4 | 38 | | 18 | 8 | 34 | 30 | | | | | | | |
| 31 | 22 | 10 | | 34 | 28 | 2 | | | | | | | | | |
| 27 | 42 | 36 | 30 | 14 | 26 | 28 | 36 | 24 | | | | | | | |
| 23 | 8 | | 38 | 32 | | 12 | 36 | 2 | | | | | | | |
| 19 | 34 | 42 | 34 | 20 | 10 | 28 | 22 | 26 | | | | | | | |
| 15 | | 40 | | 36 | | 38 | | | | | | | | | |
| 11 | | | 26 | 6 | 14 | 40 | 40 | 24 | | | | | | | |
| 07 | | | | | 40 | 2 | | | | | | | | | |
| 03 | | | | | 28 | 42 | 42 | 30 | | | | | | | |

AFTER SCRAM #2

0136

| | 02 | 06 | 10 | 14 | 18 | 22 | 26 | 30 | 34 | 38 | 42 | 46 | 50 | 54 | 58 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 59 | | | | | 30 | | 14 | 18 | | | | | | | |
| 55 | | | | 26 | 42 | 28 | | | | | | | | | |
| 51 | | | 12 | 22 | 28 | 34 | | | | | | | | | |
| 47 | | 30 | | | 12 | | | | | | | | | | |
| 43 | | 30 | 38 | | 14 | 4 | 30 | 26 | | | | | | | |
| 39 | 8 | | 30 | | | 26 | 14 | | | | | | | | |
| 35 | 14 | | 30 | | 4 | | 22 | 20 | | | | | | | |
| 31 | 8 | | | 14 | 12 | | | | | | | | | | |
| 27 | 26 | 22 | 20 | 2 | 12 | 12 | 16 | 2 | | | | | | | |
| 23 | | | 30 | 20 | | | 16 | | | | | | | | |
| 19 | 10 | 26 | 24 | | | 8 | 6 | 4 | | | | | | | |
| 15 | | 18 | | 18 | | 28 | | | | | | | | | |
| 11 | | | 12 | | | 32 | 30 | 14 | | | | | | | |
| 07 | | | | | 30 | | | | | | | | | | |
| 03 | | | | | 2 | 34 | 22 | 4 | | | | | | | |

ATTACHMENT (3)

CONTROL ROD POSITIONS

14

## Third Scram

- Operator Actions
  - Manual Scram 7 Min 56 Secs After Initial Scram
  - Reset Scram 11 Min 21 Secs After Initial Scram

- Operator Observes
  - All Scram Valves Open
  - All Accumulators Discharged
  - Some Rod Movement
  - Other Plant Parameters Normal

- Other Significant Information
  - Rods Partially In 46
  - Rods Full In 139

## PRIOR TO SCRAM #3

0136

| | 02 | 06 | 10 | 14 | 18 | 22 | 26 | 30 | 34 | 38 | 42 | 46 | 50 | 54 | 58 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 59 | | | | | 30 | | 14 | 18 | | | | | | | |
| 55 | | | | 26 | 42 | 28 | | | | | | | | | |
| 51 | | | 12 | 22 | | 28 | 34 | | | | | | | | |
| 47 | | 30 | | | | 12 | | | | | | | | | |
| 43 | | 30 | 38 | | 14 | 4 | 30 | 26 | | | | | | | |
| 39 | 8 | | 30 | | | 26 | 14 | | | | | | | | |
| 35 | 14 | | 30 | | 4 | | 12 | 20 | | | | | | | |
| 31 | 8 | | | 14 | 12 | | | | | | | | | | |
| 27 | 26 | 22 | 20 | 2 | 12 | 12 | 16 | 2 | | | | | | | |
| 23 | | | 30 | 20 | | | 16 | | | | | | | | |
| 19 | 10 | 26 | 24 | | | 8 | 6 | 4 | | | | | | | |
| 15 | | 18 | | 18 | | 28 | | | | | | | | | |
| 11 | | | 12 | | | 32 | 30 | 14 | | | | | | | |
| 07 | | | | | 30 | | | | | | | | | | |
| 03 | | | | | 2 | 34 | 22 | 4 | | | | | | | |

## AFTER SCRAM #3

0137

| | 02 | 06 | 10 | 14 | 18 | 22 | 26 | 30 | 34 | 38 | 42 | 46 | 50 | 54 | 58 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 59 | | | | | 24 | | | | | | | | | | |
| 55 | | | | 20 | 40 | 22 | | | | | | | | | |
| 51 | | | | 16 | | 24 | 30 | | | | | | | | |
| 47 | | 26 | | | | 6 | | | | | | | | | |
| 43 | | 24 | 36 | | 2 | | 24 | 18 | | | | | | | |
| 39 | 2 | | 24 | | | 20 | | | | | | | | | |
| 35 | 6 | | 26 | | | | 14 | 16 | | | | | | | |
| 31 | | | | 2 | 4 | | | | | | | | | | |
| 27 | 18 | 16 | 14 | 2 | 4 | 6 | 2 | | | | | | | | |
| 23 | | | 26 | 12 | | | 2 | | | | | | | | |
| 19 | | 16 | 18 | | | | 2 | 2 | | | | | | | |
| 15 | | 4 | | 10 | | >0 | | | | | | | | | |
| 11 | | | 6 | | | 28 | 26 | 8 | | | | | | | |
| 07 | | | | | 24 | | | | | | | | | | |
| 03 | | | | | | 30 | 10 | | | | | | | | |

ATTACHMENT (4)

CONTROL ROD POSITIONS

## Fourth Scram

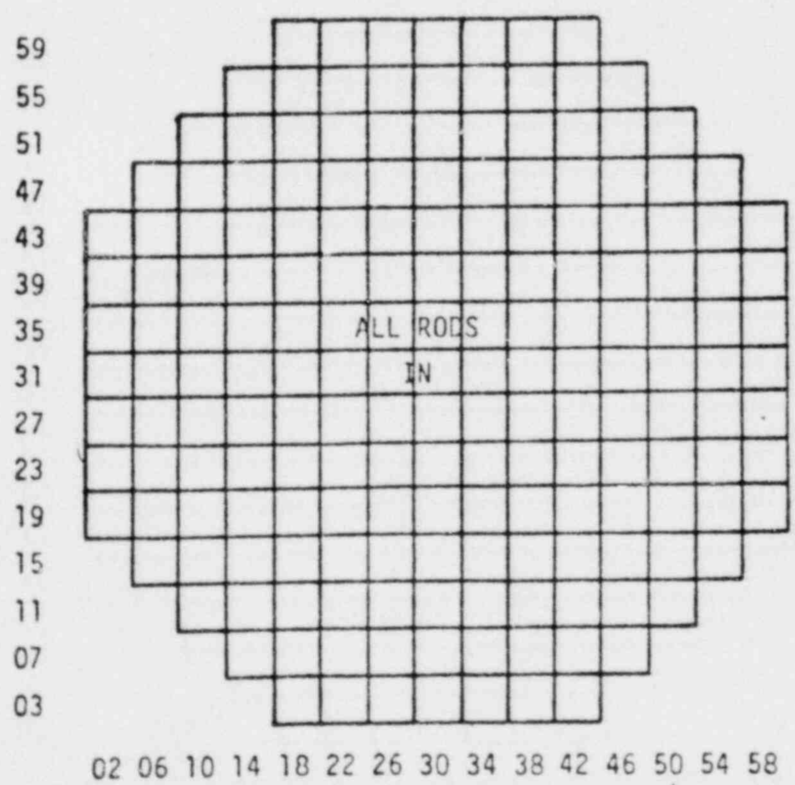
- Operator Actions
  - Auto Scram When SDV High Level Bypass Removed 14 Minutes 01 Seconds after Initial Scram
  - Reset Scram 16 Minutes 27 Seconds After Initial Scram
- Operator Observes
  - All Rods In -- Scram Appeared Normal
  - All Scram Valves Open
  - All Accumulator Discharged
  - Plant Parameters Normal
- Other Significant Information
  - SDV High Scram Trip Reset 9 Minutes 02 Seconds After Scram Reset
  - SDV Not Drained Alarm Reset 9 Minutes 51 Seconds After Scram Reset

0137

PRIOR TO SCRAM #4

| | 02 | 06 | 10 | 14 | 18 | 22 | 26 | 30 | 34 | 38 | 42 | 46 | 50 | 54 | 58 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 59 | | | | | 14 | | | | | | | | | | |
| 55 | | | | 20 | 40 | 22 | | | | | | | | | |
| 51 | | | | 16 | | 24 | 30 | | | | | | | | |
| 47 | | 26 | | | | 6 | | | | | | | | | |
| 43 | | 24 | 36 | | 2 | | 24 | 18 | | | | | | | |
| 39 | 2 | | 24 | | | 20 | | | | | | | | | |
| 35 | 6 | | 26 | | | | 14 | 16 | | | | | | | |
| 31 | | | | 2 | 4 | | | | | | | | | | |
| 27 | 18 | 16 | 14 | 2 | 4 | 6 | 2 | | | | | | | | |
| 23 | | | 26 | 12 | | | 2 | | | | | | | | |
| 19 | | 16 | 18 | | | | 2 | 2 | | | | | | | |
| 15 | | 4 | | 10 | | >0 | | | | | | | | | |
| 11 | | | 6 | | | 28 | 26 | 8 | | | | | | | |
| 07 | | | | | 24 | | | | | | | | | | |
| 03 | | | | | 30 | 10 | | | | | | | | | |

AFTER SCRAM #4




ATTACHMENT (5)

CONTROL ROD POSITIONS

## Scram Summary

| Scram/Reset | Time After Initial Scram | Time SDV Allowed to Drain |
|---|---|---|
| Initial Scram | 0 | |
| Reset | 4 Min 27 Sec | |
| | | 1 Min 37 Sec |
| Second Scram | 6 Min 04 Sec | |
| Reset | 7 Min 03 Sec | |
| | | 53 Seconds |
| Third Scram | 7 Min 56 Sec | |
| Reset | 11 Min 21 Sec | |
| | | 2 Min 40 Sec |
| Fourth Scram | 14 Min 01 Sec | |
| Reset | 16 Min 27 Sec | |
| | | 9 Min 51 Sec |

BF3 INCOMPLETE CONTROL ROD INSERTION
SEQUENCE OF EVENTS

| | |
|---|---|
| 6/27/80<br>22 12 00 | Browns Ferry Unit 3 commenced a routine shutdown to perform maintenance on a reactor feedwater pump discharge line. The initial power reduction from 1082 MWE to 542 MWE was performed by slowly reducing recirculation flow through the reactor core by recirculation pump speed reduction. |
| 6/28/80<br>00 55 00 | With the recirculation pump operating at minimum speed, additional power reduction to 400 MWE was accomplished by normal insertion of selected control rods.<br><br>The plant conditions following this power reduction were normal and as follows: |

| | |
|---|---|
| Power Level | 36% of Rated |
| Core Flow | $29 \times 10^6$ lbs. per hr. |
| Reactor Pressure | 920 psi |
| Vessel Level | 35 inches (203 inches above the top of the active fuel) |
| Generator Output | 400 MWE |
| Steam Flow | $4.9 \times 10^6$ lbs. per hr. |
| Feedwater Flow | $4.9 \times 10^6$ lbs. per hr. |
| Control Rod Pattern | 157 control rods were fully withdrawn<br>10 rods were fully inserted<br>18 rods were at intermediate position (see Attachment 1) |

| | |
|---|---|
| 01 31 16 ($T_o$) | A manual scram was initiated to complete the power reduction. This was a normal part of the Browns Ferry shutdown procedure.<br><br>Within several seconds after the scram, in accordance with normal procedures, the scram discharge volume (SDV) bypass was placed in |

"bypass" position, the reactor mode switch was placed in "shutdown" position, and insertion of the source range monitors (SRMs) and intermediate range monitors (IRMs) were initiated.

Within several seconds (approximately 5 to 10) after this scram, operating personnel noted that:

o The blue scram lights and the scram accumulator lights were lit as expected.

o A number of rods on the east side of the reactor were indicated to be not fully inserted.

During this entire sequence of events, operating personnel observed that key plant parameters (pressure, level, temperatures and flows) were well within safe limits even though a number of control rods were not fully inserted.

Subsequently, a review of plant recorders and process computer printout showed:

o A total of seventy rods did not fully insert. Another six rods settled at either position 02 or 04. The extent of insertion varied from about 5 percent of fully inserted to 90 percent of fully inserted for these partially inserted rods. The rod pattern at this time is shown by Attachment 1.

o During and after this scram, no other unusual or unexplained variations in plant parameters were observed.

Reactor pressure decreased from 920 to approximately 900 psi (this pressure remained approximately constant throughout the remainder of the event.)

Core flow decreased to 22 x $10^6$ lbs. per hr. This decrease was due to the loss of natural circulation driving head when reactor power was reduced.

Based on steam flow, the heat generation within the reactor was very close to the heat generation expected from decay heat alone, verifying that the insertion of the rods had virtually stopped the fission process.

01 31 24 ($T_o$ + 8 sec.) Low reactor water level trip occurred. (This corresponds to Level 3 which is 180.5 inches above the top of the active fuel.) The water level decrease was due to void collapse following the scram. From plant recorders it was later verified that the minimum water level reached during this event remained above the level required for emergency core cooling system initiation. (This corresponds to Level 2 which is 130 inches above the top of the active fuel.)

The level variation, including maximum and minimum values, was well within the expected range during a normal scram.

01 31 34 ($T_o$ + 18 sec.) The scram discharge volume "high-high" level was reached. This occurred 18 seconds after the manual scram. This normally occurs approximately 40 seconds after a scram. Subsequent investigation confirmed that all "high-high" instrument volume level switches were properly calibrated and functioning.

01 31 40 ($T_o$ + 24 sec.) The main turbine was tripped as part of normal procedure.

01 32 01 ($T_o$ + 45 sec.) The low reactor water level trip was reset.

Upon achieving normal water level, one feedwater pump, two condensate booster pumps and one condensate pump were secured.

| | |
|---|---|
| 01 35 43 ($T_o$ + 4 min. 27 sec.) | The scram was reset again and the hydraulic control unit accumulators were recharged until the lights cleared. |
| 01 37 20 ($T_o$ + 6 min. 4 sec.) | A second scram was manually initiated for the purpose of inserting the remaining seventy rods. Within several seconds after this scram, operating personnel observed that:<br><br>o all blue scram lights and accumulator lights were lit and scram pilot lights were out as expected.<br><br>o Rod movement was indicated, but motion appeared slower than normal.<br><br>o Some rods were indicated to be not fully inserted.<br><br>Subsequent review of plant recorders and printouts indicated that:<br><br>o a total of 59 rods were still not fully inserted. The rod pattern at this time is shown by Attachment 3. Major plant parameters (steam flow, core flow, water level and reactor pressure) remained essentially unchanged throughout the scram.<br><br>o Fluctuations of IRM sensor readings prevent determination of actual effects due to the scram. |
| 01 38 19 ($T_o$ + 7 min. 3 sec.) | The scram was reset and the hydraulic control unit accumulators recharged until the lights cleared. |
| 01 39 12 ($T_o$ + 7 min. 56 sec.) | A third manual scram was initiated. Operating personnel observed that:<br><br>o all blue scram lights and accumulator lights were lit and scram pilot lights were out.<br><br>o Rod movement was indicated.<br><br>o Some rods were indicated to be not fully inserted. |

| | |
|---|---|
| | Information obtained later from plant recorders showed that:<br><br>o a total of 47 rods were still not fully inserted. The rod pattern at this time is shown by Attachment 4.<br><br>o LPRM readings all indicated "0" except 40-57C which was failed.<br><br>o All major parameters discussed above, remained approximately constant throughout this scram. |
| 01 42 37 ($T_o$ + 11 min. 21 sec.) | The scram was reset for the third time and the hydraulic control unit accumulators were recharged until the lights cleared. |
| 0' ($T_o$ + 14 min. 01 sec.) | The operator placed the scram discharge volume (SDV) bypass switch in "normal" which resulted in a scram since the SDV was not actually fully drained. This was the fourth scram in this sequence of events.<br><br>Operating personnel observed that:<br><br>o rod insertion rate appeared normal for a scram<br><br>o all blue scram lights and accumulator lights were lit<br><br>o all rods were indicated to be fully inserted<br><br>o Plant parameters and conditions were as normally expected following a scram. |
| 01 46 30 ($T_o$ + 15 min. 14 sec.) | The operator initiated a manual scram (confirmatory). |
| 01 47 43 ($T_o$ + 16 min. 27 sec.) | The scram was reset. |
| 01 57 04 ($T_o$ + 25 min. 48 sec.) | The scram discharge volume "High-High" trip was reset. |
| 01 57 34 ($T_o$ + 26 min. 18 sec.) | The discharge volume high water level trips (50 gallon scram trips) cleared. |

# POST-INCIDENT INSPECTIONS

- HYDRAULIC CONTROL UNIT VALVE LINEUP VERIFIED CORRECT
- DRAIN AND VENT VALVES DEMONSTRATED OPERABLE
- INSTRUMENT VOLUME LEVEL SWITCHES CALIBRATED. ALL 50 GALLON (SCRAM) SWITCHES WERE TESTED. THREE (3) AND 25 GALLON SWITCHES DID NOT OPERATE ON FIRST CALIBRATION ATTEMPT (ALTHOUGH SWITCHES DID OPERATE DURING INCIDENT)
- REVIEWED SCRAM HISTORY FOR BF-1, 2, AND 3. OUT OF 320 SCRAMS, NO RELATED INCIDENTS. ALSO PERFORMED DETAILED ANALYSIS OF RECENT U-3 SCRAMS. NO MALFUNCTION FORECASTED
- REVIEWED HISTORY OF CONTROL ROD DRIVE OPERATIONS, MAINTENANCE, AND MODIFICATION ACTIVITIES. NO APPARENT RELATIONSHIP
- INSPECTED AIR LINE SUPPLIES TO HCU'S AND VALVES
- REVIEWED CRD TEMPERATURE LOGS FOR INDICATION OF EXCESSIVE SEAL LEAKAGE. NONE FOUND ON EAST SIDE
- PERFORMED PHYSICAL INSPECTION OF VENT LINES, 2" DRAIN LINE, SCRAM HEADER, AND INSTRUMENT VOLUME BY CUTTING PIPE AND USING BOROSCOPE. NO OBSTRUCTIONS FOUND. ALSO INSPECTED ROD-WASTE SUMP FOR LARGE OBJECTS. NONE FOUND
- PERFORMED COMPREHENSIVE TESTS ON EAST SIDE CRD'S, FRICTION TESTS, STILL FLOW, SCRAM TIMING. ALL RESULTS NORMAL
- PERFORMED FLOW AND DRAINAGE TESTS ON U-3 SCRAM DISCHARGE SYSTEM. INDICATED NORMAL OPERATION
- PERFORMED ADDITIONAL ELECTRICAL TESTING OF RPS LOGIC AND OPERATION. EVERYTHING FUNCTIONED AS EXPECTED
- REQUESTED GE PERFORM CONFIRMATORY TESTING TO DEMONSTRATE THAT WATER IN VOLUME WOULD PRODUCE OBSERVED RESULTS

15

## Cause Of Incomplete Insertion

## Conclusion

- The Browns Ferry 3 Event Was Caused By Undetected Water In The East Scram Discharge Volume

- Water Was Present Due To A Restriction In The East SDV Drainage System

- Since No Evidence Of A Restriction Could Physically Be Found, The Contribution Of The Vent System To The Event Cannot Be Discounted

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15

# Cause Determination

## Potential Causes Considered

- Electrical
- Hydraulic Control Unit
- Control Rod Drive
- Scram Discharge Volume Level Instrumentation
- Scram Discharge Volume
- Physical Inspections

## Supporting Evaluations

- San Jose Drive Tests
- Insertion Variations
- Analytical Programs

## Post Event Tests

- Drain Tests

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## Cause Determination

- Electrical

- Evaluation:

  - RESULTING CHECKERBOARD PATTERN NOT CONSISTENT WITH OBSERVED INCOMPLETE ROD INSERTION PATTERN

  - ROD MOTION WOULD BE EITHER COMPLETE OR NO MOTION

  - POST EVENT SCRAM TESTS SHOWED ACTUATION CIRCUITRY FUNCTIONAL

  - ELECTRICAL INDEPENDENCE OF EACH ROD SCRAM GROUP VERIFIED

- Conclusion:

NOT CAUSE OF BROWNS FERRY 3 PARTIAL ROD INSERTION

# Cause Determination

- Hydraulic Control Unit

- Evaluations:

  - HYDRAULIC CONTROL UNIT VALVE LINE-UP VERIFIED AS NORMAL
  - ACCUMULATOR CONDITION VERIFIED IN CONTROL ROOM
  - CONTROL ROOM INDICATION OF PROPER SCRAM INLET/OUTLET VALVES
  - NO EVIDENCE OF MALFUNCTIONS IN THE PNEUMATIC SYSTEM
  - POST-EVENT SCRAM TIME MEASUREMENTS CONSISTENT WITH PREVIOUSLY MEASURED VALUES
  - NO APPARENT CONTRIBUTION BY MAINTENANCE ACTIVITIES
  - WEST BANK DRIVES PERFORMED NORMALLY

- Conclusion:

NOT CAUSE OF BROWNS FERRY 3 PARTIAL ROD INSERTION

## Cause Determination

- Control Rod Drive

- Evaluations:

  - West bank drives performed normally

  - Post event scram time measurements consistent with previously measured values

  - Post event tests (friction, stall flow) results normal

  - Drive operating temperatures normal

  - No unusual maintenance history

- Conclusion:

NOT CAUSE OF BROWNS FERRY 3 PARTIAL ROD INSERTION

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## Cause Determination

- Scram Discharge Instrument Volume Level Instrumentation

- Evaluation:

  - WOULD CAUSE BOTH EAST AND WEST BANK FAILURES

  - SCRAM SENSOR OPERATION DURING EVENT VERIFIED BY PROCESS COMPUTER

  - POST-EVENT CALIBRATION DEMONSTRATED THAT SCRAM SENSORS OPERATIONAL

  - SDV VENT & DRAIN VALVES WERE VERIFIED TO BE OPERATING PROPERLY

- Conclusion:

  NOT CAUSE OF BROWNS FERRY 3 PARTIAL ROD INSERTION

## Cause Determination

- Scram Discharge Volume

- Evaluation:

  - DRIVES NOT FULLY INSERTED ALL IN EAST BANK
  - WEST BANK DRIVES SCRAMMED NORMALLY
  - SCRAM LEVEL SWITCHES TRIPPED IN 18 SECONDS (NORMAL 40/50 SECONDS)
  - SDV VENT & DRAIN VALVES OPERATED PROPERLY

- Conclusion:

WATER IN EAST SCRAM DISCHARGE VOLUME MOST LIKELY CAUSE OF BROWNS FERRY 3 PARTIAL ROD INSERTION

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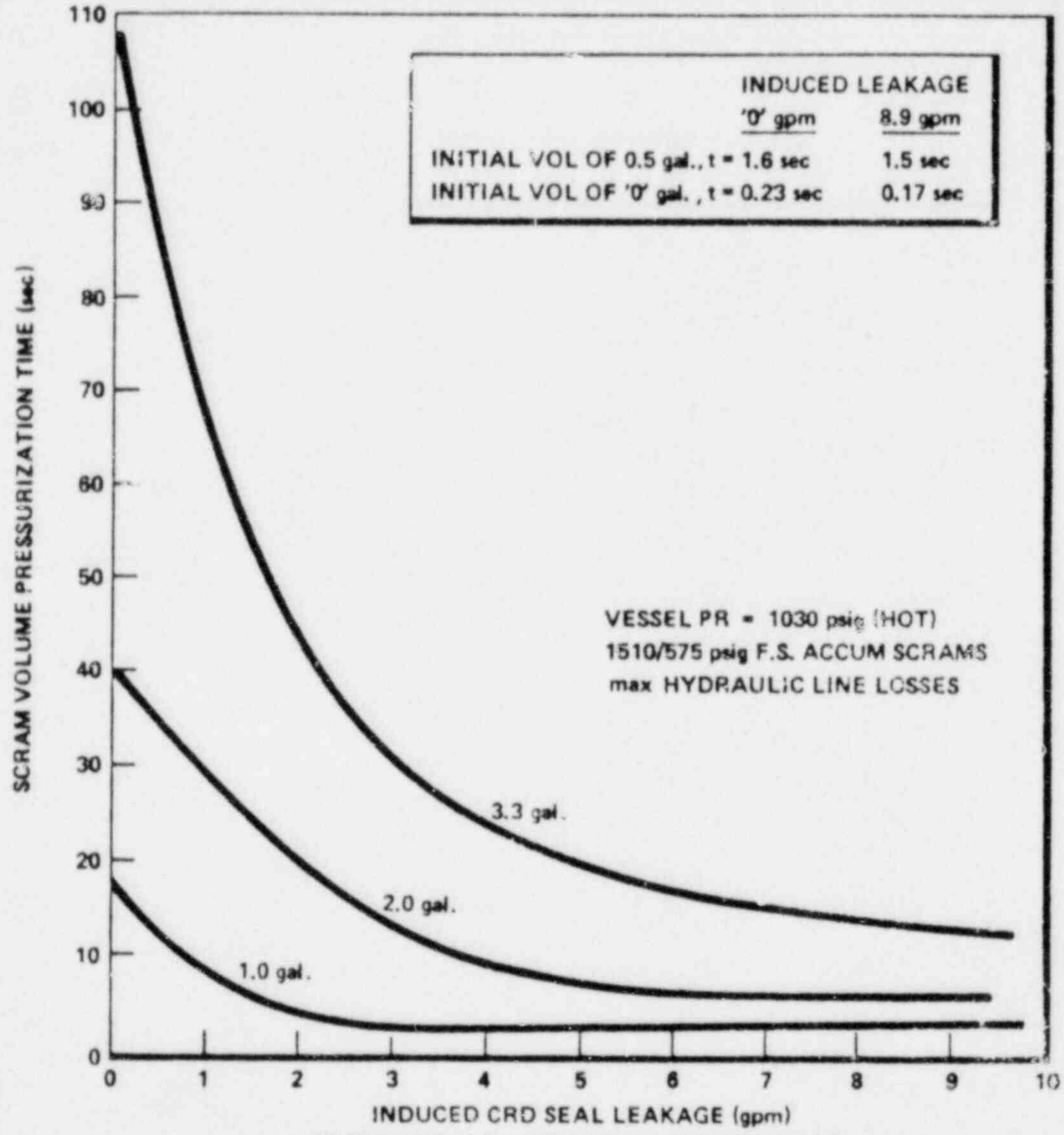
## SAN JOSE TESTING

# SCRAM VOLUME PRESSURIZATION TIME VS INDUCED CRD SEAL LEAKAGE VS AVAILABLE PRE-SCRAM VOLUME




CONCLUSION:
PERFORMANCE OF DRIVE IN TEST FACILITY COMPARABLE TO PERFORMANCE OBSERVED AT BROWNS FERRY 3

01917-1

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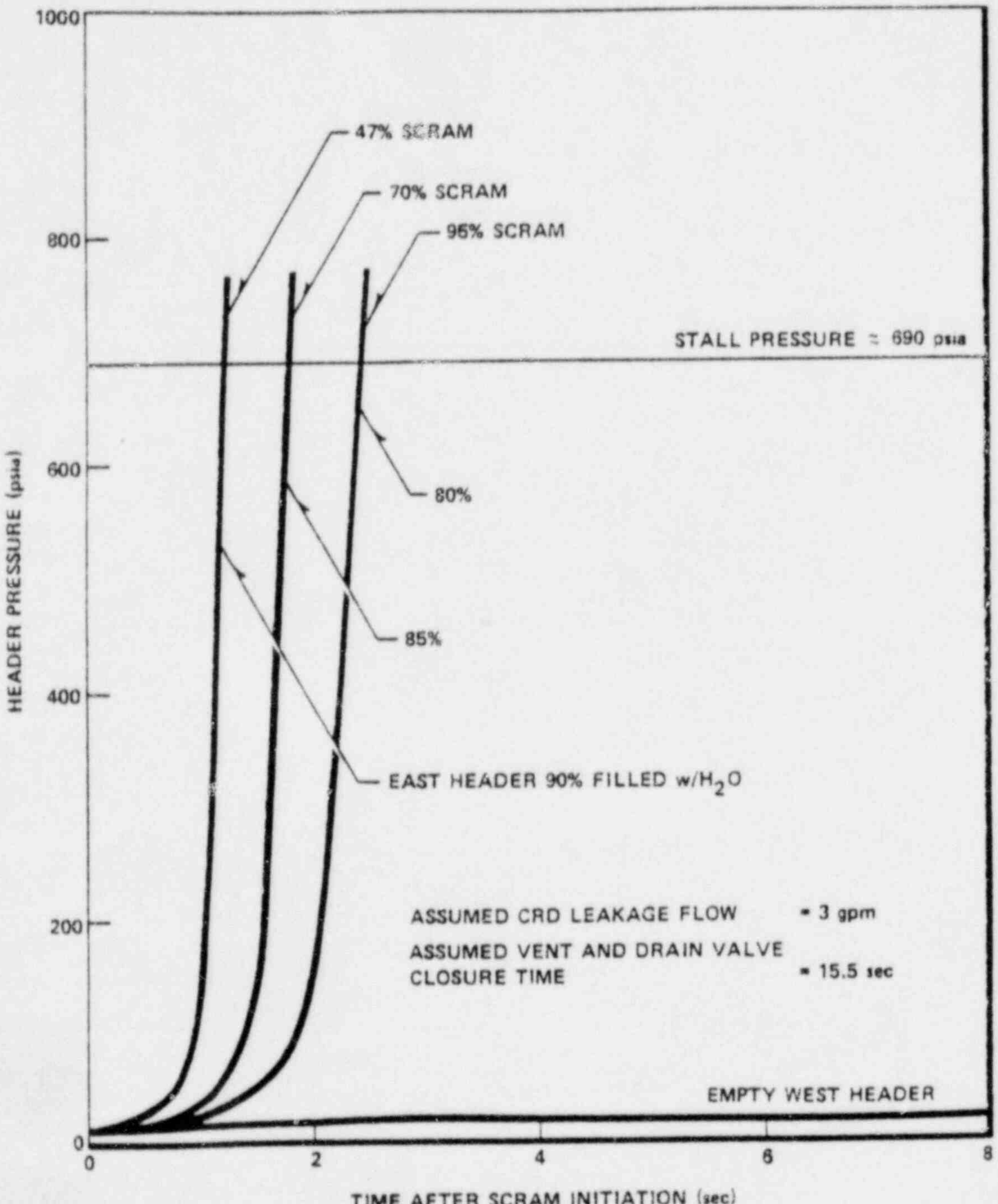
## Cause Determination

| Initial Volume (Gallons) | Percent Volume | Time (Seconds)* Induced Leakage "0" GPM | Time (Seconds)* Induced Leakage 9.0 GPM |
|---|---|---|---|
| 0.5 | 85 | 1.6 | 1.5 |
| 0.0 | 100 | 0.2 | 0.2 |

*Time for scram discharge volume to reach 1000 PSIG.

# SIMULATION OF 6/28 INCOMPLETE SCRAM – BF-3

HEADER PRESSURE vs TIME

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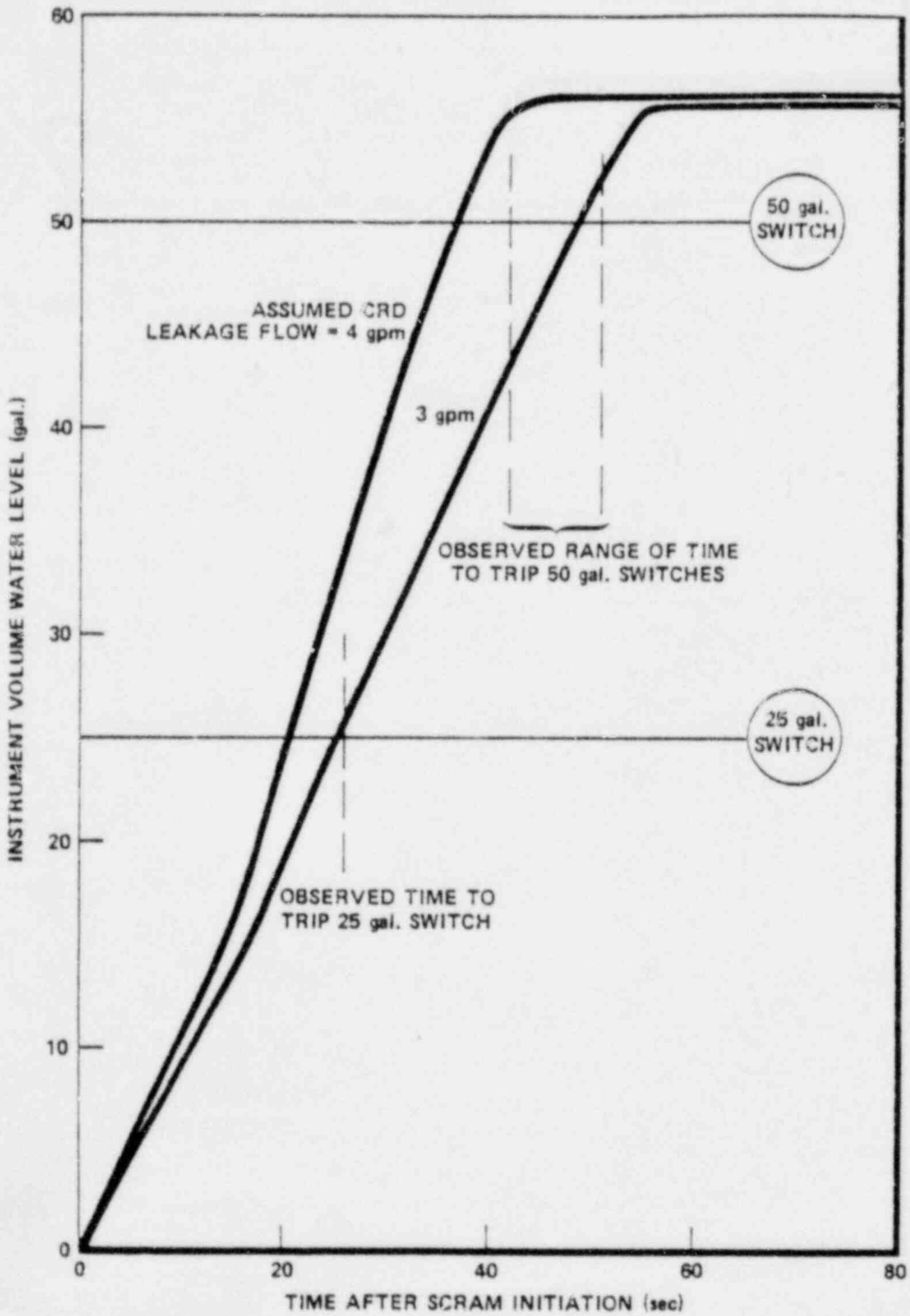
# NORMAL SCRAM
# REDUCED POWER LEVEL




01818-5

7/29/80

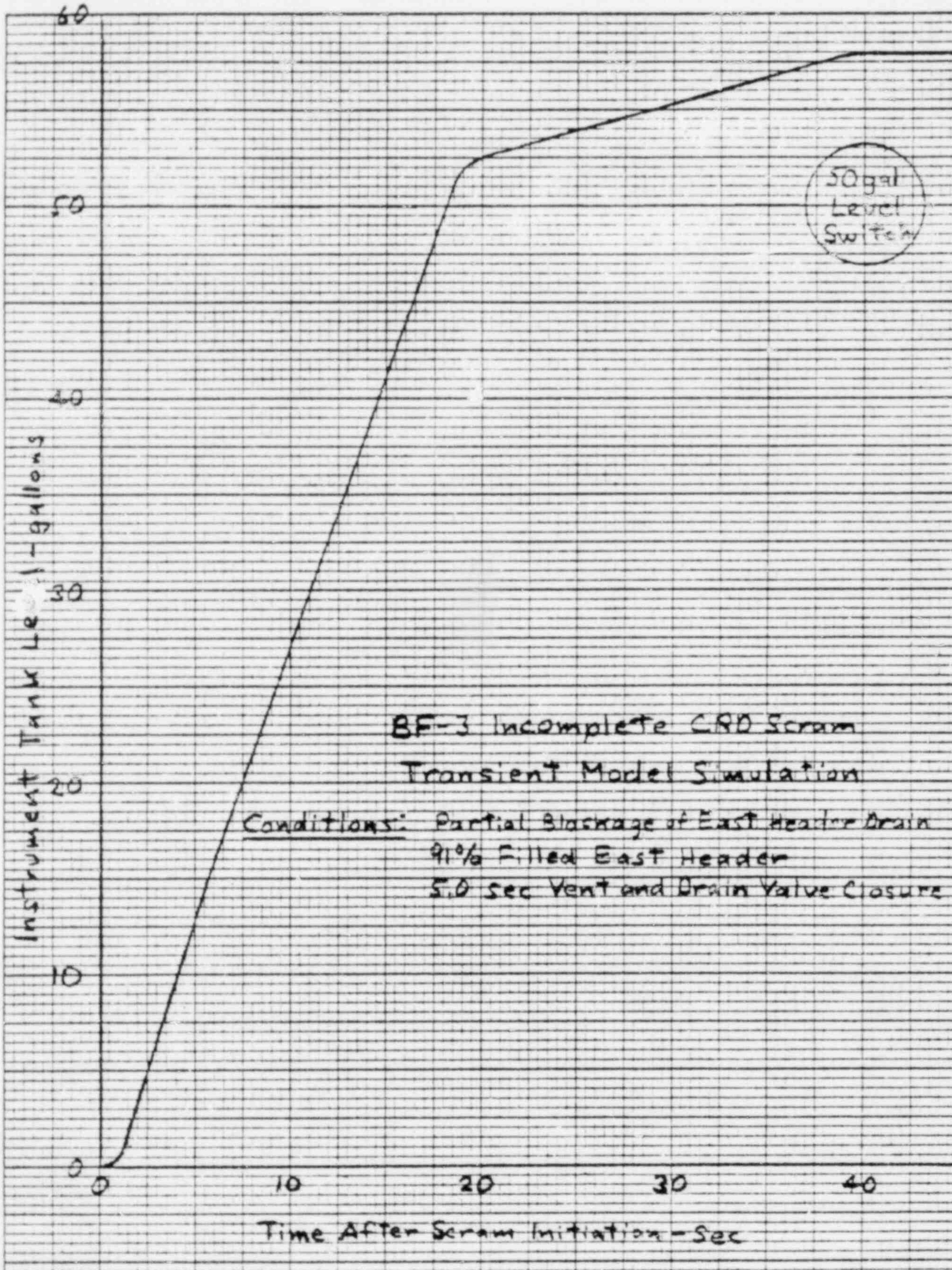



Figure 9 Instrument Tank Level - Condition #1

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## Cause Determination

## Sources of Water

- Outlet Scram Valve Leakage
- Normal Water Discharge During and Following Scram
- Introduction of Water From Vent System
- Introduction of Water From Drain System

o Flushing Connections for Decontamination

Inadequate Drainage

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## Investigation of Cause of Water in East SDV Hydraulic System

- Inspection For Restriction -- None Found
  - 6" Headers
  - 2" Drain
  - Instrument Volume
  - Drain to Equipment Drain Tank
- Scram Vent Line Not Restricted
- Verified Slope and Elevation on Two-Inch Drain Line to Instrument Volume
- Verified Slope and Elevation of Scram Discharge Volume

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## Cause of Incomplete Insertion

## Conclusion

- The Browns Ferry 3 Event Was Caused By Undetected Water In The East Scram Discharge Volume

- Water Was Present Due To A Restriction In The East SDV Drainage System

- Since No Evidence Of A Restriction Could Physically Be Found, The Contribution Of The Vent System To The Event Cannot Be Discounted

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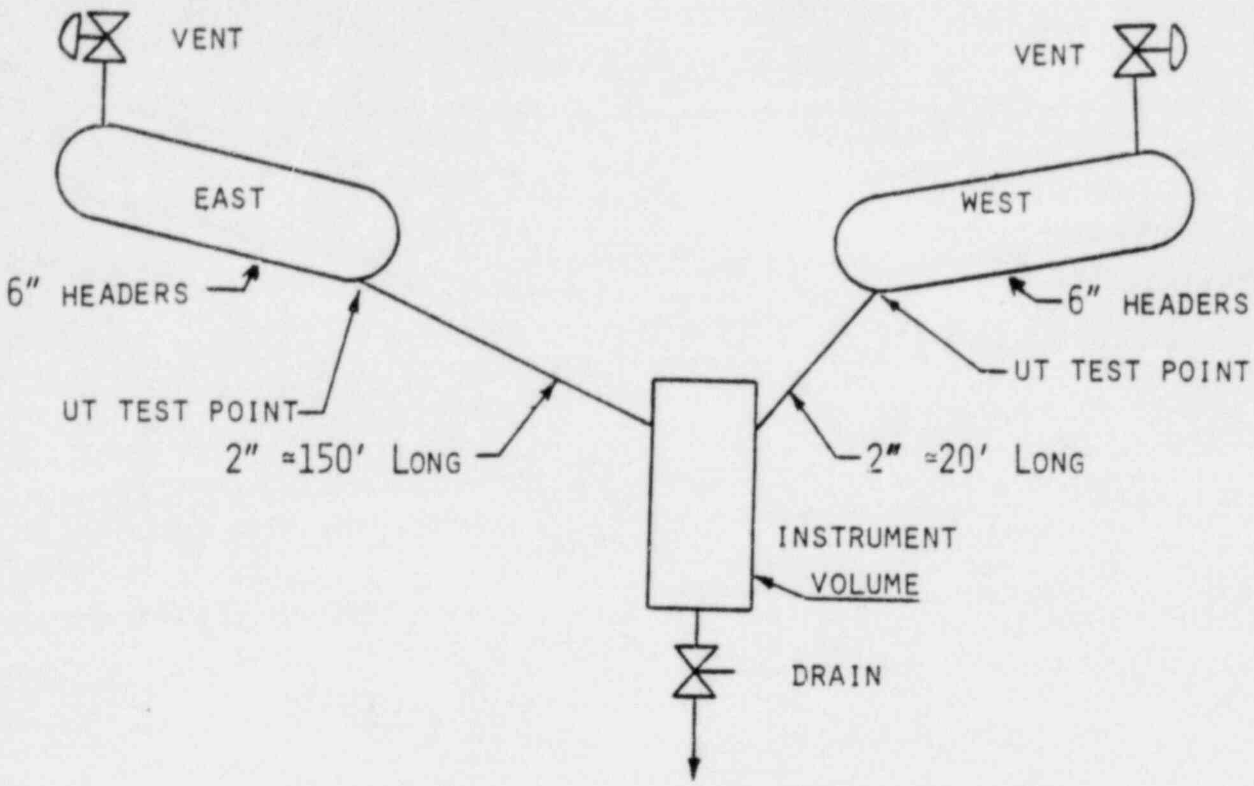
# Browns Ferry 3 Drain Tests




Reactor Building Equipment
Drain Tank

| Time to Drain 6" Header System | | | |
|---|---|---|---|
| **East** | | **West** | |
| Measured | 25.5 min. | Measured | 9.5 min. |
| Calculated | 23 min. | Calculated | 10 min. |
| Total Volume Drained 750 Gallons (Approximately) | | | |

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# SUBSEQUENT ACTIVITIES

## UNIT 3 FLOW TESTS

- PLANT MAINTENANCE, CHATTANOOGA ENGINEERING, TVA DESIGN, AND GE ALL INVOLVED DIRECTLY IN TESTING
- PROVIDED DETAILED INFORMATION ON SYSTEM DRAINAGE AND OVERALL CHARACTERISTICS OF SYSTEM, CONTRIBUTION OF VENTS
- POINTED OUT LIMITATIONS OF LEVEL INSTRUMENTATION
- GOOD BASELINE DATA TO COMPARE SYSTEM OPERATION IN FUTURE
- INDICATED SYSTEM AREAS WHICH WARRANT IMPROVEMENT

## IE BULLETIN 80-17 TESTS

- INVOLVED 2 SCRAMS ON EACH UNIT
- TESTING INVOLVED RPS ELECTRICAL SYSTEM, CRD MECHANICAL, DRAIN AND VENT VALVES, SCRAM DISCHARGE HEADER
- INDICATES BF 1, 2, AND 3 CRD SYSTEMS WORKING NORMALLY

## SYSTEM CHANGES

- UT MONITORING - CONTINUOUS READOUT MONITORS INSTALLED ON SCRAM HEADER LOWPOINTS
- EXPERIENCE DURING U-3 AND 80-17 TESTING INDICATES UT MONITORING IS RELIABLE

## VENTS

- POSITIVE VENT PROVIDED ON EAST AND WEST HEADERS

## PROCEDURES AND TRAINING

- EMERGENCY INSTRUCTION WRITTEN DESCRIBING OPERATOR SECTIONS IF WATER DETECTED IN VOLUME
- ALL OPERATORS INFORMED THOROUGHLY ON BF-3 EVENT

## DESIGN WORK

- TVA WORKING VIGOROUSLY TO FINALIZE MODIFICATIONS TO ELIMINATE POSSIBILITY OF REOCCURENCE OF THIS TYPE OF EVENT