ORIGINAL ACRST-2002

OFFICIAL TRANSCRIPT OF PROCEEDINGS

Agency: Nuclear Regulatory Commission
Advisory Committee on Reactor Safeguards

Title: Subcommittee on ABB-CE Standard Plant Designs

Docket No.

LOCATION: Bethesda, Maryland

DATE: Wednesday, April 6, 1994

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UNITED STATES NUCLEAR REGULATORY COMMISSION

ADVISORY COMMITTEE ON REACTOR SAFEGUARDS

DATE: April 6, 1994

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UNITED STATES OF AMERICA

NUCLEAR REGULATORY COMMISSION

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ADVISORY COMMITTEE ON REACTOR SAFEGUARDS

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SUBCOMMITTEE ON ABB-CE STANDARD PLANT DESIGNS

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Nuclear Regulatory Commission
Conference Room P-110
7920 Norfolk Avenue
Bethesda, Maryland

Wednesday, April 6, 1994

The Subcommittee met, pursuant to notice, before J. Carroll, Subcommittee Chairman, at 8:34 a.m.

ACRS MEMBERS PRESENT:

J. CARROLL
T. KRESS
I. CATTON
C. MICHELSON
P. DAVIS
W. LINDBALD
R. SEALE
W. SHAEK
D. COE (Cognizant ACRS Staff Member)
J. QUINTIERE (ACRS Consultant)

PRESENT FROM NRC/NRR:

B. BORCHART
M. FRANOVICH
T. WAMBACH
M. SNODDERLY
J. HOLMES
S. SUMMER
S. MAGRUDER
D. SMITH
T. CHANDRASEKRAN
C. McCRACKEN

PRESENT FROM ABB/CE:

S. RITTERBUSCH
R. MATZIE
W. HEILKER
C. BRINKMAN
F. CARPENTINO
M. CROSS
L. GERDES
C. HOFFMAN
C. KELLER
J. LONGO, JR.
B. LUBIN
D. MATTESON
R. MITCHELL
K. SCAROLA

PRESENT FROM DE&S:

T. CROM
D. BRANDES
E. INGLES

PRESENT FROM SWEC:

J. METCALF

L. BRUSTER

S. FERGUSON

S. STAMM

T. WANG

PRESENT FROM D&S:

M. CERALDI

PROCEEDINGS

[8:34 a.m.]

MR. CARROLL: The meeting will come to order. This is the second day of our April meeting on ABB/CE System 80 Plus.

We are joined today by Bill Lindblad and Pete Davis and Dr. Quintiere. I guess Charley still hasn't made it, right. Okay.

We are going to follow the agenda that was passed out yesterday with the exception that we have reversed Items 7 and Item 4 to accommodate the fact that a couple of our members have to go up and see Chairman Selin this afternoon.

Let's see. Carl, are you ready to discuss with Mike Snodderly the screen issue?

MR. MICHELSON: Yes. I read over what the change in the writeup will be. I didn't have any problem with what it says. It won't take very long to discuss.

MR. CARROLL: All right. I guess Mike wants to get this behind him so he can go do some honest work.

MR. MICHELSON: I think, though, what wasn't covered -- this is CE's writeup, of course, of it. What wasn't covered in here real well but I think we got a clarification yesterday and that is that, indeed, the NPSH on the pumps with the appropriate correction factor for whatever plugging you anticipate with these very large screens, which ought to be quite small, that the calculation will be done at approximately 212 degrees with no pressure in the containment.

Is that your understanding?

MR. SNODDERLY: I was mainly just -- from our perspective we were mainly looking at screen size and the vortex suppressors but we didn't -- I was not -- I did not review, I guess, the NPSH.

MR. MICHELSON: Tell me about the vortex suppression.

MR. SNODDERLY: They are going to be made in accordance with Appendix A of Reg Guide 1.82 and they are just going to be made out of, I believe we say in here --

MR. MICHELSON: Are these going to be vane suppressors?

MR. SNODDERLY: No, sir. Just cage type. And it is going to be just made out of floor grading material.

MR. MICHELSON: How close to the intake will it be?

MR. SNODDERLY: There was a picture on -- I don't have the figure with me, but in Chapter 6.8 there is a figure that shows the cage-type suppressors.

MR. MICHELSON: I will look that up. It's in 6.8?

MR. SNODDERLY: Yes. In Appendix A of Reg Guide 1.82, I believe, gives how the dimension, how to come up with the grating size and the distance from the inlet.

MR. MICHELSON: Is there any requirement to do a test to see if this is an effective design, or do you think enough tests have been done?

MR. SNODDERLY: I think that the tests that have been done for Reg Guide 1.82 in support of that are sufficient except as the refragmentation which we have begun to question.

MR. MICHELSON: You reviewed the ABWR also, didn't you? And it is apparently becoming an open item again.

MR. SNODDERLY: Yes, sir.

MR. MICHELSON: The general question here, since this is a different form is, simply, is there anything that prompted you to reopen that issue affecting CE in any way?

MR. SNODDERLY: Yes and that was requiring them to go from one times Reg Guide 1.82 to three times what the Reg Guide required for the area.

MR. MICHELSON: They have done that, haven't they?

MR. SNODDERLY: Yes, sir, CE has committed to three times.

MR. MICHELSON: this answer I have reflects the three time; is that correct? That was this --

MR. WAMBACH: I think, Dr. Michelson, what you are referring to there is Mike's input to us. The memo I gave you this morning.

MR. MICHELSON: Yes. Excuse me. I take it back, this indeed ought to reflect it then. Okay, I'm sorry. This is indeed what you handed to me, sure.

MR. RITTERBUSCH: Mr. Michelson, this is Stan Ritterbusch.

Our commitment to the factor of three over Reg Guide 1.82 is stated in Section 6.8.

MR. MICHELSON: That was no real problem, the way you've designed the screening anyhow it shouldn't have been hard to provide the factor of three.

So for CE, this is a nonproblem, even though you reopened it on ABWR.

MR. SNODDERLY: Yes, sir, because our position for ABWR is three times what's required to 1.82.

MR. MICHELSON: It is therefore a more difficult situation to provide these large areas.

MR. SNODDERLY: Yes, sir, their normal design is considerably less than --

MR. MICHELSON: They're just using simple cones and it's hard to get them big enough without damaging them in a blow-down.

MR. SNODDERLY: Yes, sir.

MR. MICHELSON: So it's a whole different kind of issue. And we will hear about that separately.

You're coming in, I guess, tomorrow to tell us about it?

MR. SNODDERLY: Yes, Rich Barrett, our branch chief, will be. I believe we are still waiting for GE's response.

MR. CATTON: Is this a new reg guide, or a rewritten reg guide?

MR. SNODDERLY: This -- a new reg guide has not come out, Dr. Catton, but just based on the data that we have gotten from the Swedes. So we came out with a bulletin, 94 --

MR. CATTON: The reason I asked is I believe the Swedes found there was a synergistic effect between fibrous materials and particulate?

MR. SNODDERLY: Yes --

MR. CATTON: And in the past that has not been a consideration, near as I could tell. Will it be in the future?

MR. SNODDERLY: That's the problem we are trying to deal with right now is that the fragmentation models used in the reg guide may not be --

MR. CATTON: I just want to make sure you didn't overlook it.

MR. BOEHNERT: We will hear about this on Thursday.

MR. CATTON: We should move on if we're going to hear it.

MR. MICHELSON: This is for CE only. You're going to hear it for ABWR.

For CE, the safety injection pumps, where do they get their sealed cooling water from? CE could answer it if they like.

Are you using the processed fluid for the sealed cooling, or do you have a separate clean water loop?

MR. CROSS: Mike Cross, ABB. We are using a separate cooling loop.

MR. MICHELSON: So you are just taking processed water off the suction and then injecting it into the seals?

MR. CROSS: Yes, sir.

MR. MICHELSON: Or off of the discharge side of it.

MR. CROSS: Right.

MR. MICHELSON: Okay, so then you do have to worry about the fine particles in the debris. The problem is that you are circulating this processed fluid with these particles suspended in them because any screen you put in is not going to take out the fines we are talking about?

MR. SNODDERLY: Right. The second screen is, I believe, .09 inches in diameter. So that would allow --

MR. MICHELSON: .09 inches, okay. That is still not -- I mean, fiberglass fibers are much more than that?

MR. SNODDERLY: Right.

MR. MICHELSON: Of course, they go in the long way, if you want to use them, or how they are going to do. They mat up the short -- on the long way into the one, they go through on the short way, they mat up.

MR. CARROLL: Well, is this a problem on the 80-Plus design? Do they use that kind of insulation?

MR. MICHELSON: Well, that we are going to --

MR. SNODDERLY: That is one reason the commitment is written the way it is. They haven't determined how much fibers and metallic insulation is going to be in containment.

So when they do the final design, they will go back and compare with what they would calculate for Reg Guide 182. And if it is less than three, they will have to back and make some changes in the amount of fibers insulations.

MR. MICHELSON: Well, the reason for asking the question on the seals is there is a concern. Since you are recirculating constantly, there is processed fluid through the seals.

MR. SNODDERLY: Right.

MR. MICHELSON: Not recirculating, you are circulating one time through. It becomes the filter and it does filter it out nicely because your bearing clearances are very small. They will tend to mat up in the bearing. Of course, you will lose the cooling to the bearing, and then that is the end of pump, too.

So you have to make sure to account for it. I just wondered what your approach is. We went through this. We went through this on Reg Guide 182 a long time ago. Al Serkiz, I think, was running it at that time.

I am not sure the Reg Guide ever made it very clear that you have to account for such things as bearing cooling if you are going to use the processed water for the cooling. Therefore, the bearing becomes the filter.

MR. CARROLL: Bearing or bearing jack?

MR. MICHELSON: Well, the bearing itself. They will run the water right through the bearing, normally, right through the bearing clearances. That is how they cool it. It goes right back into the process again.

MR. CATTON: This is water lubrication?

MR. MICHELSON: Yes, cooling mostly.

MR. CARROLL: Of the pump bearing?

MR. MICHELSON: Yes. That is why you like to do it this way because you have no rad waste to worry about. Then you just pump it out of -- take it off of discharge and run it through the bearing and back into the pump again.

MR. CARROLL: I know what you are talking about.

MR. MICHELSON: That cools the bearing in the process.

MR. CARROLL: I would have thought that it would have been an oil lubricated bearing and the injection was going into the seal.

MR. MICHELSON: No, that is why I asked is the seal cooling. Now maybe I was misunderstood. I am talking about using seal -- processed water directly for seal injection.

MR. CROSS: Mike Cross, ABB. As far as these seals go, it would be a mechanical type of seal.

MR. MICHELSON: That's right.

MR. CROSS: But when we start talking about the bearings, I am not totally positive --

MR. MICHELSON: Well, let me state it differently. The cooling can be one of two ways. You can use direct injection to cool the bearing, or you can cool a little cooler that has its own little impeller inside the pump and is circulating the water, which is what Westinghouse does.

MR. CARROLL: Or you can have oil cooled bearings.

MR. MICHELSON: Not for these, no.

MR. CROSS: Right, you can. But I would have to go back and confirm that. I am not really positive on this pump.

MR. MICHELSON: But if the processed fluid circulates through the bearing directly, then you have to worry about the particulates hanging up in the bearing.

MR. CROSS: I understand. But I don't think that is the type of pump.

MR. MICHELSON: If it isn't, then that is the question. If it isn't, then you can clarify it for the next meeting. If it isn't, it is a non-problem, which is the way Westinghouse does it. They use a separate impeller and a separate circulating system. But GE does not, for instance.

MR. CARROLL: Okay. Does that take care of it?

MR. MICHELSON: Do you have anything else?

MR. SNODDERLY: No, Dr. Michelson, but you have raised an excellent point. We will go back and think about it. If you will bring it up again tomorrow --

MR. MICHELSON: It may be a non-problem for them, just depending on what kind of pump they are proposing.

MR. SNODDERLY: Okay.

MR. MICHELSON: If they are leaving it open either way, then you have to consider that they are going to use direct seal injection.

MR. SNODDERLY: Okay. I will expect ABB to get back to you on that.

MR. MICHELSON: This, of course, was the question on ABWR.

MR. SNODDERLY: Right, and then tomorrow we will bring it up again.

MR. MICHELSON: Okay. So when you do your ABWR revaluation, make sure you ask about the seals because the water is used for seal injection there.

MR. CARROLL: Okay. Can we let Mike go back to work now?

MR. MICHELSON: Yes.

MR. CARROLL: All right.

MR. CATTON: I guess we will see him on Thursday.

MR. CARROLL: Yes. Okay. I guess this brings us up to Chapter 9, HVAC and fire protection, right, Stan?

I guess we will let Dr. Quintiere go first.

MR. QUINTIERE: Thank you.

All right. This work was done at the request of, I believe, Ivan, if he still remembers it, for the Auxiliary and Secondary Systems Subcommittee.

MR. CATTON: Is that comment because I might have forgotten or because you were so slow?

MR. QUINTIERE: No, because it took me so long to do it.

MR. CATTON: Okay.

MR. QUINTIERE: Maybe you will see why when I show you how I did it.

The task was -- I don't have a viewgraph of this. It says, "To review the adequacy of existing standards for fire barriers for nuclear power plant application. This should include the ability to isolate adjacent areas from smoke as well as heat and the impact of pressure."

But really we are talking -- fire barriers really attempt to prevent fire from going to the next base. But there has been this continual issue of what happens to the smoke associated with this fire and any collateral damage that the smoke may then do to the adjacent areas as well as what is in the space.

It says also, "To determine the industry practice for oil fire barriers, in particular, its adequacy for diesel fire in a diesel engine room or a generating room." So, I have looked at that as an example.

Now, in approaching this, I have reviewed the standards. I will give you some benefit of that. Some people in this room probably knew them better than I do. All right. So we might talk a little bit about that.

But the other thing I have done is I have made a mathematical model to try to simulate what a fire in a space like this would do and how the smoke might leak out. I have based this on the state of the art and what people call fire modeling for compartment fires.

However, I couldn't use a canned code because those codes you can't go in easily and change things. Some of the things I wanted to do, they wouldn't allow me easily to do, even if I talked to the people that invented the code. It is really very frustrating.

So we solved it in a different way. I had a student, Homan Arabsahi, who did it as a special project. It was very good. He used a computer code called "Mathematica." Some of you may know it. And in about three lines, he solved three differential equations for me, which I was very gratified. So, it took a little long to do that because of those steps.

Let me just now present what we have done here. I will try to -- I think you all probably have a copy of the report; is that correct?

MR. CATTON: Some of us do. If not, Doug can hand it out.

MR. LINDBLAD: The members should have it, yes.

[Slide.]

MR. QUINTIERE: All right. Okay.

From the standpoint of fire standards, these are the fire resistant standards -- ASTM, NFPA, Underwriters Laboratory -- all have standards related to construction, like walls, ceilings, and floors. Doors are tested, and also fire stops, any penetration or dampers and ducts. They are all tested. The system, actually, is tested relative to a prescribed temperature time curve in a furnace.

Virtually this curve is identical for all these tests. The criteria for failure is slightly different in these tests, but what is remarkable is that the criteria between these tests, like say, for doors, are virtually identical.

There is no recognition of smoke penetration in these tests. Flame can actually penetrate through cracks in a door, and the door can still pass. There is a concern that these furnaces operate so called at atmospheric pressure. That is what, 100,000 Pascals. The kind of pressures that drives smoke around in fires are 10 to maybe 100 Pascals.

So you see that relative to atmospheric pressure, the pressure pushing things around in fire are peanuts, but are very significant, because that is what makes the smoke do what it does.

These furnaces are said to operate at atmospheric pressure. So, slight changes really are not that important for them, and as a consequence, most of them are designed to operate at slightly negative pressures relative to atmosphere, so flow is always in.

I have been told -- I don't have documentation for this -- that when they operate at slightly positive pressure differentials relative to what you might find in a room fire, then things like doors fail a lot sooner.

So these tests really are not meant to be a test that represents all fires in all compartments. All right.

It is a prescribed test. The temperature levels that are attained here are the levels that you would get if you have a fairly large fire in a room.

[Slide.]

MR. QUINTIERE: For example, what I have depicted here. In other words, if we have full involvement of a space with flames and flames are coming out of an opening, that is what the furnace test and fire resistance test is intended to address.

Now, there has been a lot of work done to try to bring an equivalency between the furnace test and actual fires in a compartment. That work, however, has been based fires involving wood, which is depicted here, usually stacks of woods, sticks of wood, called cribs, and openings that are window-like openings. All right.

So it is not like a diesel fire with a fuel spill in a space that is really buttoned up that might have some little leakage through cracks or little vents. It is not that kind of fire situation.

This kind of fire has been studied very well. The burning characteristics are well known. The burning behavior is a function of the ventilation size, the ventilation height, and the area of the room. And because of that, people can make some equivalency with the furnace test.

[Slide.]

MR. QUINTIERE: What they can do is actually develop a very simple formula that says, "The fire endurance time of a fire, let's say, in this space, is a function of the amount of wood you have here in kilograms. So, we are visualizing a wood fire in this space.

The size of the opening -- let's say the windows are broken. So we know what that is. And the area of the surfaces -- the wall, and ceiling, and floor surfaces in a space. So, you can get a very simple result for the duration of this fire.

Then if we wanted to engineer the fire barriers here so that heat wouldn't penetrate to the next space, we can go test these walls, and floors and ceilings in the furnace test for that time. That is the way to match the two together.

But this is for wood fires, and as I said, for fires that have window-like openings. When you go beyond that, then it is a different ballgame, and you really have to go back and reestablish some equivalents. That has not been done.

There has been a recognition that wood fires and other conventional fuel-type fires that you might find in a room may be developed slowly, like that curve I originally showed you, which was developed, you know, almost a century ago -- not quite, maybe a half a century ago -- for things that burned in offices. All right?

So, that is where that curve came from. Also, it goes back to somebody in Columbia University that had a furnace and he can control his furnace that way. So then it became the gospel.

If you have something like a liquid-spill fire, and it gets ignited, flames will spread very fast over that surface and the fire build-up time would be a lot quicker. As a consequence of that, the oil industry said, "We need a different curve." They developed a curve that approaches a temperature of about 1,000 C. much faster.

They call that -- refer to it as the mobil curve. Some people in the petroleum industry use that, particularly for structural applications in off-shore platforms and things of that sort.

So that is the extent of what goes on relative to some other fuels -- not a heck of a lot. All right.

MR. CATTON: Is that Mobile Oil Company

MR. QUINTIERE: I think it relates back to Mobile Oil. All right. I don't know the full history of that. It is not widely used other than probably in places in that area.

MR. DAVIS: Excuse me. The nuclear plant that I am familiar with require that any wood inside the plant be treated with some fire retardant covering.

MR. QUINTIERE: Right.

MR. DAVIS: Of course, you don't see much wood. Once in a while, there will be scaffolding and so forth. How effective is that fire retardant that they treat it with? It is going to prevent ignition?

MR. QUINTIERE: No. The word "fire retardant" does not mean "won't burn." It means that its ignition temperature may be a little bit higher than it was before, or it means that maybe the heat of combustion might be a little bit lower than it was before. Basically that is all that it means.

So things might take a little longer to initiate, or might burn a little slower. But it still may be fast enough to be a hazard for you. Fire retardant is really amazing.

If I can just give a little anecdote for a second, there are people who test antennas with anechoic-like chambers. I don't know if anybody is familiar with that. But it is carbon-impregnated foam. It looks like an anechoic chamber, but it is an air field antenna test. They have a wall of this foam with these big cones sticking out.

These are sophisticated people who deal with electronics and microwaves. They said, "Gee, that material is fire retardant. It won't burn." We kept telling them it should be tested.

Finally, one day they burned a little piece in their parking lot. They were really surprised how fast it burned. Fire retardant does not mean "won't burn." So there are a lot of things like that that could mislead people. I would just throw that out.

[Slide.]

MR. QUINTIERE: All right. So what was done? If one envisualizes something like a diesel generating room, we might imagine that it is pretty well closed. There may be some openings, and I have just depicted them here at the top and the bottom to make my model simpler. All right.

And this might be an undercut and an overcut on a door. It might be some vents, you know, for ventilation. In event of a fire, the ventilation system would be shut off so there wouldn't be any forced ventilation.

But fire flows could go in or out of these vents as they wished based on natural convection and based on the pressures that might generate due to the energy.

Here I have depicted a spill fire. You might imagine this in a dike. We have selected dimensions that I think are typical of what a typical diesel generator room might have. We have considered diesel fuel.

What I also have allowed for in the model is that some of these spaces have sprinklers. So let's assume that the sprinkler comes on, but it doesn't put out the fire, but some of the water is evaporated.

The reason why that is important is because if we are adding mass to this system by evaporation, then that is going to go into increasing the pressure of the gasses in the compartment. That will help drive it out. All right.

So, that was something that we wanted to add. We could take it out of the model and see how important it is. We haven't done these parametric studies yet.

So I took a fraction of the energy that would come from putting water in and I put it into the model. I didn't want to overwhelm it, so we put about, I think it is about 5 or 10 percent of the water that would have extinguished this fire, I put that in here.

I made that water evaporation rate proportional to the fire. I selected that by using an empirical constant that represents -- it's about 10 percent of the water that would put out this fire.

So you might assume some catastrophe happens. Here is a fire. Sprinklers go on. It can't get at this. It is shielded somehow. Some of this water gets evaporated in the system.

MR. SEALE: What is the dimension Y?

MR. QUINTIERE: That is the distance up, and you will see that we have derived some equations, and so it is just a coordinate.

MR. SEALE: And Y-ox is?

MR. QUINTIERE: All right. T is the temperature, P is the pressure, and Y-oxygen is the concentration of oxygen. Very good, I am glad you brought that up. Q-dot is the energy release rate of this fire in kilowatts. We have assumed that this space is well mixed and all of these properties are uniform over this space. It may not be true in the early stage because we may have a fire developing a smoke layer that is descending, but after a few minutes, that smoke layer for this kind of leakage space will virtually fill the space and we might say that this is well mixed. So that is the assumption.

MR. DAVIS: Do you assume unlimited oxygen?

MR. QUINTIERE: No.

MR. DAVIS: Even though the room is ventilated?

MR. QUINTIERE: No. What we are assuming now is that there is -- the space out here is uncontaminated. That may not be true forever, but we are assuming that this is air. These flows can go in or out depending upon what the fire is telling it to do, based on temperature, which would establish buoyancy, but also based in energy release that would actually give this a little pressure push. So this is how the fire is going to behave. If I add mass to this or energy, I think you can realize, if this were a totally closed system, if I add mass or energy, the pressure goes up. So if I have some little leakage, it might still go up and then relieve itself through the cracks. At the same time, because I have a hot layer here, I can have buoyancy make flow go in and out. These are the possible conditions.

That is why, when I was asked to do this, you can't just qualitatively say, these are the kinds of things that can happen, you really have to take a look at it with a model, and some funny things can happen in a situation like this because you can get flows either in or out. The fire is now going to be affected by the oxygen because as the oxygen goes down in this space, potentially, the fire will go down. At some oxygen, the fire may go out. We have not put that in the model yet, but we can.

When it goes out, then more oxygen can come back in to reignite it, and it is possible to get not just oscillations from a float mechanical point of view but oscillations from a combustion point of view in that the fire can go out and come on again, and out and come on again. There have been studies done for small ventilated spaces with liquid fires showing that that, indeed, happens, and it is documented in the report.

[Slide.]

MR. QUINTIERE:

I don't want to bore people. We write a

conservation of mass. That contains the flows in and out. It contains the evaporation of water, it contains some fuel added. This is a relatively small term. We can work on this equation a little bit with perfect gas law and get this in terms of temperature.

[Slide.]

MR. QUINTIERE: This is the relationship we use for the water vapor evaporated. It is proportional basically. This is a constant, proportional to the energy release of the fire. If that goes down due to oxygen, then we evaporate less. As I said, it is about 10 percent of the water that it would take to put out this fire.

This is the heat of gasification of the water. Basically that is the energy required to evaporate the water.

[Slide.]

MR. QUINTIERE: The flows in and out are governed by the pressure difference at that opening, that is what that quantity is. This is density, this is an orifice coefficient. This is the size of the opening. These are just step functions that says, if the pressure is positive in to out then the flow goes out. If the pressure is negative in to out, then the flow goes in. So in the model we either turn this one on or this one on, depending upon what the pressure tells us to do. We have a similar expression for the vent on the bottom.

[Slide.]

MR. QUINTIERE: We write the energy equation, rate of change of internal energy, enthapy terms due to flows, water, some fuel enthapy, the energy release of the fire, some heat transfer to the walls. We assume that in a very simple fashion. If someone wanted to do this better, they can, but this probably takes care of it enough for our purposes, at least here, and this is the energy required to evaporate the water.

Again, the energy release of the fire is proportional to oxygen times the energy that this fire would release if it were burning in pure air. We can determine that for a pool of diesel oil. So if you specified the dimensions of the diesel oil, we can look up some data in literature, and we could determine the energy release rate of that. We say that if the oxygen goes down, then it goes down, and there is justification to do this from the theory of combustion.

If we work on this formula, basically we get this in terms of a derivative of the pressure in the enclosure, the pressure in the enclosure.

[Slide.]

MR. QUINTIERE: Then finally we have an equation for conservation of the oxygen. So we have three equations.

We have the conservation of oxygen, energy and mass, and we have three variables. The temperature, the pressure in the compartment and the concentration of the oxygen, and the flows are driven basically by the pressure. So we can solve this.

[Slide.]

MR. QUINTIERE: What I really liked about it because, when I got to that point, I said, I don't know if I really have the time to program this up, and a student came to me and said he wanted to try Mathematica. I said, great, here are some three equations, tell me if it works, and he came back, and on one page, he put down on that page all the input information, like this. Heat transfer coefficient, this is the temperature of the water which evaporates at the heat of gasification of the water. This constant that was in the evaporation formula, the height of the room. Here you can tell me if we got a diesel room. He told me eight meters, nine meters wide, 16 meters long, and the area of the dike, I guess -- well, let's see, that is not the area of the dike. This is the fire area. One of these cases we have taken five square meters and ten square meters, basically, so that is kind of the area that we are considering involved.

We have taken vent sizes of basically a meter or a half-a-meter. In the example I will show you, it is a half a meter. So it is a half a square meter vent on top and on bottom, relatively small openings. Based on the area of the fire, then we can calculate the energy release of the fire as it burns initially.

So all of this is put in. This is on the top of the page in his computer program, and then there are a few more lines that take the second half of the page that basically describe the variables and the equations, and then everything gets plotted out.

[Slide.]

MR. QUINTIERE: So I became a real bully for using something like Mathematica. I will just show you some results. This is a result for temperature, this is in Kelvin, this is for a Case II on that chart, you can see that the temperature initially bounces up and there are some oscillations that get damped out.

If the fire goes out, this might be repeated again. We haven't really looked at that. You can see this is the kind of temperatures that you would get in a space like this. So if one wanted to develop some equivalents with the furnace test and did a model like this with a little more perfection for your space, you would get the temperatures and the duration of that fire in that space. Now, if someone comes and opens up a door, then the vent changes, and the fire condition might change.

[Slide.]

MR. QUINTIERE: This is how the fire itself behaves in terms of energy release. You can see it is going down due to oxygen. There are some little bumps in here, and then it almost levels off at some equilibrium.

[Slide.]

MR. QUINTIERE: The oxygen is very similar to that, obviously it should.

[Slide.]

MR. QUINTIERE: This is the mass flow at the bottom. You can see initially it pushes out. The fire gets turned on, things go out, then it comes back in, it goes negative, bounces up and almost wants to go positive again, and then it levels off.

[Slide.]

MR. QUINTIERE: The top vent is primarily out. No, I guess it comes back in, too. For this case, it goes out, it comes in a little bit at the top, and then levels off going out.

[Slide.]

MR. QUINTIERE: These are the corresponding pressures, you can see the levels that we are getting of the order of maybe 100 Pascals, maximum.

What does this all mean? I mean, here is a way to actually model a fire in a space and if you want to do some engineering on it to relate it to fire resistance, or smoke movement, in my opinion, this is what you have to do, and you have to be very specific about your space, and if you don't like this model as an example, you might try to make it better. This is where I really urge people to go, if they want a design from an engineering point of view, not from a prescription point of view and say, we have this standard. Let's have a three-hour barrier, or whatever, and just subscribe to that. I think people have to go beyond that, particularly for situations that have a little more risk to them, and particularly where things are happening that we don't fully understand, like where is the smoke going.

Now, you saw flows are going in and out of there. What I did not do, I did not couple this with the calculation for the smoke particulate itself, which would enable us to calculate the disability of that smoke, and which would enable us to make some estimates of the deposition of the smoke and its damagability to equipment.

What I have done in the report is, I have illustrated how that could be done. So I did it after the fact of this modelling, and what I said is that for some period of time, let's assume that these flow conditions are constant, and I have so much flow out, and I have so much temperature in this compartment, and over that time period let me assume things are constant. For that case, I show some formulas that allow us to calculate what the smoke concentration is, assuming that about 5 percent of the fuel turns into soot for diesel, which is not such a bad number. You can go into the literature and get parameters like that.

[Slide.]

MR. QUINTIERE: In doing that, for one of these cases, I think it is Case 3, after about 120 seconds, this is just early in this fire. The fire starts up and just pushes stuff out. Early in this fire it says that the visibility of that smoke after two minutes is about one meter. So roughly in the space we only can see one meter, and the smoke now coming out of these cracks have that visibility also.

Now they are going to mix with air, so that should be pretty clear after a while. Again, you can see how you can carry this calculation further.

The other thing I have calculated here is the deposition of the soot per unit area. I got some equations from Mike Delichatsios, who addressed that subcommittee some time ago and he gave me a formula that calculates the transfer of soot to surfaces. He says it is a good one. So I used it in here. He also gave me some criteria for damagability to electronic equipment based on this number.

Now, the damagability was much higher than this.

I think it is a number of about 30 micrograms per centimeter squared, and you can see we are only about of the order of one after two minutes. So the question of damagability can be addressed in principal by using something like this. Obviously, you would want to really take it to the next phase and then assess it.

So what I have tried to do here is just present an example and a framework of what I think should be done in addressing some of these issues, and I will stop at that point.

MR. CATTON: Thank you.

MR. KRESS: Could you put your pressure curve back up, the last one you had?

MR. QUINTIERE: Yes.

[Slide.]

MR. QUINTIERE: I think that was the one?

MR. KRESS: Yes. Those are kilo-Pascals?

MR. QUINTIERE: No, not kilo-Pascals, Pascals.

MR. KRESS: Okay. Do you have a good explanation for why that goes negative?

MR. QUINTIERE: Why it goes negative?

MR. KRESS: Yes.

MR. QUINTIERE: This is the -- which one is it, the bottom one?

MR. KRESS: Yes.

MR. QUINTIERE: If we have a fire in this space and now this room gets hot, and imagine that doors are closed like they are, if we calculate, just due to natural convection, what the pressure is going to be at the floor relative to the other room, we will find that that is negative relative to the other room.

There will be, based on conservation of mass, that has to happen because flow has to come in, if we have steady-state conditions, and flow has to go out. The only way that flow is going to come in is due to a pressure drop across the vent orifice.

MR. KRESS: That brings me to my other question. Your equations were generally for well-mixed homogeneous volumes?

MR. QUINTIERE: Right.

MR. KRESS: Somehow then you get a pressure for that entire volume and have to translate it into a pressure at the bottom and a pressure at the top. I didn't see how you did that?

MR. QUINTIERE: It is in the report, and it is a standard assumption in these fire models, and it is valid. It is based on this, basically, as I said earlier, one atmospheric pressure is what, 100,000 Pascals. So pressures in fire vary very little from that. But it is the pressure differences that are going to drive the flows. So when we have a flow equation, we calculate the pressure difference by assuming that there is a gradient in pressure from floor to ceiling.

But when we go to the other equations that have the pressure term in, then we ignore that gradient. If you go to perfect gas law, we just say pressure is pressure in that room, and I don't care if it is at the top or the bottom. However, I have used the bottom pressure to represent the pressure in that room, and any departure from that is small other than what it takes to bring the flows in or out.

MR. KRESS: Sure, that is reasonable.

MR. QUINTIERE: This is a standard, and it is a well established assumption in terms of its accuracy in this spirit of fire modelling.

MR. KRESS: That is why I asked if that was kilo-Pascals, because those are small numbers.

MR. QUINTIERE: Yes, these are pressure differences.

MR. CATTON: I think the thing you want to keep in mind is that the areas that he chose were relatively large. If I start shrinking the area down, that peak is going to go up.

MR. QUINTIERE: It is a half a square meter. This guy works for a construction company, so he had some vision of diesel rooms, and he picked sizes that were, he thought, representative. I don't know, maybe people here might challenge that.

MR. CATTON: A fire door has about an inch on the bottom, I guess.

MR. QUINTIERE: He was basing it on vents like this that might be in the system, too.

MR. CATTON: They have dampers that will probably shut those.

MR. MICHELSON: No, not necessarily.

MR. CATTON: Not necessarily. In any event, that peak goes up as the area comes down, and if it goes up a whole lot, that door will go out, probably.

MR. QUINTIERE: That is another thing, too.

MR. CATTON: That is another part of it.

MR. QUINTIERE: Yes, the door may fail. If you button up the space, you are going to get tremendous pressures. You know that, just calculating this in a --

MR. MICHELSON: But race, though, to using up the oxygen as the pressure rises, so you are in a race to see if --

MR. QUINTIERE: You are in a race, yes.

MR. MICHELSON: I was going to ask that question, have you tried to estimate the transient, and what transient pressure you might get to in the process of a confined box sort of fire?

MR. QUINTIERE: Yes. We could shut the vents off and run it, but you can calculate that without a computer program.

MR. MICHELSON: Yes, that is just heating up the gases, for one thing, and putting the energy into the room.

MR. QUINTIERE: Yes.

MR. MICHELSON: And it goes up very fast, and that is when you lose doors.

MR. QUINTIERE: Yes. You could get to another, go up by an atmosphere almost under these conditions.

MR. MICHELSON: Yes, and a door will fail long before that.

MR. QUINTIERE: But, you see, unless you are really in an aircraft -- well, not even an aircraft, let's say a space capsule or something like that, it is very rare to have a compartment, a building compartment really tight. There will be leakage, and even small leakages will cause you to relieve the pressure, but it is possible that you can blow something out if you make it too tight.

MR. MICHELSON: In the real world, there are all kinds of arrangements depending on what your fire protection arrangement is. In the case of the water sprinklers, if you have air intakes to the compartments you may or may not have dampers on them because you are not trying to confine atmospheres now but rather you are trying to deliver water to cool the fire down.

If it is a CO-2 cooled compartment then you have to put tight dampers and try to tighten the room up to let the CO-2 do its thing.

MR. QUINTIERE: The thing is it's not to say that there is a smoke hazard. It's not to say that really the fire might last for three hours. It's to say that if you adopt an approach like this you might find out what the equivalency is for that space to a furnace curve and you may find that the fire is not likely to last that long because of these things.

Now one might have to consider fire-fighting when they open up a door --

MR. MICHELSON: That's the part that worries --

MR. QUINTIERE: -- but there is a way in which you can estimate all of these things and relate it back to your system. There may be a smoke problem.

MR. MICHELSON: I think that is very important for those people who propose to use manual means of mitigation or at least as these main back-up to whatever automatic means were provided. Opening doors is perhaps bad news in these situations. That you'll have to do by looking at enough parametric studies.

MR. QUINTIERE: Yes, but you have to put out the fire, though, Carl.

MR. MICHELSON: Yes, you're damned, you're caught, but that means maybe you have to have better automatic mitigation.

MR. QUINTIERE: Or you might want to anticipate what is going to happen when you open up that door.

MR. MICHELSON: Yes. You don't want to be surprised when you open it up.

MR. QUINTIERE: You don't want to be surprised.

MR. MICHELSON: Yes, you may find that the hot gases are coming out.

MR. QUINTIERE: I think that's the key word, and it's a good one. Somebody that worked for a company that dealt with materials in the area of, you know, performance of materials relative to fire retardants and things like that, said that his job was to ensure that the company was not surprised.

I really think that is a very good point. You really don't want to be surprised in any of these situations.

MR. MICHELSON: Now the water mitigation may be actually a foam-type system or may be a straight sprinkler system and I guess you from your studies can tell which might be the preferred means from the viewpoint of what is happening.

MR. QUINTIERE: No, I mean I can't -- suppression has been not studied in a scientific way to any great extent, all right? There have been some studies and I haven't done any work directly in that area and I know what is in the literature and there's a lot of different suppression agents. They all work but these models are really not going to give you an answer there.

MR. MICHELSON: But that is an important consideration because when you talk to all the experts out there and there's lots of them and each one has his own idea of what's right and wrong in terms of suppressing this type of a fire situation, there are those who swear by water and those who say water is no good, you have got to use foam. Others are saying that is not any good, you have got to use CO-2 and there's a whole complement of possibilities.

I am confused as to which is acceptable or not acceptable.

MR. QUINTIERE: I think they'll all work provided you can get the right amount of that agent to the material.

MR. MICHELSON: Well, what have we really learned so far? You have shown that it might be possible to model such situations so we can better understand and incorporate all the phenomenon that are occurring at that point in time.

Have you actually drawn any conclusions thus far though or any directions in which you think this thing might be going?

MR. QUINTIERE: No, because I haven't taken this model to the point of exercising it against particular spaces and imagining the scenarios that could occur there from the standpoint of what is likely to burn and how that fire is intended to be mitigated and suppressed, all right, and what is adjacent to that space and how critical is that, so there's a lot of issues there that can be addressed with approaches like this.

An approach like this is relatively novel in the field of fire protection engineering.

MR. CATTON: But if we are going to go to a risk-based fire protection regulation, we're going to have to do it.

MR. QUINTIERE: Also, if you want engineered safety, fire protection is going to have to embrace approaches like this and if they have any doubts they are going to have to evaluate it and bring it up to the level so that it can be done in the same way you address other issues in this field.

MR. SEALE: Are there any -- is there let's say a history or however you want to say it of test results that you might be able to check your model against? This is not a terribly sophisticated arrangement.

MR. QUINTIERE: Right.

MR. SEALE: I would think that you might at least have constants or something like that.

MR. QUINTIERE: In the report there is a small-scale study of liquid fires in spaces that are tightly ventilated. For this particular arrangement with the vent on the top and the bottom, I don't think there's been any studies like that.

We have a demonstration little compartment at the university where some people have just done things like that and you do get this pulsating pressure phenomena but no measurements have been made.

There's a whole host of fire models that people can buy and try to exercise things like that but, as I said earlier, if you wanted to go change the fire to something that is going to decrease with oxygen, it's not in there. If you wanted to put in the effect of water evaporation it's not in there -- and then it really challenges the user to figure out how to change it. Most of the time the user can't change it. He only has a user-friendly interface. He doesn't have a connection back to the program.

MR. DAVIS: The concern I would have, and this is a scenario that I think is probably the most risk-significant is you have a situation where the diesel is demanded to start. Just having a fire in a diesel compartment is not a particular problem unless the diesel --

it needs to run and I think the diesel would be a source of ignition. The running diesel vibrates, say, a fuel line, off and you have an oil leak and now the fire starts. In the adjacent compartment the other diesel is running and the question is can the smoke now affect the other running diesel because you need at least one of the two diesels to continue running?

I am not sure how one would analyze that situation, but the smoke can get into the air intake of the other diesel. Would that be a problem?

MR. CARROLL: Sure, but normally air intakes are quite remote from the --

MR. DAVIS: But the diesels are close together. Now you might get smoke coming into the other diesel compartment and affect the electrical gear or something like that. I guess that would be a potential problem.

MR. QUINTIERE: Yes, and again you have to look at that specific situation and you would have to say how can I address that by using models like this or modifications, obviously, of models like this so I can take into account the next space and maybe I can put some more physics in this model that are not there now that can make it more realistic and pertinent to that space.

That's the only thing I am trying to say with this presentation. I tried to address what was asked of me and I couldn't see how to do that by just sort of reading the literature and coming back and telling the story. I tried to put this in the form where we're saying here is the way that you can actually solve some equations that could get from an engineering point of view some answers.

Now the question is should this be applied, you know, in a deeper way and in a specific way to look at some of these issues, because we could sit around a table for the next 10 years. If that is not done, either by analysis or by experiment, we're always going to be wondering whether it is a problem or now and it may or may not be.

MR. MICHELSON: I think one of the important things is to use this sort of approach to decide whether certain arrangements are acceptable.

For instance, on the ABWR we have the diesels inside of the reactor building. Furthermore, we have double doors from the -- not double, double-wide doors from the diesel compartment to the rest of the reactor building.

The question is, are we going to be able to confine whatever is going on to the one compartment so indeed it doesn't affect what has to happen in the rest of the building to obtain appropriate safe shutdown.

It is hard to evaluate the goodness of those doors under these kinds of conditions. I just don't know how to even go about it. I'm just saying that a three-hour door doesn't lend me total comfort by any means and furthermore, you have got to ask how you are going to open the doors to get in to do things, just as mitigate the fire. Well, you've got some automatic suppression and you have to ask, well, is that enough, will that do it all alone?

This model of course doesn't help you much in that regard. It may give you some idea of what is going on but if the pressures in the room are sufficient so the operators can't open the doors to get into the room to mitigate the fire, that would be a little troublesome, too, which is a possibility depending on what the pressure history of the room is going to be.

MR. CARROLL: We have to move ahead on this CE System 80+ review.

MR. CATTON: Doug, could you get copies of the report for anyone who wants them? If you want a copy of the report, just let him know.

MR. BRANDES: I have an extra copy if anybody needs one.

MR. MICHELSON: I think when we look at the System 80+ arrangement we have to look at such things as these sliding doors that they are going to use between the nuclear complex and the diesel compartment from the viewpoint of smoke migration and so forth, to make sure that isn't a real problem. It is a practical issue.

[Slide.]

MR. CROM: I'm Tom Crom from Duke Engineering. I am going to lead the presentation on the fire protection System 80+. However, I have two experts in the back, Doug Brandes from Duke Power Company, who has been involved in fire protection many years, was here before the ACRS on Catawba when we were going through licensing process then, and handles all the fire protection issues in all the Duke plants, not only for nuclear but all the fossil plants.

I also have Les Ingles from Duke Engineering who previously worked on Catawba, has recently been with Duke Engineering working on fire protection on Bellefonte Nuclear Station and also been doing a significant amount of work doing fire hazard analyses and stuff on Savannah River.

Both of these have been very active on NFPA code committees and can answer just about any fire protection question.

[Slide.]

MR. CROM: Just quickly, most of these type of things, the goals in our design is, of course, the traditional: to prevention radioactive releases from a fire, prevent core melt, prevent personnel injury, maintain unit availability, and protect the capital investment of the plant.

[Slide.]

MR. CROM: Our design basis objections, of course, is to prevent the possibility of a fire affecting redundant division of equipment required for cold shutdown; prevent a fire-induced LOCA; and prevent interaction with other system which could lead to a fire-induced LOCA.

We also want to provide adequate access and egress for personnel protection; provide sufficient compartmentalization to preclude damage to redundant equipment; provide fixed systems for prompt fire detection and suppression; and also cover manual fire fighting for suppression as well.

[Slide.]

MR. CROM: We also, as we just heard from Dr. Quintiere -- and that was a very good paper, Dr. Quintiere. We read it and we have really no disagreements with it. It think it was very good. We can address on how we handle smoke control in our design and we think that we have a lot of good answers for you.

As I said here, we address smoke removal for manual fire fighting and prevent migration of smoke beyond the fire area of origin.

We also then, besides the current regulations that are in NUREG-0800, the Branch Technical Position addressed the positions in SECY 90-16 in fire protection.

[Slide.]

MR. CROM: Basically, we can go over this slide. Other than SECY 16 and the standard review plan, we also looked of course to Generic Letter 8610 which clarifies a lot of the issues on Appendix R.

[Slide.]

MR. CROM: We will talk a little bit about how we handle safe shutdown following a fire. My first bullet: we obtain -- cold shutdown can be accomplished using one of the two safety related divisions.

I think it is important point here because it is a lot different than current plants where it may need multiple shutdown paths. We credit either Division 1 or Division 2, and we fully protect those. That is a point to keep in mind particularly when we talk about remote shutdown and things like that. We are not talking about multiple shutdown paths. We are only talking about Division 1 or Division 2.

It can also go all the way to cold shutdown, can be accomplished from the control room or the remote shutdown panel, and when we do go to the remote shutdown panel, we go all the way to cold shutdown from there, and we do not have to access operators in the plant to go from hot standby to cold shutdown. That is another important point.

Cold shutdown can be accomplished without making repairs. That is the difference between current plan where Appendix R allows you to stay at hot standby and then you will be able to go out and do repairs. We do not do that in our fire protection strategy. We ensure that there is adequate protection to go all the way to cold shutdown without repairs.

Again, no manual actions are required. When I say that, it is basically no repairs and all the action in the remote shutdown panel are exactly going to cold shutdown the same way as in the control room. The only thing that has to be done is the transfer switches at the two control room doors. The six transfer switches have to be switched in order to switch the control room to the remote shutdown panel.

MR. MICHELSON: Are you prepared to talk just a little bit about how you are looking the control scheme then between the main control room and the shutdown room?

MR. CROM: You are talking about your question on separation?

MR. MICHELSON: Yes.

MR. CROM: Yes. I can address that. I have a later bullet that I want to address that on.

MR. MICHELSON: All right. Thank you.

MR. CROM: It is coming up, I believe, on the next slide.

[Slide.]

MR. CROM: As far as separation, outside

containment, we provide three-hour barriers. Let me just throw that up, the one elevation.

[Slide.]

MR. CROM: Of course, we have talked over and over again, our main barrier being the divisional wall. We also provide three-hour barriers within the division as required by the Branch Technical Position, and also we consider the quadrant wall to be a significant barrier when we talk about risk-based fires.

We will talk about it a little bit later, and how our separation is done there for risk-based fires.

MR. MICHELSON: When you refer to barriers, of course, you are referring to the ability to confine the spread of the fire, not necessarily a barrier for heat, smoke, or even flame?

MR. CROM: That is correct. We agree with everything that Dr. Quintiere said. That the barriers -- I think Doug might want to say something on that.

MR. BRANDES: Yes. Doug Brandes. The barriers are also qualified, particularly everything but the doors for heat as well as flame.

MR. MICHELSON: They are qualified for heat by the testing, of course. But we are talking about heat transfer now. They are not qualified for their ability to bar a heat transfer from one area to another. Like the doors aren't qualified as heat barriers, they are qualified only as fire barriers. If you are just using the 152 test.

MR. CATTON: Do you understand the difference?

MR. BRANDES: Yes, sir, indeed I do. This might be esoteric, but the doors are not qualified for heat because you don't expect anything to be stored directly against the door.

MR. MICHELSON: That is right. And from the viewpoint of propagation of the fire, that is an important consideration, but I might have 10 feet away from the door electronic equipment that has to be kept sufficiently cooled.

MR. CROM: Let me address that later as we do not. That is an important point again. It is the same question on smoke. When I get to the slides on smoke migration and even some of the doors, we will talk about that.

MR. LINDBLAD: You spoke of a three-hour barrier as required by the branch technical position. Have you done engineering evaluation as well, or what is does your fire experience judgment tell you as to the necessity or the adequacy of three-hour barriers versus anything else?

MR. BRANDES: The barriers that we are using in the System 80+ are generally of masonry. They are concrete or in some cases concrete block which have good fire resistive characteristics at any temperature, so we have not done an engineering analysis similar to what Dr. Quintiere proposes.

My personal view is that is the method that should indeed be used for fire hazards analysis to validate your selection.

MR. LINDBLAD: What method is that? I'm sorry, I missed the point.

MR. BRANDES: To calculate the potential heat release due to a fire and mathematically impress that heat onto the barrier material and assess the heat transfer.

MR. LINDBLAD: I guess I ask you again. If the Branch Technical Position had not identified three-hour barriers as being adequate, what do you think you would have come up with?

MR. BRANDES: That is kind of a hypothetical question because there is a design standard --

MR. LINDBLAD: No. It is an engineering question, as distinguished from a licensing question.

MR. BRANDES: Let me answer it this way, if I may. The other practical consideration for walls, barriers, et cetera, are things like resiliency, cost, et cetera. Our experience in our plants is we would use masonry. We have had experience with gypsum board, for example, that is not good for power plants, so we would use something very much similar, I believe.

MR. MICHELSON: Most people are worried about masonry wall for any of this fire consideration. The worry is the penetrations of the masonry walls with doors, electrical, piping. That is where the crux of the problem is. To just get the penetrations fixed, I think we are okay because masonry walls indeed are quite substantial.

MR. CROM: We must answer the question on doors right away since that seems to be one.

MR. MICHELSON: Yes. That is in my mind.

[Slide.]

MR. CROM: Some of these slides, these are ITAAC slides, and let's look at where some of the doors are. What I want to point out is everywhere we have a door through a divisional wall they are marked by the dots here for ITAAC figures.

Some of these ITAAC figures don't have all the fire barriers that we have on. I will mention that.

They are only the ones for the Branch Technical Position. We have a lot of other fire barriers, per our fire hazard assessment, we think are just good ideas We have two-hour barriers for life safety and so forth and so one.

But everywhere we have located a door, it goes into either a maintenance aisle or a maintenance access where electrical equipment or anything like that that is safety related would have to go through another door.

So both from smoke migration or from the flames coming through there, there will not be any affect on any safety related equipment.

Yes, we agree that there may be some smoke migration through there, and yes we agree there may be some flames and there may be some heat. But if you look, like in this area here, where the electrical equipment is located, there is another fire barrier and another fire door that it has to go through, and that has been reviewed in our fire hazard assessment in much detail to ensure that the doors going through that divisional wall do not have essential equipment on the other side.

MR. MICHELSON: Lead me through one of those with the pointer.

MR. CROM: Okay. For example, here is a door and divisional wall. Here is a door, and then there is one back in between the control complex.

Let's take a diesel generator fire, since that was an example. Here is the diesel generator room; here is the diesel generator room. If we had a fire in the diesel generator room, if we have two door, it migrates into a maintenance access aisle.

MR. CARROLL: By definition there is no important equipment in --

MR. CROM: That is correct.

MR. CARROLL: It is just empty space?

MR. CROM: That is correct. Now, we do require the COL applicant to do a detailed fire hazards analysis to ensure that there isn't it the detailed design, but as far as the design is right now, there should not be anything there, and we preclude it.

MR. LINDBLAD: Are there conduit runs?

MR. CROM: Conduit runs?

MR. LINDBLAD: Yes.

MR. CROM: Yes. And we will talk about that a little bit. How we separate the two electrical buses within a division with conduits and that type of thing.

But again, to illustrate, even though there would be some smoke migration through this door, it would have to propagate all the way down through this aisleway, up through this door. It would have to pass through this door, and, again, we are going into another maintenance aisleway. Then it may have to penetrate -- here is the electrical room -- it would have to penetrate either one of these two doors.

So we are talking multiple doors that we would have to have smoke migration through to get to the other division.

I think that is our main point on smoke migration, heat on doors, and that type of thing.

MR. CARROLL: Typically, these are all solid doors? Do they have louvers in them for ventilation?

MR. CROM: Doug, can you answer that question?

MR. BRANDES: Yes. They will be probably hollow metal doors, and probably the only gap is up to three-quarters of an inch that is permitted under the door, between that and the floor.

MR. CARROLL: Okay.

MR. DAVIS: While we are on this separation issue, we toured the Palo Verde plant last month. I noticed that in the electrical-driven emergency feedwater room they had cable routed through there that went to the steam turbine-driven emergency feedwater pump for control, which brings up the problem that if you had a fire in the electric motor-driven room, you might burn the control cable to the steam turbine. It was covered with Thermal Lag, but we all know about that problem.

MR. CROM: The answer is no, and I will talk about that in our quadrant separation.

MR. DAVIS: You won't allow that situation to exist from this plant?

MR. CROM: That's right. We specify on those pumps that they have been coming off of different electrical buses and that the cables do not pass through that quadrant barrier.

Even from the diesel generator, we have one of the -- of course, the diesel generator is a common fire area, but we have cables going to one of the electrical buses in that division, routed through the space. Another one goes a conduit. So they are separated by three-hour barriers fully.

MR. DAVIS: Thank you.

MR. CARROLL: Pete, I think you have to keep in mind that although Palo Verde is a combustion engineering and SSS, it is a Bechtel balance of plant, and the problem you saw was probably a Bechtel --

MR. DAVIS: Yes. I just wanted to make sure there was some way to prevent it in this design.

[Slide.]

MR. CROM: Next one. Of course, outside of containment we also handle control room fires. We separate -- the control room is separated from the remote shutdown panel with three-hour fire rated barriers and are physically and electrically isolated from each other.

Again, when we go to the remote shutdown panel, of course, we would have both divisions available at that time since it was a control room fire, and we can shut down with one of the two divisions or we can shutdown with both from the remote shutdown panel.

Inside containment and annulus, we require cables for safe shutdown to be mineral insulated and three-hour rated. We also have redundant shutdown paths are separated either by reinforced concrete walls, a component such as a steam generator or pressurizer.

What I am particularly talking about there are the instruments, the level taps, and those type of things that are in quadrants on the four channels around the equipment.

Also -- and there is only one instance, and we say here a spatial separate of at least 20 feet with no intervening combustibles. In our review, the only situation we had like that in the design is the shutdown cooling isolation valves, and they are over 100 feet apart inside the containment, and 180 degrees apart.

MR. CATTON: Mineral insulated, does that -- that doesn't mean armored cable, does it?

MR. CROM: No. It is mineral insulated cable. We have used it on Catawba. We have experience with it. It has a UL rating, and we can get it as a three-hour barrier.

Doug, do you have anymore you want to say on that? We will leave it at that.

MR. MICHELSON: What is it jacketed with?

MR. CROM: I think Doug has the answer to that.

MR. BRANDES: It is a copper-nickel element.

MR. MICHELSON: The jacketing then is a braided cable jacketing or something?

MR. BRANDES: No, sir. It is a solid jacket.

MR. MICHELSON: It is solid? Well, it is armored then.

MR. BRANDES: Yes.

MR. MICHELSON: Well, I thought the question was asked --

MR. CROM: Maybe I misunderstood. We had one we used to call armored cable in Catawba. It is not the same as we used on Catawba.

MR. MICHELSON: It is just a question of what the armoring is. That ought to be pretty good stuff.

MR. CATTON: Charlie will be happy.

MR. MICHELSON: He ought to be very happy.

MR. CROM: Yes. Charlie was the one that put it in on Catawba, so I know he will be happy. He went through the full testing programs.

[Slide.]

MR. CROM: We also have additional three-hour rated barriers provided for property protection. What I am talking about is like from the nuclear annex of the turbine building or nuclear annex from the rad waste building, or any of the adjacent structures.

The point is the need for a cable spreading room has been eliminated due to fiber optics.

We do have four cable chases separated by three-hour barriers for each of the electrical channels.

This is probably the good point for me to answer your question, Mr. Michelson, on the remote shutdown panel.

MR. MICHELSON: I have one on what you were just talking about. What is the highest-rated cabling going into the control room. You must have some amount of instruments, power supplies and so forth that you have got to power. I suspect they are 125?

MR. CROM: I think they are 125. Ken Searola. He would be the one to answer that.

MR. RITTERBUSCH: This is Stan Ritterbusch. That was the correct answer. It is 125. We have summarized our answer in the response package that we handed out yesterday.

MR. MICHELSON: Which answer was it? I must have missed it. I looked for it.

MR. RITTERBUSCH: I will find it and give it to you at the break. But Ken Scarola will be in later on today if you have any further questions.

MR. MICHELSON: If I recall the answer I read in here, it didn't tell me what the powering on the cable was. Is this a 20-amp branch circuits or 30 amp, 10 amp, five amp, what is it? 125 volts helps partly, but that doesn't tell me how much energy I have. I've got to know how big the cabling is, the power behind it.

MR. CROM: The four cable chases I am talking about are these right here, one for each of the channels. Of course, those would be routed up. This is the remote shutdown panel; I'll get to that next.

Once it gets to the control room, we run each channel in the floor, which is a three-hour rated floor, in conduit to the control panel, so they are all entering the control panel separated.

MR. MICHELSON: There is matrix and conduits underneath the control room embedded in concrete?

MR. CROM: That's correct.

MR. MICHELSON: Okay.

MR. CROM: The same is true for the remote shutdown panel. We can bring the two channels of division one separated into the remote shutdown panel. Now, the two channels in division two are embedded in the floor and separated in conduit. That was your question from last --

MR. MICHELSON: The real question is, how are you lashing this together? If you are going to control from two different potential points to a single device, you have to decide how to route the control cabling, the control priority and so forth. Are you going to go to the control room and then branch out to the backup control center or are you going to go to some third point and branch to both the control room and the backup control center? What's your philosophy? How do you look --

MR. CROM: Again, Ken addressed that when we talked about the transfer switch. It is an umbilical cord.

MR. MICHELSON: But that was just for one particular group of equipment though, if I understood it.

MR. CROM: No, that's the whole -- when you hit the transfer switches, you transfer the whole control room to the remote shutdown panel.

MR. MICHELSON: And if I recall, he was going to put the transfer switch outside the control room.

MR. CROM: No, it's in the control room at each of the doors. There are six switches.

MR. MICHELSON: That means you have to loop through the control room to the backup control center.

MR. CROM: No, no, no. The operator --

MR. MICHELSON: But if the fire is at the switch, what happens?

MR. CROM: Goes to the other door.

MR. MATZIE: Regis Matzie. There are two doors and two sets of transfer switches. Either one of which will --

MR. CROM: Let me address that. That was an issue with NRC as well.

We do credit in our safety related mains the transfer switches at either doors, and they are on opposite sides of the control room. If, for some reason, and we think it is very unlikely that he can't get to one or the other, that he cannot get to those, he could do it at the equipment rooms.

MR. MICHELSON: No doubt.

My question is, if you are going to have two transfer switches, one on each side of the room if that's the model you're using, what happens when you burn up one of the two transfer switches?

MR. CROM: We address that also with NRC. The worst thing that can happen is you transfer to the remote shutdown panel.

MR. MICHELSON: You transfer to the remote shutdown panel?

MR. CROM: That's correct.

MR. MICHELSON: From the fault created by the fire?

MR. CROM: That's correct.

MR. MICHELSON: But you do not interfere with what the --

MR. CROM: That's correct. The worst thing can happen with the fiber optics is that you transfer --

MR. MICHELSON: You'd really look at all the details of that one. But I guess the Staff did and they're satisfied that a fire on one of the two --

MR. CROM: We provided a very detailed report to them on that.

MR. MICHELSON: I will take their word for it, I guess. Thank you.

MR. CARROLL: So the destruction of the switch by a fire is -- subjecting the switch to a fire is a bimodal situation, there's nothing in between. It either at some point makes the transfer happen or it stays connected?

MR. CROM: That's correct.

MR. MICHELSON: With fiber optics that might work, but it wouldn't work with hard wires.

MR. CROM: I agree.

MR. CARROLL: You just melt the fiber and --

MR. CROM: -- and it does the transfer.

MR. CARROLL: Is there some way to purposely melt the fiber?

MR. MICHELSON: There's a lot to this thing --

MR. CATTON: If you just heat it up, does it get foggy?

MR. CROM: We need -- Ken Scarola is the person to answer all these questions.

MR. CARROLL: It's a good thing Ken is coming.

MR. DAVIS: The PRA says you can't have a fire in the control room anyway.

MR. CROM: That, I think, is addressed on another question. That's not really a true statement, per se. You can have a fire in the control room. I saw people throwing paper here and I thought that's what they were trying to indicate.

[Laughter.]

MR. SEALE: No surrender.

[Slide.]

MR. CROM: The last one we talked about, all fire barriers are listed and improved fire doors are equivalent for the appropriate ASTM in FPA standards.

[Slide.]

MR. CROM: We address the spurious operation valves and containment are protected by one or more of the following means.

First, we provide two valves provided in series with power from different electrical control channels. The power to these valves are normally energized at the MCC breaker. In other words, the MCC breaker is open and those MCC breakers are, of course, located outside containment.

Also, the MCC, the channelized motor control centers, are located outside containment and are separated by a three-hour barrier. In other words, they are in different quadrants of the building when we come out.

We also channelized the motor control centers -- excuse me.

Also, we have two situations where we have to have breaker removal. That is fewer situations than we have in current plants. The two situations where we have breaker removal are one on the accumulators or the safety injection tanks vent lines. We remove the power from those particular valves because there is only a single valve there.

Also, on the seal return lines coming out of the reactor core and pump seal returns, there is a valve there we don't want to close and remove the breaker on that. Again, neither of these are any safety related functions, they're just to maintain the pressure boundary and the flow paths in that particular system.

[Slide.]

MR. CROM: I touched on this --

MR. CARROLL: It has been my experience this idea of racking out breakers has often resulted in some compromises that I always haven't approved of.

MR. CROM: I agree with you. What we have here is we don't have anything where we have safety-related functions like shutdown cooling valves and things like that, in order to shut the plant down you've got to go out and send an operator out and put the breaker in before you can do that. We have none of those situations.

The valves we are talking about here are maintenance valves. We just want to ensure that they don't spuriously open to the wrong position to prevent safe shutdown.

MR. CARROLL: When you say power to valves is normally deenergized, breakers open at the motor control center --

MR. CROM: That means the cable going into containment has no electrical power going through it.

MR. CARROLL: But can I operate that from the control room?

MR. CROM: Yes, you can.

All it says is that it is normally -- once it has been positioned, the breaker is open and therefore you don't have a hot short that's going to change its position.

MR. CARROLL: Got you.

MR. CROM: Now, once the operator wants to change the position, then it will of course close and then energize it.

As far as additional separation, and this is beyond really our design bases, but just from a risk standpoint we want to ensure we have additional fire separation. Of course, you have seen our reactor building subsphere is divided into quadrants with three-hour rated walls within a division, each safety injection pump, shutdown cooling pump and containment spray pump which are interchangeable.

In the Class 1-E 4160 volt switchgears, along with associated cabling -- and I did not mention it but there is also an emergency feedwater pumps on your question -- associated cabling are separated by three-hour barriers. In other words, we run from each of the switchgear within a division we separate that cable by the three-hour quadrant walls.

The cables from the diesel generator room to each of those switchgears with the division are also separated. That is where I was telling you we run one of them through conduits so that we keep it in a three-hour barrier in the floor and the walls.

I just noticed Ken Scarola is walking in, so maybe he can answer some of your previous questions.

MR. RITTERBUSCH: We will give him a chance to get adjusted to the atmosphere.

MR. CROM: An additional thing is that the permanent X and Y switchgear and alternate AC source, the combustion turbine, are located in different buildings from the Class 1-E switchgear and diesel generators so they are in different fire areas. We also separate the permanent nonsafety switchgear X and Y buses by the division wall.

What I am trying to say here is we can have a fire and still meet single failure, which is not a design-based requirement from current NRC regulations, but we can do it in our design.

MR. MICHELSON: Now the divisional wall you are referring to at this elevation is not the hardened divisional wall referred to down at lower elevations.

MR. CROM: Yes.

MR. MICHELSON: This now has doorways through it and penetrations and so forth?

MR. CROM: Yes, but they are all three-hour rated.

MR. MICHELSON: Yes, a nominal three-hour.

MR. CROM: Yes.

[Slide.]

MR. CROM: Now on to smoke control. First of all, ventilation systems are designed in accordance to NFPA-90A which is mostly dealing with fire dampers and so forth, and also NFPA-92B, which is Guide for Smoke Management Systems. That is more of what you have to size your particular fans for as far as smoke removal.

We also separate ventilation systems in each division of the nuclear annex thus that there is no duct penetration through the divisional wall. I want to clarify that there is two exceptions, but these ventilation systems are not your normal ones where you have intakes and exhaust into each room.

The two exceptions are the control room, since the control room ventilation system has to be able to take intake from two sides of the building, we have to run that intake through the divisional wall to get to both divisions. We do provide a fire damper and a smoke damper on that particular penetration.

The other one is the fuel building exhaust, again, that is going into an area that is neither really Division I or Division II, it is a common area. But to separate the two divisions of the fuel building exhaust, we do have them on opposite sides of the divisional wall, and of course there has to be a penetration into the fuel building.

MR. MICHELSON: Just to be sure, your normal ventilation, is it also your emergency ventilation for these various areas?

MR. CROM: Of course, the control room, yes.

MR. MICHELSON: No, I talking about out in the nuclear annex.

MR. CROM: The nuclear annex itself, the ventilation system is a nonsafety system.

MR. MICHELSON: Now that nonsafety system, though, is divisionalized?

MR. CROM: Yes. We do not provide any -- the two divisions do not have any shared ductwork.

MR. MICHELSON: So you just have divisionalized nonsafety normal ventilation.

MR. CROM: That's correct.

MR. MICHELSON: Then emergency is local air handling units through the chilled water systems?

MR. CROM: That's correct.

The subsphere building ventilation, we will talk about ventilation systems. Of course, the exhaust is safety-related. Collecting the pump leakage, it is also divisionally separated with no ductwork on the divisional wall.

Finally, control room and remote shutdown rooms have separate HVAC intakes so that for fires outside, we are not pulling in smoke into the same intakes.

[Slide.]

MR. CROM: We also have stairways between the control room and remote shutdown rooms are pressurized to have pressurization fans so that we do not get smoke migration between the two elevations.

We also have smoke purge fans in the control complex ventilation system. I mention the control complex because there is where we don't have once through ventilation systems. There are just intake air and some recirculation. We have smoke purge fans to prevent migration from one channel to the other channel within a division. In other words, each room has a smoke purge fan.

If there is a fire in that particular area, we can start the fan to purge smoke out of that particular room within a division to prevent it from migrating to other channels.

MR. MICHELSON: How assured are you that the smoke removal equipment is not also involved in the fire and, therefore, doesn't remove the smoke?

MR. CROM: It is located outside of the fire barrier. The fire barrier for that particular room.

MR. MICHELSON: Everything is outside the compartment you are trying to evacuate?

MR. CROM: That's correct.

MR. MICHELSON: Is there some place that it says that so the COL holder does it that way?

MR. CROM: Yes.

Smoke purge for the containment, subsphere and fuel pool area nuclear annex in the diesel generator rooms is basically accomplished by the 100 percent supply and exhaust ventilation systems. Since those are once through systems, we can purge the smoke directly from those systems with the exhaust.

MR. DAVIS: Are those systems on an emergency power?

MR. CROM: The subsphere and fuel pool, yes, the exhausts are. The nuclear annex is, I believe, on the combustion turbine but not on the diesel generator.

MR. MICHELSON: But that is a nonsafety system, though.

MR. CROM: That's correct.

MR. MICHELSON: So you don't know whether all the dampers and everything -- I don't know if you are using air operated dampers or electric operated dampers or whatever, are all your damper controls on emergency power, whatever their mode of power might be?

MR. CROM: The answer is no.

MR. DAVIS: The concern I have is, if you have a loss of offsite power and you need diesels, will this system still provide the purging for the diesel generator room?

MR. CROM: The diesel, yes. The diesel is an emergency system. We will get to that.

MR. DAVIS: I know the diesel is.

MR. CROM: I am talking about the diesel ventilation system is an emergency safety-related system.

MR. DAVIS: Thank you.

MR. MICHELSON: He is talking about purging the room, not just cooling the room.

MR. CROM: As far as the diesel room itself, the ventilation fans in it -- we will get to ventilation and you will understand it more. They are actually just two exhaust fans that pull air through, and they will be used for the smoke control and smoke purge there, and they are on the diesel generator.

MR. CARROLL: It looks like you are going to a new topic, suppression systems.

MR. MICHELSON: We have these various questions, are you going to do those all as a separate set?

MR. CROM: I have a slide. I am going into suppression systems right now and fire protection.

MR. CARROLL: I was thinking, break.

MR. CROM: Okay. When I go to suppression systems, we have the question on diesel, I have some backup slides, and we can address that.

MR. MICHELSON: Are you going to cover those under these topics or do them as a separate --

MR. CROM: I would do it right now.

MR. CARROLL: Let's kill them while they are fresh.

MR. CROM: My fire protection guys, they can be done for the day and leave.

MR. CARROLL: All right. So let's return at 10:25.

[Recess.]

MR. CARROLL: Let's reconvene.

Tom, do you want to?

MR. CROM: Yes, I am ready.

MR. CARROLL: Let me say that the plan is that we will stop wherever we are at 11:00 and go into our closed session to talk about steam generator issues, and pick this up this afternoon.

MR. CROM: Okay. I am hoping we will have fire protection done by 11:00.

MR. CARROLL: Do we want to deal with the Scarola questions at this time?

MR. CROM: He said he had one he is still calling back to Windsor on, and he just requested that we try to address it right at the very end of mine.

MR. CARROLL: Let's go.

[Slide.]

MR. CROM: What I want to talk on now is suppression systems. The main point I want to make, we have no gaseous suppression, we have no CO2, no halon. We think that is a good point in our design because of the hazards that we have seen, personnel hazards from CO2 systems.

We have water-based preaction sprinklers. Some of the points about that is water damage due to pipe rupture and leakage is minimized. That was the resolution to a generic issue for deluge systems is to change those over to preaction systems. We protect all the areas of regulatory concern, basically everything in the BTP we provide automatic preaction sprinklers as specified in the BTP.

MR. MICHELSON: Now how do I know where these sprinklers might be located from looking at just the SSAR?

MR. CROM: The SSAR and we also have the Fire

Hazards Assessment that has the locations. The Fire Hazards Assessment is about --

MR. MICHELSON: Which chapter is the Fire Hazards Assessment?

MR. CROM: It is not in the SSAR, it is a separate document on the dockets about ten volumes.

MR. MICHELSON: In other words, you have just gone through and done the room-by-room inventory of what is in there now is protected, and so forth?

MR. CROM: Yes.

MR. MICHELSON: I hadn't seen that.

MR. CROM: It is on the docket.

MR. MICHELSON: That is one more piece of paper.

MR. WAMBACH: We will get a reference for you and give Doug the microfiche numbers.

MR. MICHELSON: But you do know every room that is sprinkled?

MR. WAMBACH: Yes.

MR. MICHELSON: And every one of them will preaction, no other types?

MR. CROM: That's correct.

MR. CARROLL: Now combustion in those last couple of days has mentioned separate reports of various kinds, this being one of them, and said, that is on the docket. Has the staff agreed with every time they have said that it is on the docket?

MR. WAMBACH: Yes, sir.

MR. MICHELSON: And that means it is, in effect, part of the Tier Two material?

MR. WAMBACH: No. The Tier Two material will be what is in the SSAR. Now, if there is a reference to the material in the SSAR, that reference is in Tier Two, but the document itself is not included unless it is directly referenced in the SSAR.

MR. CROM: This is directly referenced in the SSAR because we say the COL applicant has to complete the Fire Hazards Analysis using the Fire Hazards Assessment as the starting point.

MR. CARROLL: Didn't yesterday we hear about a flooding analysis that was in the same category?

MR. CROM: I don't know if the flood analysis is referenced in the SSAR or not.

MR. MICHELSON: Is there a flood analysis available, has the staff seen a real flood analysis?

MR. WAMBACH: Yes, sir. If it is on the docket, we have seen it.

MR. MICHELSON: I could get a copy of it, then?

MR. WAMBACH: Do you want to reference them for both the Fire Hazards Analysis and the Flood Analysis?

MR. MICHELSON: And the Flood Analysis, right, and then we have got it.

One more question, if this is not a part of the certification process, which it wouldn't be if it is not even in volume two -- I mean in Tier Two rather, how do we know that these are design commitments?

MR. CARROLL: No, Tom just said that, for example, this one --

MR. CROM: This one is. Fire Hazards Assessment is sort of a living document. What it is is, we have taken the Fire Hazards Assessment, and we have gone as far as we could in a detailed Fire Hazards Analysis, and we know you have to go further, and we have outlined all the methodology in the front of it. I have some slides to show you everything in it.

MR. MICHELSON: Is the ITAAC going to pick it up then and make sure it is completed?

MR. CROM: The ITAAC says the detailed Fire Hazards Analysis has to be completed by the COL.

MR. MICHELSON: What I am really concerned about is whether or not the detail has to be carried out as initially prescribed in this first draft, so to speak.

MR. CROM: We say that the COL applicant has to do it as outlined in thee Fire Hazards Assessment.

MR. MICHELSON: All right, that becomes a design commitment?

MR. CROM: Exactly.

MR. CARROLL: On suppression systems, Tom, historically a lot of what I will categorize as skid-mounted equipment for these purposes has included Mercoid switches, the old Cardox tanks, and that sort of thing.

MR. CROM: Doug has to know. Can you address that?

MR. CARROLL: Are you sure you have no Mercoids in the design?

MR. CROM: Doug, can you address that?

MR. BRANDES: We haven't reached that level of detail of design yet, but the industry practice is absolutely no more Mercoids.

MR. CARROLL: Okay.

MR. MICHELSON: Which industry practice are you talking about, the fire protection industry or are you talking about nuclear, because you are buying them from the fire protection industry?

MR. BRANDES: I am talking about the fire protection for the nuclear industry.

MR. MICHELSON: How do you know that is outlawed? The manufacturers still use these routinely for other applications of fire protection, but maybe not in the nuclear industry. I don't know if it has really been outlawed or not from the industry viewpoint.

MR. BRANDES: Doug Brandes. I can't tell you that it has been outlawed, I can tell you it is standard practice not to use them.

MR. CARROLL: Do you say someplace that they are not to be used?

MR. BRANDES: No, we do not.

MR. CARROLL: Should you?

MR. MICHELSON: In just a couple of words, what are you worried about? If it is going to be standard practice to do it this way, why are you not saying it?

MR. CROM: I have no problem putting that in the SSAR.

MR. MICHELSON: I would like to see it in there.

MR. CROM: I have no problem putting that in the SSAR. It is just not in there now.

Of course, we also will provide sprinklers on other areas within the nuclear annex as determined by the Fire Hazards Analysis. There may be other areas outlined in the BTP that in the detailed Fire Hazards Analysis you will want to sprinkle.

As far as standpipe systems for fire hoses for secondary protection for sprinkled areas, of course, the primary protections for unsprinkled areas and have adjustable spray nozzles are listed and used as energized electrical equipment.

MR. MICHELSON: You know, everything you do is going to be damned either way you try, but if you are going to use manual mitigation, you have to be reasonably sure that the fire you are trying to get in to mitigate that you do have access to the fire, which means it hasn't built up enough pressure to prevent you from opening the doors.

MR. CROM: That's absolutely right, and you have to train your fire brigade appropriately.

MR. MICHELSON: So are you going to prescribe that the calculations be done to assure that you don't have an unacceptable pressure build up before you get there in 20 minutes, or whatever your timing is?

MR. CARROLL: Are firemen going to carry axes?

MR. MICHELSON: These steel doors are a little hard to --

MR. CROM: I think you have to address that issue on the fire brigade. The fire brigade has to be trained to know what he is getting into when he goes in. If he knows that he is going to open a door and the fire is going to enflame again --

MR. MICHELSON: The concern is, he can't get the door open.

MR. CROM: Those doors open out.

MR. MICHELSON: Well, it depends on where the fire is as to what out means.

MR. CROM: The diesel generator which we talked about, the doors open out for life safety reasons.

MR. MICHELSON: But you have to look at all fire areas to be sure that you can get access to them. Opening out is great if you watch out for the flame, but getting in is a problem if you can't open the door.

MR. McCRACKEN: Conrad McCracken, the NRC Staff. I would like to comment that I have personal experience with three-hour metal fire doors and the ability of fire departments to get through them with axes.

MR. MICHELSON: With axes?

MR. McCRACKEN: Yes.

MR. MICHELSON: And these are steel doors?

MR. McCRACKEN: Yes. They are the three-hour metal fire doors, and you can get through them if you need to.

MR. MICHELSON: You have to do more than puncture a hole through them, you know.

MR. McCRACKEN: Yes, I am well aware of that.

[Slide.]

MR. CROM: Continuing on, our fire suppression source is -- one thing I want to note -- is a treated water source. Of course, we did that to prevent the problems that we have had on current problems in the industry on biological fouling and microbiology induced corrosion, so all our sources of water are either from wells or from municipal systems. Essentially it is a potable source that would be in the two redundant fire storage tanks. We have two 300,000 gallon tanks which are located in the yard.

We also, as far as fire pumps, we have two redundant pumps, one electrical pump which is powered from the combustion turbine, and one diesel driven pump that has an eight-hour fuel supply.

MR. MICHELSON: Are the fire tanks going to be elevated or at ground level?

MR. CROM: They will be at ground level.

[Slide.]

MR. CROM: The system also has a jockey pump that maintains system pressure so that you are not turning your main fire pumps on all the time to maintain the system pressure.

There is also a dedicated fire protection system. We use it for no other functions. We don't use it for severe accidents or anything like that. There are no connections going for other functions for this system.

It also makes sure -- and that was one of the big things that was a plus for us when we did our shutdown risk analysis, because people use fire protection systems and they are out of service during shutdown modes for doing other things. We ensure it is in operation during that time frame.

The safety related standpipe system is seismically qualified. It assures efficient water for a minimum of two hours -- a minimum of two inside hoses for two hours following a seismic event. We do this by providing a separate seismically qualified water supply tank and pump within the building. What we have is an 18,000 gallon tank in a single fire pump, power it from the diesel generator at 150 gpm. That's for our seismic firefighting requirements.

MR. MICHELSON: Where are that tank and pump located?

MR. CROM: It is in an upper elevation. It is not shown on the general arrangement right now, it is on the upper elevation close to the component cooling water surge tanks.

Of course, it is seismically qualified piping and, of course, those standpipes are supplied normally from the main fire pumps. We do have a seismically qualified check valve at that interface to ensure that there is no backflow out if the nonseismic portion should fail.

MR. MICHELSON: Are you saying that all the piping inside the building is seismically qualified, all the fire protection piping?

MR. CROM: No. What I am saying, for these particular standpipes, for those particular areas where you need seismic category one manual suppression, the piping for the manual suppression to that connection is seismically qualified.

MR. MICHELSON: What is the water treatment used, do you know?

MR. CROM: The water treatment is going to be side dependent.

You're asking what is the water treatment?

MR. MICHELSON: In the fire water system.

MR. CROM: It will be a potable water-type source. We have not specified what the actual water treatment will be. That will be site dependent on what the water makeup is.

Let me ask, is this a good time to hit the issue on the diesel suppression, because I am done with suppression and want to go on to detection.

[Slide.]

MR. CROM: Let me go ahead and hit that now. I have some backup slides.

Of course, like I think you all know, we have a preaction sprinkler system for the diesel generator room. The preaction valve is actuated on heat detection rather than smoke detection. That was of some concerns and that is in the fire hazards assessment.

We do have outlined what the heat -- it is a heat detection device rather than a smoke detection for actuation in the preaction valve.

MR. DAVIS: Where is that device located?

MR. CROM: Doug, do you know?

MR. BRANDES: The heat detectors will be located at the ceiling and there will be several of them within the room.

MR. DAVIS: The concern, of course, is that with the diesels running, it generates a lot of heat and you sure don't want the valve to open at that time.

What temperature are these set for, typically, 130, 140?

MR. CROM: Doug, do you know?

MR. BRANDES: In our plants, they're 225. But that would need to be seriously analyzed at the time they're selected.

MR. CROM: The diesel HVAC keeps the room less than 125 when the diesel's operating.

MR. MICHELSON: For your sprinkler nozzles, what are your fusible links going to be set at?

MR. BRANDES: Again, that's a design selection, but probably 286 degrees. That's a standard practice.

MR. MICHELSON: 286?

MR. BRANDES: Yes, sir.

MR. MICHELSON: That's very high.

MR. BRANDES: No, that's an intermediate temperature head.

MR. MICHELSON: For this kind of application, normally you're dealing with 170 degree links, more or less, aren't you?

MR. BRANDES: My concern is that they might spuriously actuate.

MR. MICHELSON: So you are setting the heat detectors at 286 also. You said 220?

MR. BRANDES: The heat detectors would be 225. Again, that's our standard practice.

MR. MICHELSON: What you have to worry about, if you have enough -- if the engines are running and the fire starts and you still are pulling all that ventilation air through, that's coming in at the top in your plan, I think, and you are going to cool that area for a long time while that fire's burning like mad but not being detected. That's the way you get into the problem.

Have you got the detectors in the right place relative to the anticipated air flows at the time and are you going to feed a fire and flame it and everything with air flow when you haven't even detected it yet with heat?

MR. CROM: That's true with any suppression svstem.

MR. MICHELSON: But setting it this high makes it that much tougher, that's all.

MR. CROM: I am just pointing out that it's true with any suppression system.

MR. MICHELSON: Here you have very large forced ventilation in that room.

MR. CROM: I agree.

MR. MICHELSON: It's like a wind storm in it.

MR. CATTON: I heard something about analysis. What kind of analysis are you going to do? Is it going to be a detailed evaluation of what's going on in the room?

MR. CROM: We, in our fire hazards -- Doug, you may want to -- you can address it better than I can.

MR. BRANDES: That is, indeed, a design detail. But the standard practice for selecting type of detectors and location is to look at the anticipated fire growth. As a matter of fact, using a table that's an appendix to the fire protection standard to select temperature, spacing and location.

MR. CATTON: Does this table account for the ventilation system, which sounds to me like is a little bit more than one usually has?

MR. BRANDES: It gives a guide. But you'd need a real engineering analysis to properly do it.

MR. CATTON: When you say "engineering analysis," what do you mean?

MR. BRANDES: I mean looking at rooms, specific conditions, geometries, air flows, et cetera.

MR. MICHELSON: This is a very deep compartment with the air flow coming in from the top, right?

MR. CROM: Yes.

MR. BRANDES: That's correct.

MR. MICHELSON: And you are going to get some complicated convection patterns with the heat source on the floor and cold air flowing in on the ceiling. It is not a trivial analysis. It is not one that you can do. I mean, I'd like to do it, but it's not one you can do using a handbook. As a matter of fact --

MR. McCRACKEN: Conrad McCracken, NRC Staff.

This is typically an area where we wind up with arguments with licensees as we are going through the construction, the location, detection for actuation of suppression systems. They go through and come up with their analysis, we go back and look at it ourselves. We look at it based on where we think we are going to get the high temperature areas, the amount of fuel loading and so on. That's where we do use some of the small codes that we use. It is an area where there's room to discuss when you're putting them in what the lower limits should be for detection, actuation. And we have made them change them on occasion.

This is an area where we get into on, basically, fire area by fire area.

MR. MICHELSON: I thought you were certifying this plant now.

MR. CROM: We do have both a COL action item and an ITAAC item to do a detailed fire hazards analysis and our fire hazards assessment. Now, that methodology --

MR. MICHELSON: That includes setting the detectors.

MR. CROM: I have a slide that shows everything that we're going to do in the fire hazards assessment.

MR. MICHELSON: That's fine.

MR. CROM: It's coming up.

MR. CARROLL: This raises a kind of interesting question. Why isn't this a DAC?

MR. MICHELSON: I agree. Most everything is a DAC if you want to get down to it.

MR. McCRACKEN: The difference between a DAC and an ITAAC is only in the eye of the beholder.

MR. CARROLL: Do we have that on the record?

MR. McCRACKEN: No, the record was closed for that statement.

[Laughter.]

MR. CARROLL: Moving on.

MR. CROM: Okay.

One thing that we have committed to from our last meeting was a question. We have revised the SSAR when we come out with Amendment B that says -- it's going to say fire suppression piping in the diesel generator room is designed to seismic category one criteria.

MR. DAVIS: That will include the valves and the heads, sprinkler heads, too?

MR. CROM: Yes, yes it will.

MR. MICHELSON: That didn't gain you anything unless the supply is going to be this seismically qualified supply.

MR. CROM: The idea is to present the inadvertent suppression in a seismic event.

MR. MICHELSON: But not to provide seismically qualified fire protection?

MR. CROM: That's correct.

MR. MICHELSON: Some people might infer because it is all qualified it must be -- it will operate after an earthquake. That's not true.

MR. CROM: I am looking at the situation where the preaction valve can come open due to a seismic event and the failure of the piping both.

The electrical cabinets in the generator within the diesel generator room are drip proof per the appropriate NEMA standard. Water suppression --

MR. CATTON: What does "drip proof" mean? Does it mean that it just stops rain from above?

MR. CROM: Yes.

MR. CATTON: You have a rather -- I remember the spray -- I guess it's a video that's available of the Zion containment when they turned on the sprays. Water goes every which way, including up.

MR. MICHELSON: It's even worse there, because they've got an air-cooled generator that's sucking all this wet air into it.

MR. CATTON: I'm not sure that drip proof is going to be enough.

MR. MICHELSON: No, it won't.

MR. CATTON: To protect you from your sprays.

MR. CROM: It will prevent you from damaging your -- your generator can run with some water in it for some short period of time. We will concede if you continue to run it and you continue to spray the room it will eventually fail.

MR. CATTON: Until you put the sprinklers in and do an evaluation, you will not know what they will do.

MR. CROM: We agree. It has to be done as a detailed analysis.

MR. CATTON: You get literally -- water falling through the air creates a tremendous air current.

MR. CROM: Let me address something else. It is going to be true with any suppression system.

MR. CATTON: I agree.

MR. CROM: Foam was even worse. Foam was even worse than water. It will migrate up and get into the generator and get into every crack that is in there.

MR. MICHELSON: The truth of the matter is you just can't take credit if you ever actuate the fire protection. You can't take credit for that generator period.

MR. CROM: I agree

MR. MICHELSON: Why worry much about it. Scratch it off then.

MR. CARROLL: No true of CO2.

MR. CROM: But CO2, you now have to worry about it migrating to the control room, so you have a hazard there too. That was also in the NUREG -- in the generic issue.

CO2, then you have to isolate all the air intakes. You can't run the diesel.

MR. SNODDERLY: Well, some people have separate -- combustion in their supply from the cooling air, but they think that they can run that way, but they can't. They have to cool the room.

MR. CROM: CO2, the problem is you have to design the whole room differently. You've got to isolate everything. We had an incident at Catawba where 50 people were in there and they couldn't get out because the doors locked.

MR. MICHELSON: Just enough pressure so you couldn't get the door open in some cases too. That is even worse.

MR. CATTON: So what you are saying is you don't care?

MR. CROM: Yes.

MR. CATTON: It probably would have been better not even to have that up there.

MR. CROM: Well, we do protect it. That 's a part of the resolution to this issue is to make the cabinets in there drip-proof, and we do that.

MR. MICHELSON: It doesn't solve anything.

MR. CATTON: If you are going to turn off sprays to put out that fire, you need waterproof if you want them to --

MR. MICHELSON: Weatherproof them.

MR. CROM: It is only an investment prctection issue. You want them to be drip-proof in case they inadvertently got hot and the guy can stop it.

I totally agree with you if you let it run and you keep the engine spry you are going to lose your generator. We conceded that.

MR. CATTON: Even in a university laboratory, when you inadvertently set off those sprinklers, it wipes everything electrical out. Everything. That is certainly true.. The quality is not the same.

MR. CARROLL: Okay. Moving on.

MR. CROM: Let me go on. I also have that water suppression is utilized in several current plants. I think the NUREG count is nine. It is also recommended in NFPA 803 for the diesel generator room.

Also note that NFPA 804, which is a new standard that is currently being developed for advanced lightwater reactors, will specify automatic sprinkler, water spray, or foam water sprinkler systems for the diesel generator room protection. That is why it is currently being discussed on that code committee right now.

[Slide.]

MR. CROM: This is what NUREG-1472 provides: the following resolutions to GSI 57 to replace -- deluge system with reaction sprinkler systems. We have done that.

Replace smoke detectors with heat detectors. We have done that. Upgrade electrical cabinets to prevent water intrusion. We have done that. And upgrade actuation controls with seismically qualified printed circuit boards.

I don't personally think that really buys you anything because your pre-action valve, since it is solenoid, is not really qualified for seismic event. It could open. Providing the seismic category 1 piping downstream of that resolves that particular issue.

MR. MICHELSON: The basic issue here, of course, is -- and depending on which expert you talk to -- is it acceptable to not have a deluge system?

There are those experts who say a sprinkler head at a time is not the way to fight an oil fire. If you do, you are liable to localize where you get the spray. The rest of the room doesn't get the spray. In the meantime the fire can get out of control.

I don't know. I think somebody has got to look at whether deluge is the way to fight an oil fire or single head -- what this is is single head: one at a time comes on as they get hot enough.

MR. CROM: Well, the resolution to this Reg. Guide doesn't allow you to --

MR. MICHELSON: If the set point is up at 225, it is even going to get a little tougher on the feasible links and you are going to get less distribution of water.

It is not a simple issue. It is one the staff ought to be thrashing with as to what is acceptable, and it means you got to go back and do some real homework on fighting oil fires.

MR. CARROLL: Have you got a guess as to how many sprinkler heads you have in run like this?

MR. CROM: Doug, do you have any idea?

It would be located in NFPA-803, isn't it?

MR. BRANDES: Typically, they would be located less or no more than 100 feet -- square feet on center.

MR. CATTON: It would be a 50 foot radius from each sprinkler.

MR. MICHELSON: It would be 20 feet apart, from head to head.

MR. BRANDES: Excuse me. Doug Brandes again. I just spoke. What I meant to say is that they are no more than 10 feet apart.

MR. MICHELSON: So that is about 25 square feet per head. That's right.

MR. CATTON: What is the oil industry? Do you know?

MR. CROM: I have no idea. Doug, do you have any idea what the oil industry uses?

MR. CATTON: Does Mobile have a standard?

MR. BRANDES: I don't know.

MR. CATTON: They worried about these things a lot.

MR. MICHELSON: That is what, I think, we have to learn. We are just going to have to do it separately to find out what the heck is going on because I don't know what the right answer is. I'm not sure the staff can tell me what the right answer is.

MR. CARROLL: As things stand right now, it sounds like the design is state-of-the-art.

MR. CROM: That is my current -- my last bullet. My conclusion is that we think the pre-action sprinkler system for the diesel generator room is the best choice of best fire suppression technologies. Currently, of what is available out there today, we think it is the best choice.

MR. CATTON: And a lot of it is going to roll over on the COL anyway. Right? To change the spacing of the sprinkler heads, probably the sprinkler head characteristics. All of these things will are going to be decided.

MR. MICHELSON: But it will be a pre-action.

MR. CATTON: Actuation temperatures. A lot of these things are left to the COL.

MR. MICHELSON: But the pre-action is --

MR. CATTON: Well, pre-action is the only thing that looks like it is part of the design.

MR. MICHELSON: If you want to go to deluge, you got to go back.

MR. CATTON: So that means, Carl, there is time to take a good look at this.

MR. MICHELSON: Or at least the pre-action.

MR. CATTON: You may have the next 10 or 15 years.

MR. McCRACKEN: Conrad McCracken, NRC Staff. Let me give you a quick pre-look at it. Perhaps it will put people at ease.

The disadvantage to the deluge system is if it actuates by accident you just wiped out a whole lot of stuff. That is why people don't like it.

If you have an oil fire in a pool, if you remember listening to your discussion this morning from Dr. Quintiere, it is going to spread relatively quickly. You may have a difference of a matter of seconds between sprinkler heads going off, but it isn't going to be a long time if that fire is continuing to spread.

If it is being controlled, the Fire Brigade is going to arrive.

So it is an issue where there are pros and cons and you've got to look at that on every time you install a sprinkler system.

MR. MICHELSON: This room is about 60 feet -- height of the ceilings to floors is about 50 to 60 feet, isn't it?

MR. CROM: About 60 feet.

MR. MICHELSON: You've got that enormous air input coming in across the ceiling trying to get down to cool the room. And then you are expecting the sprinkler heads set at

225 degrees to fuse. It takes a while.

MR. McCRACKEN: That is what I said we will have to review and be sure we agree with them on what the settings are, when they should actuate with location detectors.

MR. MICHELSON: Okay.

MR. CROM: I've got two slides. I hope I can get done before 11 on fire protection.

MR. CARROLL: I sure hope you can too.

MR. CROM: At least that are the two that are critical

[Slide.]

MR. CROM: Fire detection. Let me go over this quickly. We have fixed detection alarm system to provide for prompt notification of fire. The detectors are specified and selected by location based on the potential fire hazard.

Need for timely actuation: ambient conditions, ventilation, ceiling height -- the questions you were asking -- as determined by the fire hazards analysis.

I've got a slide. I am not going to go over every one of them, but it outlines the things that we have in the fire hazards analysis.

MR. MICHELSON: You do have temperature distribution in the room as a required calculation then in the fire hazards? That is the only way you will get that information is to calculate the temperature distribution in the room.

MR. CROM: Doug, do you recall what we have on that?

MR. BRANDES: I beg your pardon. I missed the question. Can you repeat it?

MR. MICHELSON: Yes. If we are going to get these various parameters indicated by the second dot, one of them is temperature. Does the fire hazards analysis do a thermal distribution calculation in the room to find out if we actuated in a timely manner and so forth? Is that a part of a requirement in doing the fire hazards analysis?

MR. BRANDES: I guess the short answer is no, that is not a part of the requirement, but it would be an appropriate engineering technique.

MR. MICHELSON: Yes, but not a requirement to do it.

MR. CROM: Correct.

MR. MICHELSON: So I don't think you know all the things that are listed there. You can cite pressure as the same argument and so forth.

MR. CROM: Manual pool stations are located as determined by the fire hazards analysis. Battery supply backup power for the detection alarm system is provided, and alarms are provided in the control room and locally in the vicinity of the activated device.

[Slide.]

MR. CROM: The next issue that was always on fire protection, which we have somewhat talked throughout is, of course, systems interactions.

We talked that the fire hoses and standpipe systems located in the reactor building in nuclear annex are seismic category 1.

We use -- automatic pre-action sprinkler systems are utilized in the nuclear annex reactor building and alternate AC combustion turbine.

The sprinkler system piping is seismically restrained to avoid interaction with safety related systems and equipment. We are talking seismic category 2 here. Basically, we don't allow it to fall.

Divisional separation prevents spraying and flooding of redundant safety related equipment. We have talked about flood and how we control that in previous presentations.

A potential discharge of fixed fire suppressions and fire hoses are considered in sizing of floor drains along with putting them on elevated pedestals to avoid damages, which I have in the next bullet.

[Slide.]

MR. CROM: Finally, as I have been stating all along, a fire hazards assessment have been performed. It is about five to six volumes. The COL applicant shall utilize the fire hazards assessment to complete its fire hazards analysis. That is specified, as I said, both as a COL action item and in the ITAAC.

MR. CATTON: We heard that he would have to do some engineering analysis as well.

MR. CROM: Correct.

[Slide.]

MR. CROM: Just quickly I will put the slides up. These are some of the title areas that we have in our fire hazards assessment essentially covering the fire area descriptions, operator actions, maintenance activities that have to occur in each of the fire areas.

MR. MICHELSON: You have a lot more than just the five methodologies there.

MR. CROM: That's correct.

MR. MICHELSON: A lot more.

MR. CROM: Correct.

[Slide.]

MR. CROM: Other activities: radiological and toxic material; potential ignition source; curbs, drains, equipment pedestals; summary of combustible material.

[Slide.]

MR. CROM: We specified the fixed automatic suppression and manual suppression for each fire area.

[Slide.]

MR. CROM: Again, just more things on the manual fire suppression that are discussed in the fire hazards assessment.

[Slide.]

MR. CROM: Finally, ITAAC. We give the basic configuration of the fire protection mechanical system in the ITAAC.

We specify the 300,000 gallon tank water capacity. We specify the fire pumps, the electric and motor-driven in their sizing criteria.

The power supply, we say that the motor-driven pump has to be from the combustion turbine. Like I said, fire pump capacity is given as an ITAAC.

The fuel supply, we say it has to be an eight-hour fuel supply to the diesel driven, and we specify the standpipes and nuclear annex and reactor building must be seismic category 1.

[Slide.]

MR. CROM: Last slide. We also have requirements in ITAAC for the seismic category 1 backup supply, the power supply for the detection alarm systems. We do have the fire hazards that has to be completed by the COL applicant in the

ITAAC.

We also, in the building ITAAC, the nuclear island structures, component cooling water heat exchanger structure, and diesel fuel storage structure.

Each of those building ITAACs have the fire barrier specified in it.

We also have separation requirements covered in each of the system ITAACs and electrical ITAACs. It has to be checked by the COL applicant at the time of the ITAAC.

That concludes the fire protection.

MR. MICHELSON: The question that you said we were going to cover later.

MR. CROM: Ken, do you have some answers?

MR. MICHELSON: Question number 12.

MR. SNODDERLY: I know the question.

MR. CATTON: How long is this going to take, Ken? Do you know?

MR. CROM: These are the two questions that occurred during my presentation.

MR. CARROLL: Can you stay around afterwards?

MR. SNODDERLY: Yes. That is not a problem. I can stay.

MR. CARROLL: Okay. Let's move into the planned 11 o'clock session on steam generators, which means we are going to have the clear the room of people that do not have a need to know.

MR. COE: Right now I think we will have the staff, CE and ACRS, and CE contractors or DOE personnel. Other than that, everyone should leave the room.

[Whereupon, at 11:03 a.m. the subcommittee meeting proceeded in camera.]

OPEN SESSION

AFTERNOON SESSION

[1:21 p.m.]

MR. CARROLL: Let's reconvene.

All right. After a lot of deliberations, we decided we are going to deal with the questions later in the afternoon, after Carl and Ivan get back. I guess, at this point, we are going to launch into Chapter 15.

Let's see. The staff has a whole bunch of people here to participate in the discussion of protective action guidelines.

Do you want to sit in on the whole Chapter 15 or would it be preferable if we did PAGs first?

Can we order things such that we get into the issue of PAGs?

MR. RITTERBUSCH: This is Stan Ritterbusch.

Yes, we can. The speaker would be Jim Metcalf from Stone & Webster.

MR. KRESS: That was one of the most concise talks we had.

MR. CARROLL: I wish all of our speakers could be as brief, but concise, as you were.

We are going to 15, but we are going to do the piece first on Protective Action Guidelines.

[Slide.]

MR. METCALF: My name is Jim Metcalf. I am a consultant in the Mechanical Division of the Stone & Webster Engineering Corporation. We are under contract, ABB-CE, in the area of accident analysis, and I will be talking further on the Chapter 15 analyses this afternoon.

My background is about 23 years in the nuclear industry; of that, about 19 being involved in safety analysis; the remainder being fluid systems experience on Naval reactors and commercial reactors.

This is a little bit out of order. This is actually the last overhead from my Chapter 15 presentation. So you will find it at the back, and there was a lot of information building up to this, but let me just cut to the chase, and perhaps we can discuss some of the points that may arise further.

The reason that we do the Protective Action Guideline comparison dose analysis is because the Utility Requirement Document places that requirement on the vendor. Obviously, this comparison has to do with emergency planning and emergency planning requirements for the next generation of reactors. However, it is not really incumbent on ABB, I don't think, at this point to make any claims for the Protective Action Guideline analysis. That will be coming through in a separate activity through the ALWR program, and it is a generic activity that applies not only to this plan.

What I do want to explain is the way in which the analysis was done and what the analysis includes. I think it is important that we understand that rather than, perhaps, the emergency planning implications of that analysis.

MR. KRESS: As a quick question on that, in doing the analysis, did you follow a regulatory prescription that might be in the Reg Guide like 1.3 and 1.4?

MR. METCALF: No, we did not. I will explain, Dr. Kress, what the assumptions are and, roughly, where they come from. That is part of the presentation.

MR. KRESS: The reason for asking the question is it seems to me that whether or not you make Protective Action Guideline means you have done so by following a specific prescription, and that was the motive behind my question. So you might want to think about that as you present it.

MR. METCALF: I certainly will.

The objective of the calculation is to show that for an event that involves the licensing design basis source term as a starting point -- that would be your 10 CFR 100 DBA source term as a starting point -- plus, a contribution from a vessel failure, which is not included in the 10 CFR 100 DBA.

With the further assumption of an intact and functioning containment, the Protective Action Guideline dose would not be exceeded at the site boundary. That is the basic parameters of the calculation.

Now, in order to make that demonstration, we, of course, assume that the containment is intact and leaking at its design leak rate, so-called L_A. That is the allowable tested leak rate for the containment.

MR. KRESS: Those assumptions are all consistent with the prescription I had in mind with the fact that they may even be a little more conservative because of the vessel failure source term.

MR. METCALF: That is correct.

MR. KRESS: As you go through this, if you come upon something that is not consistent, could you, maybe, point it out to us?

MR. METCALF: Certainly.

Let me point out the first one right here. When we analyzed the containment for design basis or analyzed the performance of the containment for design basis, we make conservative assumptions with regard to things such as spray effectiveness. For purposes of the PAG comparison calculation, we approach it more from a best-estimate point of view. So that would be a departure from what would be done in Reg Guide 1.4 space, if you will, the DBA.

MR. KRESS: The 1.4 space, I recall, allows, for the sprays, a system case-by-case evaluation as opposed to specific spray parameters being specified. So that is still consistent except I think the 1.4 -- and refresh my memory -- says that if you have spray systems, only one train is working.

MR. METCALF: Yes, that is correct. Actually, even here, we assume only one train is operating. However, the way in which we calculate the spray LAMBDA, the actual removal coefficient, it is less conservative for the PAG calculation than it is for our DBA calculation.

MR. KRESS: But that is still consistent with the 1.4 because it allows that on a case-by-case basis, I think.

MR. METCALF: I think that the staff has traditionally wanted to see some measure of conservatism in all of the parameters that enter into the DBA analyses, and we would have less of that conservatism in the PAG approach.

MR. KRESS: Thank you.

MR. METCALF: Once again, there is augmentation of the licensing design basis source term, which is another departure from the Reg Guide approach, or the DBA approach.

Finally, I think, probably, the largest difference is that the dose that we are reporting for the purposes of comparing to the protective action guidelines is a median dose. It is 24-hour exposure to ground contamination.

It also is independent of direction. In other words, when we say a median dose, what we are doing is we are summing over all directions around the plant because each individual sector away from the plant would have its own probability of exceeding a certain dose. Rather than taking any kind of an average, we sum those.

MR. KRESS: That certainly looks to me like a departure from the prescription.

MR. METCALF: Well, it is a departure in the sense that the prescriptive approach, the DBA approach, is to use a Chi over "Q," a dispersion, that is very conservative --

MR. KRESS: Very conservative, yes.

MR. METCALF: -- and it is calculated using the methods of Reg 1.145 which codifies that in a conservative sense.

MR. KRESS: I assume your median dose comes out something like a MACCS calculation --

MR. METCALF: That is correct.

MR. KRESS: -- which has to have a wind probability in it.

MR. METCALF: That is correct.

MR. KRESS: You said you are not talking about a site. Where did you get that information for the calculation?

MR. METCALF: The Utility Requirement Document has a design basis site, if you will.

MR. KRESS: I see.

MR. METCALF: The database for that site, which is a very conservative site, is used for making this demonstration.

MR. DAVIS: What weather parameters do you use? Do you use Class F stability or something similar?

MR. METCALF: Well, when you are talking about the median dose, you are looking at the entire spectrum of meteorological conditions, which would include the wind speed and the stability class.

MR. DAVIS: It is not a worse case then?

MR. METCALF: No. That is what we say when we talk about a median dose. We are reporting a dose that would be exceeded 50 percent of the time based upon whether conditions.

Since we only have a single source term, the only source of variability in the calculation is the meteorology.

MR. KRESS: That would probably be the biggest departure from the prescription.

MR. METCALF: It is. It actually translates, Dr. Kress, into a different dose of about a factor of 6.

The reason this is done, once again, not wanting to drag the entire emergency planning issue into this discussion, these assumptions are fully consistent with what was done in developing the present basis for emergency planning, and the issue of the conditions under which the PAGs might be exceeded at some distance from the reactor, from the plant, were part of the deliberations that led to the current requirements for emergency planning.

So what we are doing is we are, essentially, repeating that calculation in the same way that it was done to develop that basis, but we are using the source terms and the containment performance that are unique to the System 80+.

The results are that we are well within the PAGs. For the committed effective dose equivalent, we are roughly 30 percent of the PAG value, .3 REM versus 1 REM, and, of course, that is another departure.

In the way that DBAs are analyzed, you report doses in terms of whole body dose. Some years ago, the PAGs were changed from a whole body dose basis to a committed effective dose equivalent basis. So, naturally, we do the dose calculation consistent with the measure of dose that is used in the PAG.

Now, for the thyroid dose, that is done, pretty much, the same way in either case. In terms of dose conversion, the actual dose calculation methodology is the same for both the DBA and the PAG.

In the case of the thyroid dose, we are about a factor of 2 below the PAG value.

MR. KRESS: This is using the new source terms, plus some additions from the vessel failure source term.

MR. METCALF: That is right.

MR. KRESS: Had you used the old source terms in this design and the prescription for the atmospheric transport, even using the same site things, but go back to the prescription for it, what would you have gotten? Did you do that exercise, and what would you have gotten for the result there?

MR. METCALF: No, we have not done that exercise, and it would be a hypothetical.

MR. KRESS: It certainly would be hypothetical, yes.

MR. METCALF: My guess is it would certainly be, in my opinion, somewhat higher than what we are presenting here. Whether or not it would exceed the PAGs, I can't honestly say for sure. My guess is it might very well.

There is definitely a contribution from the new source term, but it is not a factor of 10 contribution. It is something less than that.

MR. KRESS: You used a spray LAMBDA that is pretty high for this calculation; if I recall, 20.

MR. METCALF: It is 20 per hour, yes.

MR. KRESS: Per hour?

That is based on the fact that you have sprays that are pretty good. They have small drop sizes, and the flow rate and coverage would give you LAMBDAs of that value.

MR. METCALF: Once again, if we had gone through my entire presentation for the DBA leading up to this overhead, you would have seen exactly what we did for the DBA.

The major difference between what we did for the DBA and this analysis with regard to the spray LAMBDA is the inclusion of some credit for hygroscopicity of cesium hydroxide.

In the DBA analysis, in calculating the removal LAMBDAs for the DBA analysis, we took no credit for condensation on the particulate in the containment atmosphere at all, let alone the hygroscopic effect. It was dry particle analysis.

MR. KRESS: How does the hygroscopic affect the efficiency of sprays?

MR. METCALF: It is quite dramatic because it raises the particle size distribution into a range where the sprays are much more effective in removing the material.

MR. KRESS: By agglomeration?

MR. METCALF: Well, cesium hydroxide is extremely hygroscopic.

MR. KRESS: I understand that, yes.

MR. METCALF: Near saturation, it will absorb something like 100 times its mass in water.

When the water condenses on the particles, particularly as enhanced by hygroscopicity, the particle sizes will increase in radius tremendously, and as a result, they move into a size range in the neighborhood of, say, 1 to 2 microns where the sprays are almost 100-percent efficient in the capture.

So the effect of the hygroscopic material is to increase the size distribution and, as a result, make the sprays much more effective.

MR. KRESS: In order for this to happen, the assumption must be that the aerosols come into the containment and under go an agglomeration procedure before the sprays come on or do the sprays come on simultaneously?

MR. METCALF: You are correct that agglomeration is another way in which the particle size distribution can shift upward, can become larger and, therefore, more easily removed by the sprays.

MR. KRESS: I mean, the absorption of the moisture.

MR. METCALF: That is going to be very rapid.

MR. KRESS: So the calculation of the particle size by the absorption of the moisture is almost instantaneous as the particles get into the containment?

MR. METCALF: Yes, exactly.

Agglomeration takes time, but the increase in the size associated with taking on the water due to the hygroscopic nature of the material is much more rapid.

The material is well dispersed in the containment atmosphere. If the containment atmosphere is near saturation, the condensation is very rapid.

MR. KRESS: Were you going to go back and go through the DBA and calculate this?

MR. METCALF: This was my final overhead.

MR. KRESS: This was the result, yes.

MR. METCALF: Well, this is the result for the PAG calculation. The DBA discussion goes into a lot more detail on how the spray LAMBDAs are calculated and so on.

MR. CARROLL: Do you want to back up and hear that?

MR. KRESS: Yes. I mean, this is good, but it doesn't answer a lot of the question.

MR. CARROLL: All right. We have got to go through it eventually.

[Slide.]

MR. METCALF: This is the sum total of the presentation that I am going to be giving on Chapter 15, and we will also, of course, touch on Chapter 6 insofar as the engineered safety features that affect the dose calculation.

I am going to talk about the revised source term in general, what it is and how it is different from what has been used in the past.

I am going to talk about the containment transport and deposition. That would touch on the spray LAMBDA calculation.

I know that there is some specific interest in the area of IRWST pH and the associated potential for reevolution of iodine.

I will be talking about how we do dose consequence analysis for the DBAs. Since we now have a source term that is a little different than the previous practice, we have had to approach the dose calculation a little bit differently.

I will be talking about the issue of equipment qualification.

I will spend some time discussing Chapter 15 accidents other than the DBA LOCA.

Finally, this is what we have already done, and I guess we will build up to it once again.

[Slide.]

MR. METCALF: When I refer to the new source term, what I am really talking about is the draft NUREG 1465 source term, the June 1992 draft. That was not always the case.

When we started this effort, and actually when I was here speaking to the ACRS in February of '93, we were doing something a little bit different from the draft NUREG, but we now are using the draft NUREG source term identically.

As we compare the timing, the quantity, and, later, the form of the material released to the containment, we will see the differences between the old and the new, the old being TID-14844, which is the source term that is suggested for use by 10 CFR 100.

TID-14844 and its associated regulatory guidance requires the entire source term to be introduced into the containment at times 0. Whereas, the new source term is a progressive release that more closely conforms to what we understand accidents will actually do, beginning with a coolant release phase, followed by a heatup and the bursting of fuel rods and the associated gap release, and, finally, should the accident proceed far enough, we would have a contribution from the actual melting of fuel. So these are the three contributions in terms of time frame.

In terms of the quantities of material, in either case, we are talking about a release of 100 percent of the noble gases. We are talking about comparable releases of iodine, actually a little bit less.

MR. KRESS: Refresh my memory on that.

MR. METCALF: Okay.

MR. KRESS: That is in TID-14844, but when it got translated into the Reg Guide, I believe the 50 percent iodine effectively became 25 percent in that they dropped the 1 percent others. Is my memory correct on that?

MR. METCALF: That is absolutely correct.

MR. KRESS: So you actually have more iodine, really.

MR. METCALF: Exactly. We don't treat that as part of the source term. We treat that 50-percent removal as a removal mechanism. That is why you don't see it on this slide.

MR. KRESS: It will show up in yours practically as a removal.

MR. METCALF: That is exactly correct. You are right. The 50 percent is released according to the TID. The regulatory guidance says that you can also make an assumption of an instantaneous 50 percent. So this becomes effectively 25 percent. That is correct.

As you point out, the 1 percent of the other is only to the containment sump. It is not released to the containment atmosphere, as implemented by the regulatory guidance.

For the new source term, we release not only a relatively large fraction of the iodine, but also a relatively large fraction of the cesium which is considerably different from what was done in accordance with previous regulatory guidance.

Then there are six other radionuclide groups that also participate and are also included in the source term, and they are released in fractions from considerably less than 1 percent to something like 15 percent in the case of tellurium.

MR. CARROLL: Missing units on that slide are minutes, next to fuel release?

MR. METCALF: I am sorry. Yes. It is minutes, yes.

MR. KRESS: In your opinion of those differences, which are the most important ones?

MR. METCALF: Well, it depends on what you are talking about.

MR. KRESS: You forgot to mention that iodine is particulate in your case.

MR. METCALF: That is my next overhead.

MR. KRESS: Oh, sorry. Go ahead and do the next slide.

[Slide.]

MR. METCALF: In the old source term, the release was predominantly gaseous to the containment; whereas, in the new source term, it is predominantly particulate. Noble gases, of course, are gaseous in either case.

Of the 95 percent that was gaseous and the old TID, 4 percent of that was organic.

Of the 5 percent that is gaseous in the new source term, .25 percent of that is organic. Now, this was not actually covered in the draft NUREG 1565. There is a draft Commission paper presently on the street which uses the .25 percent, and that is what we are using as well in our calculation.

Of course, the other material, other than the noble gases and the iodine and the old source term, was not specified because it was in solution in the sump water, in any case. It never got to the containment atmosphere. In the case of the new source term, it is in particulate form.

Coming back to your question on what is more important, it really depends on what you are talking about. For example, from the standpoint of equipment qualification, as we will discuss in a moment, the large quantities of cesium are important.

MR. KRESS: I am more interested in PAGs right now.

MR. METCALF: Okay. From the standpoint of the Protective Action Guidelines, I think the timing, of course, is somewhat important.

MR. KRESS: Yes.

MR. METCALF: If you release the material over a longer period of time, the average amount of material airborne in the containment is going to be somewhat less than if it comes out instantaneously, but for a 24-hour dose calculation which is what the PAG comparison dose is calculated for and which also was the basis for the existing urgency planning requirements, it is not as important as it is safe for a 2-hour exclusionary boundary dose calculation, but there is some influence from the timing.

I think that there is also a contribution from the fact that the organic iodine is relatively low in the new source term as opposed to the old source term.

MR. KRESS: From that standpoint, could you contrast a typical spray LAMBDA for gaseous iodine versus particulate?

MR. CARROLL: I will bet that is coming up, too.

MR. METCALF: Actually, that comparison is not quite coming up, but, yes, I can characterize it.

The particulate LAMBDAs are, in general, a little bit lower, actually, than the elemental iodine LAMBDA. An elemental iodine LAMBDA that you would calculate might be of the order of 20 or 30. In practice, you are limited to something like 20.

For the case without hygroscopicity being included, we are talking about LAMBDAs that are of the order of 10 to 15 for particulate.

MR. KRESS: Yes.

MR. METCALF: Now, if hygroscopicity is credited, the value will become considerably greater. We only took credit for 20 in the calculation that we did, but it could conceivably be greater than that.

MR. KRESS: So that, if your source terms were following the old prescription that it were 95 percent gaseous, you wouldn't expect much difference because your sprays are almost as effective for the gaseous iodine as they are for particulates.

MR. METCALF: If the full credit were given for hygroscopicity, I believe that the particulate LAMBDA would be greater.

MR. KRESS: But not a lot greater?

MR. METCALF: Well, I have a backup overhead to cover that. Let me present to you the calculation that we presently do for the DBA. Then I will show you the impact of the hygroscopicity.

MR. DAVIS: In the new source term, the particulate iodine is assumed to be cesium iodine?

MR. METCALF: That is correct.

MR. DAVIS: Thank you.

[Slide.]

MR. METCALF: The spray removal is dominated by elemental, as we were just discussing, and the spray

LAMBDAs, the calculation of the spray LAMBDAs are guided by NUREG-0800 Section 6.5.2, the standard review plan.

In the new source term, the spray LAMBDA is dominated by the particulate form. The expression that currently appears in the standard review plan for particulate is quite conservative; really, in our opinion, too conservative. It was fine when it was only 5 percent of the release, but in today's world, it simply was excessively conservative. Plus, it is also geared to an instantaneous release. Therefore, for the time-dependent release of the new source term, it was really not applicable.

So the calculation that we have done for spray LAMBDA has made use of the SWNAUA code, which is a variation on the NAUA code developed by KFK some years ago, and that is the way we do that calculation.

MR. KRESS: Since you are on this slide, let me ask you a question. Spray sweep things out of the air by impacting on them and collecting them, and the LAMBDA you get, then, becomes a function of the efficiency of the flow rate of the liquid and the droplet size and the concentration of this particulate material.

MR. METCALF: Yes.

MR. KRESS: Now, when you say your realistic calculation, you are including this concentration variation? You want to SWNAUA calculation and then you back out of it, these LAMBDAs, for given time increments and then go back and use constant values of LAMBDAs over time increments? I am a little confused about the process.

MR. METCALF: If I go through the development of the containment transport aspects of it, the spray LAMBDA and the spray mixing, that might become a little bit more clear. So can we just wait until that?

MR. KRESS: Sure.

MR. METCALF: If your question persists, then we can go over it.

Finally, the dose calculation methodology, as I already mentioned, has to change because of the nature of the source term.

[Slide.]

MR. METCALF: Also, Dr. Kress, I wanted to point out, when I said realistic, the terminology on that overhead meant more realistic as compared to the draft NUREG. It is still a conservative calculation, as we will see.

For System 80+, the containment sprays are the dominant mechanisms for fission product removal from the containment atmosphere.

The approach that is used with regard to the calculation of spray LAMBDA and spray mixing is covered in the Evolutionary Plant Source Term Report of September 1990, but there are some differences, and I will touch on those.

There are two major issues. One is the removal coefficient, the so-called spray LAMBDA, and the second is the rate of mixing within the containment.

Now, the calculation that is presented in the Evolutionary Plant Source Term Report is a typical calculation. It is not for a System 80+. It was intended for illustrative purposes. However, interestingly, the volume flow times the fall height divided by the containment volume is roughly the same between the System 80+ actual values and the typical values that were given in that report.

So that, in general, we would expect similar performance from our actual calculation as compared to the EPRI report. There are, however, some differences.

Number one, the EPRI report did include the effects of hygroscopicity on the spray LAMBDA, which is the principal reason why the spray LAMBDAs are as high as they are in that report.

In fact, for System 80+, not only did we neglect the hygroscopicity, but, as I said before, we neglected all condensation on the particles. So it is a dry particle analysis, which is quite conservative for a system that is close to saturation.

The spray droplet size assumed in the EPRI calculation was about a factor of 3 smaller than what is used by System 80+. System 80+ is using the 1713A spray nozzle. It is a proven design. For that reason, the spray droplet size is about a factor of 3 greater for the System 80+, and it is quite comparable to what is used in current plants.

The input particle size is somewhat different. This is the particle size distribution that characterizes the release to the containment, and I will cover that right now.

[Slide.]

MR. METCALF: This was a question that came up in the February presentation of last year, and at that time, on a preliminary basis, we were using the same distribution that came from the EPRI report that characterized the entire release to the containment with a geometric radius of .21 of log normal distribution with a geometric radius of .21 microns and a sigma of 1.7.

For that case, at the end of 100 minutes -- and I chose 100 minutes to make the two cases comparable -- for a similar case without hygro, same containment leak rate, .5 percent per day, we had released a fraction, a percentage of about 6.5 times 10 to the minus 4 using this distribution.

For System 80+, after the preliminary work that we did, in order to refine that work and update it, we went back and found what we believed to be a better characterization of the particle size which breaks down the difference between the gap release and the fuel release.

During the gap release phase, the concentration of the aerosol is considerably lower than during the fuel release phase, and, therefore, the particle size distribution is somewhat smaller.

MR. KRESS: I presume the 100 minutes significance is that, by then, you have released about all you are going to release.

MR. METCALF: Exactly, exactly. In both cases.

MR. KRESS: Yes.

MR. METCALF: So the design basis analysis that we did for System 80+ uses two different sized distributions, one smaller than what was being used a year ago and one somewhat larger.

MR. KRESS: What are typical particle sizes in NUREG 1150 from which the new source terms were loosely based on going into containment as compared to the numbers you are showing here?

MR. METCALF: The NUREG-1150 particle size distributions, I don't think were actually well-defined. As you know, a lot of what was done in NUREG-1150 was done on the basis of eliciting expert opinion from panels.

MR. KRESS: Expert opinion.

MR. METCALF: Certainly, particle size

distributions would have been considered by those panels in terms of looking at things like spray effectiveness and other aspects of the problem, but I am not familiar with any compilation of particle size distributions that was actually published as part of NUREG-1150 that would give that information in a readily retrievable way.

MR. KRESS: I believe they were bigger than this, which means you are probably conservative here.

MR. METCALF: In our view, we are conservative.

MR. KRESS: Yes. The reason I brought the question up, one reason is I am not sure whether the new source term specification discuss particle size. It seems like that is a possible shortcoming of them because it certainly is an important consideration when you look at spray effects and other things. Does this show up in the new source terms anywhere?

I recognize it is in the URD, which is good, but in the new source term guidance document that is to replace Reg Guide 1.4, for example, maybe this is a question that I need to be directing at staff.

Do they give any guidance on the particle size to use?

MR. METCALF: In the draft NUREG, there is no specification of particle size distribution, but before the staff answers, if I can make just one additional point.

If you notice, if you compare this fractional release of 1.8 times 10 to the minus 3 percent to the 6.5 times 10 to the minus 4 percent, you will notice it is about a factor of 3 difference, which corresponds to the factor of 3 difference in spray droplet size.

The conclusion to be reached is that even though we use a different particle size distribution in both of these cases, the result is pretty much the same.

That is not to suggest that particle size distributions do not have an effect because they certainly do, but I think the fact of the matter is, it is not a dominant parameter in terms of determining spray effectiveness. It is important. It needs to be defined. You need to put something in there that makes sense.

Just based upon this one calculation or comparison of two calculations, it appears as though the two particle size distributions or two sets of those distributions are performing about the same.

MR. CARROLL: Do you want to hear what the staff had to say on this, Tom?

MR. KRESS: Yes.

MR. LEE: My name is Jay Lee.

Jimmy is right that we did not specify particle size in the draft NUREG-1465.

MR. KRESS: Well, I guess the question is why not.

MR. METCALF: If I can just add one thing, one of the things that we have been very interested in is the fact that our calculation of spray LAMBDA has been independently reviewed by an NRC contractor at Sandia.

Coming at the problem from an entirely different direction -- and I know that in the determination of the spray LAMBDAs and the work done by that contractor -- particle size was considered as one of the important parameters. It was a range of particle sizes that were included in that assessment.

When our spray LAMBDAs were compared to the spray LAMBDAs that came out of that work, they were very similar. So, even though the particle size distribution may not have been specified in the NUREG, it certainly is considered in the removal mechanisms, the work that is supplementing the NUREG in the area of removal mechanisms.

MR. LEE: To answer your question, Dr. Kress, the reason we did not specify in NUREG-1465 was that we were going to review particle size for individual design, such as System 80+.

MR. KRESS: I see, because it would depend on the primary system characteristics.

MR. LEE: Right.

So we didn't think we could generalize with a certain particle size.

[Slide.]

MR. METCALF: These are the spray LAMBDAs that actually went into the calculation for System 80+. This is the spray LAMBDA. I apologize for having left the units off of here. This should be spray LAMBDA per hour, which is the unit.

This is the time from the start of the DBA. I have only provided five hours worth of data. In terms of particulate removal, by the time you get five hours into the accident, it is pretty much done with.

MR. KRESS: Now, that is the input to the code or to the calculation. I presume that came out of a calculation of some sort using Stone & Webster NAUA --

MR. METCALF: SWNAUA. That is correct. That is correct.

MR. KRESS: -- which would have given you some sort of smooth curve that you have drawn these lines through.

The question I have about that process, as long as you are using SWNAUA, why didn't you just let it tell you what the release was from the containment?

MR. METCALF: Because SWNAUA is not capable of taking into account radioactive decay.

MR. KRESS: If you have over 100 minutes, who cares?

MR. METCALF: There are other things going on, including things like equipment qualification, dose calculations and so on. We would rather do it in an integrated way, but the way that we determine whether or not this discretization is adequate -- because this discretization goes into the PERC2 code, which I will describe in a minute -- what we do is to make sure that we match deposition from the SWNAUA code.

We would prefer to do the entire radiological analysis in one place which is the PERC2 code, and what we need for input to PERC2 is the spray LAMBDA.

For example, there is also containment mixing going on which has an impact between sprayed and unsprayed regions.

MR. KRESS: That is not in NAUA. That is right.

MR. METCALF: No. NAUA is a single-node calculation. So that, the mixing effect needs to be included as well, and that is all integrated into the PERC2 calculation.

MR. KRESS: I am not complaining about the procedure, but just trying to understand it.

[Slide.]

MR. METCALF: In talking about mixing, the mixing model is described in the September 1990 Evolutionary Plant Source Term Report. It is a two-compartment, density-driven flow model that ignores some effects that I think are very important.

It ignores, for example, the momentum exchange between the spray droplets in the containment atmosphere which can be a tremendous source of mixing.

Someone was mentioning yesterday about the Zion spray test, and I have heard anecdotal evidence from that test that indicates that the containment atmosphere was very much stirred up by the momentum exchange between the spray droplets and the air in the containment, but that is not credited in what we do.

Also, the density is only a function of temperature. That is to say, it is a perfect gas law relationship. As the sprays are actuated and as steam is condensed in the sprayed region, density will not only be a function of temperature, it will also be a function of the mole fraction of the steam, which will be considerably lower in the spray region, which will further increase the density of the air of the gas in the spray region.

MR. KRESS: Does the efficiency of the sprays in collecting aerosols count for condensation of steam onto the sprays?

MR. METCALF: Yes, it does.

We are talking about diffusiophoretic deposition, and it does. However, diffusiophoresis on structures is conservatively ignored. We only include the diffusiophoretic effect on the spray itself.

MR. KRESS: When you are talking about sprays, you can practically ignore everything else, I guess.

MR. METCALF: Yes, you can while the sprays are running. That is pretty much true.

Interestingly, though, the sprays are most effective in a certain particle size range, and when you get down below that value, the diffusiophoretic deposition on the sprays is important.

The assumption is made that prior to the initiation of sprays, the containment atmosphere is homogenous. Of course, we would not really expect that to be true, but it is a conservative assumption. In fact, we would expect most of the radioactive material to be in the upper part of the containment, where the sprays are, because of the heat of release from the primary system.

MR. KRESS: Why do you say that is a conservative assumption?

MR. METCALF: For the reason I just mentioned, that if one were to look at stratification in the containment, the sprays are, for the most part, concentrated in the upper two-thirds of the containment, if you will.

If one were to consider the actual behavior of the radioactive material coming from the primary system, it would have a tendency to concentrate in the areas where the sprays are located, which is high in the containment.

I already mentioned the perfect gas assumption with regard to the density of the gas.

[Slide.]

MR. METCALF: When we apply that model to the System 80+ design, we find the following input. This is the calculated input to the dose analysis in terms of containment mixing rate. This is expressed in terms of sprayed volumes per hour, which is the traditional way of expressing containment mixing, once again, for the first five hours of the DBA.

There are two conditions under which we default to the standard review plan, the NUREG-0800 value of two per hour. The NUREG-0800 will give you two per hour without any justification.

There are two sets of circumstances where we use that value. One is if the containment sprays are not the dominant heat removal mechanism, which is true early in the event, because of the fact that there is so much condensation going on, on structures. So, during the period of time that the containment sprays are not the dominant heat removal mechanism from the containment, we default to the two per hour.

We also default to the two per hour when the containment cooldown rate becomes less than 10 degrees F per hour because that weakens the mixing between the sprayed and unsprayed regions due to the density-driven flow.

So, during the period of the mass and energy release and the associated spray cooldown, we have, initially, values of the order of about eight to nine per hour as compared to the two per hour from NUREG-0800.

Associated with the source term specification is that the event is arrested in vessel, which means that there will be some kind of a quenching process at the end of the core heatup. That also introduces steam into the containment, resulting in a second cooldown of the containment, if you will, which corresponds to the second peak value in the mixing rate. So that is the reason that the mixing rate has the profile that it does, and these are the values, then, that are used in the dose analysis.

[Slide.]

MR. METCALF: Before I leave the subject of containment transport, let me use one overhead to address the question of IRWST pH and its impact on iodine.

What I am presenting here is the iodine concentration in the containment atmosphere as a function of time, and this is given in gram atoms per liter of iodine.

This is the particulate, the elemental, and the organic contribution.

We make the assumption that the elemental iodine experiences the same removal LAMBDA as the particulate, and the reason we do that is because, number one, it is conservative. The elemental LAMBDA would actually be somewhat higher if it were treated independently, but we also believe that most of the elemental iodine will deposit on the very large surface area presented by the dispersed particulate. So, in fact, it is appropriate to use the same removal term for the elemental iodine and the particulate iodine.

The organic iodine, of course, is not removed at all. This is simply the rate at which it is introduced. When we come to the end of the injection period or the end of the release period, the organic iodine remains constant in the containment atmosphere, except for decay.

The question is what happens to the iodine that is deposited in the IRWST water in terms of its potential for reevolution. If the pH is not controlled, some fraction of that iodine will certainly reevolve into the containment atmosphere.

In the original analysis that we did, we assumed that the trisodium phosphate dodecahydrate would be dissolved. That is the buffering agent for the IRWST. It would be completely dissolved in one pass through the holdup volume.

We still believe that is a correct characterization, but we were asked by the NRC staff to look at a case where it would take, perhaps, three times through the holdup volume. What we are looking at here is the difference between those two cases in terms of the elemental iodine airborne.

If it dissolves in something of the order of two and a half hours, there is no effect of reevolution because, in fact, the material can only be removed so fast, and the water is always able to retain what has been removed.

That is not the case if it takes three times as long. This is the pH transient in the IRWST for the sensitivity case, and as you can see, the pH of 7 is assumed to be reached in eight hours. It is actually a calculation, but the assumption of three times through leads to a pH of 7 being reached in about eight hours.

Under those conditions, the equilibrium iodine airborne will be such that there would be reevolution from the spray. However, the reevolution from the spray which would follow this path is still well under the organic iodine fraction. So the organic iodine will continue to control the dose calculation even for the case where it takes three times as long to raise the IRWST pH.

[Slide.]

MR. METCALF: Let me talk now about the dose consequence model. As I mentioned, because of the fact that the new source term is a time-dependent release and because of the fact it involves other contributors than iodine and noble gas, the dose calculation methodology had to be adapted.

Stone & Webster prepared a computer code called PERC2 which has a five-region model, one of the regions being the control room, two of them being in the containment, sprayed and unsprayed region. In each region, we do the following. I won't read through the whole list, but we basically know where the material is.

We track 12 chemical groups. This corresponds to the specification of the source term in draft NUREG-1465. We also include a daughter ingrowth. With all of the additional radionuclides, we felt that we needed to track the decay products of the various components of the source term. So we have a 4-isotope decay chain, and as present, we are using 150-decay chains. The code has the capability for 200.

MR. SEALE: As these things decay, do they hop from one chemical group to another?

MR. METCALF: Yes. Let me explain how that is done.

[Slide.]

MR. METCALF: The daughter products are

identified, and, in fact, there is a user-specified input that describes the way in which that daughter product will act.

So that, for example, we can release it from filters. We can release it from wall deposits. For example, if iodine decays the xenon, we can release the xenon to the containment.

The removal LAMBDAs other than decay are user-specified, naturally.

The filter DFs are time-dependent and user-specified, so that we can effectively turn filters on and off with time by changing the efficiency of those filters, removal efficiency.

There is a separate dispersion value, a Chi over Q calculated for each release point, so that we can treat multiple release points associated with these several volumes.

Also, we track the integrated concentrations in each location for purposes of doing equipment qualification dose calculations.

[Slide.]

MR. METCALF: The dose conversion methodology is identical to that from TID-14844 in that we have only changed the source term. We have not changed the method of actually calculating the dose. I will get into this a little bit further when we discuss non-LOCA DBAs.

We calculate the whole body dose and a thyroid dose for the exclusionary boundary and the low-population zone. We calculate whole body and thyroid and also a skin dose, a beta dose, for the control room.

What I presented here are the actual dose values and, in parentheses after them, the limits, the corresponding limits from either 10 CFR 100 or GDC-19. So we are, as you can see, well within the limits.

[Slide.]

MR. METCALF: I wanted to talk about equipment qualification for at least one overhead.

There are a number of impacts on equipment qualification. The new source term has delayed release timing, as we have talked about, which has some importance.

This is really the key, though, is the large quantity of cesium that we see in the new source term that was not part of the old source term. That has a real impact on a long-term EQ.

It has almost no impact on the airborne EQ because the material is removed from the air so rapidly, but it has an importance for the IRWST exposure, or the sump water exposure, that is to say, the water in the IRWST, and we can characterize it in the following way. At about 100 days, you would see a factor of two greater integrated gamma dose for the new source term as compared to that corresponded at TID-14844.

In calculating exposure times for purposes of equipment qualification, we have used two default exposures, if you will. In other words, if a particular component cannot be specifically identified as having a mission time that is shorter than these values, these become the values for the qualification, 100 days for mitigation systems and 180 days for monitoring systems to provide some overlap for the monitoring into the recovery phase.

Also, we provided for two levels of qualification. Level 1 corresponds only to the gap release. Level 2 corresponds to the full licensing design basis source term which would include the gap plus the early-in vessel contributions as defined by draft NUREG-1465.

MR. KRESS: I am not quite sure I understand the reasons for these two levels. Is the gap release level used to qualify containment closure equipment or what?

MR. METCALF: No. The basis for it is as follows. The licensing design base source term corresponds to a significant core melt, as required by 10 CFR 100, and there are certain safety features.

For example, the key one is the emergency feed water that really don't have a role any longer.

MR. KRESS: After they perform their function?

MR. METCALF: For such an event.

MR. KRESS: I see.

MR. METCALF: So we differentiate between Level 1 and Level 2.

There are certain systems that are important for events that may involve damaged fuel, but would not be, really, almost a severe accident, which is what the LDB source term corresponds to.

So we have broken it down in the following way. At this point, there really is only one system that is placed in Level 1, which is the emergency feedwater system.

[Slide.]

MR. METCALF: I am going to touch now on the accidents other than DBA LOCA.

Joe Rezendes from ABB will be presenting some additional information on the system analysis of these events, and a lot of the inputs to this analysis come from that system analysis of the events.

The first thing to do, of course, is to identify those events in Chapter 15 that involve radioactive releases. We did that.

We need to develop, then, the off-site and control room doses that correspond to those accidents. Finally, we examined the plant design to see if there is any optimization that can be achieved in terms of mitigation systems for those various accidents.

For example, one of the things that was done over the past year was to add automatic selection capability for control room air intakes to make sure that the least contaminated air intake is the one that is chosen to supply the control room. That arose from this analysis.

On the other hand, we have removed the safety-grade designation of the charcoal filters for the building exhaust units because we do not credit elemental iodine retention in those units, nor do we credit organic iodine retention in those units. So that, it is not necessary now to maintain the safety grade classification of those charcoal filters. These are the accidents that we analyze that involve the release of radioactivity.

[Slide.]

MR. METCALF: The methodology that I am going through now is equally applicable to the DBA LOCA in terms of dose conversion. I will get to that in a moment.

The transport mechanisms are action-specific, and a lot of the assumptions that are made with regard to transport deposition, holdup decay, and so on, come from the standard review plan.

To the extent possible, we have tried to remain consistent with the standard review plan, NUREG-0800, in terms of how these accidents are analyzed. There are some differences, and I will touch on those in a moment.

We take no credit for decay during plume transit. That is also the case for the DBA LOCA.

I was asked a question earlier about the site data that is used to do the analysis. It is the ALWR program design basis site, if you will, which represents an 80th-to-90th percentile of the sites currently in use in the United States.

The dose calculation methodology for beta and gamma dose is identical to current practice for the plume exposure.

[Slide.]

MR. METCALF: For the off-site dose, we use a semi-infinite cloud. For the control room, we use a finite cloud as the basis for calculating the beta and gamma doses.

The dose conversion factors for inhalation for the thyroid doses come from ICRP 2, and, of course, there is some conservatism there relative to ICRP 30.

We take no credit for any operation action for 30 minutes in the assessment of radiological consequences for these accidents, and as I said, except as noted, we have conformed to the standard review plan.

Now, the areas where we depart from the standard review plan are as follows. For those cases that involve failed fuel, and there are some, Joe Rezendes from ABB will be describing the events that do. For those events that involve failed fuel and a release of gap activity, the release now conforms the draft NUREG 1465 instead of the safety guide, and the conformance is in two areas.

First of all, the actual activity in the GAP, as you can see, there has been a reduction in draft NUREG-1465 in terms of gap activity as compared to safety guide 25; also, in terms of the speciation of the iodine in the gap, where we are not recognizing that a large fraction of that will be cesium iodine.

However, interestingly, the fraction that remains organic is the same. The .25 percent organic is the same for both the draft NUREG-1465 and also the safety guide 25 from the standard review which is consistent with the standard review plan.

[Slide.]

MR. METCALF: The second area of difference has to do with the control room dispersion factors. We are now using the more advanced Ramsdell methodology for calculating dispersion factors from the release points on site to the control room air intakes and other areas of leakage into the control room instead of Murphy & Campe, which was a straight line gaussian plume model.

Finally, some of the standard review plan specifications or acceptable practices for analyzing the radiological consequences allow you to take credit for iodine deposition in the containment. Of course, those standard review plans were written around elemental iodine as being the dominant form. So where the particulate is now the dominant form, we have adopted the minimum gravitational setting coefficient of .15 per hour per the Evolutionary Plant Source Term Report. So this is essentially a replacement for the credit that the standard review plan would allow for the elemental iodine.

[Slide.]

MR. METCALF: Finally, in all cases, we are within the limits of 10 CFR 100 or the applicable portions of NUREG-0800 that give specific limits that are less than 10 CFR 100.

So that is really by way of summing it up. There are no cases where we are above the limits, and, in fact, in most cases, we have considerable margin to the limits.

That completes my presentation. If you have any questions, feel free to ask.

MR. CARROLL: What are the implications, if any, to emergency planning from the results you have obtained?

MR. METCALF: The emergency planning implications, there are certainly many, many aspects to emergency planning, and I don't want to simplify the discussion at all. It is a discussion that deserves to be fully aired.

One of the major bases for the existing emergency planning requirements is a perception that is put forth in NUREG-0396 and also in NUREG-0654 that there is a significant likelihood that the protective action guidelines would be exceeded beyond the site boundary.

I think that the protective action guideline analysis as it stands on the System 80+ docket demonstrates that that likelihood is certainly far, far lower than was perceived to be the case in 1975 or 1978 when NUREG-0396 was promulgated.

That in conjunction with other observations has led the Advanced Light Water Reactor Program to the point of view that emergency planning requirements should be reconsidered, but, clearly, any plant that intends to follow that course, however many twists and turns it may take, needs to make a demonstration that they meet that Utility Requirements Document requirement, and that is what the purpose of that calculation is.

MR. CARROLL: So you would see this as a possible action that the COL holder would possibly take?

MR. METCALF: I think that the demonstration has been made. The required demonstration has been made, and I don't know whether the staff would want to comment on their review of that -- they may or may not -- but, certainly, in our view, the demonstration has been made that for most core melt accidents -- in fact, for a very large fraction of the core melt accidents for this plant, the protective action guidelines will not be exceeded beyond the site boundary.

Now, that, in my mind, obviously has implications with regard to emergency planning requirements. It may not be so obvious to other people. So, if that demonstration has been made, exactly where this leads in terms of further work in the area, further communication with ACRS, I am sure the ALWR program will be following up on that.

MR. CARROLL: Would the staff like to comment on this issue?

You might as well stay up there. You are probably going to get some questions, too.

MR. KANTOR: Falk Kantor of the Emergency Preparedness Branch of the NRR staff.

For emergency planning requirements for advanced light water reactors, the policy was in 9308.74, the evolutionary reactors, and following that, the Commission did direct the staff to consider possible recommendations for criteria for simplification of emergency planning, and staff is developing a plan of action, and we are just, more or less, initiating that.

There are various staff groups involved in that effort. We are also talking to the industry; in particular, NEI for a plan course of action, which we will be proceeding on.

MR. CARROLL: You slipped NEI in on us. For us that were hear last month, that is NUMARC, right?

MR. KANTOR: Right, right.

But it is pretty premature as far as where this will all lead to, as indicated. In addition to technical factors, there are policy-type issues that have to be addressed, and we fully expect to be briefing the ACRS on this progress as we go along in the future.

MR. CARROLL: Do you basically agree with the evaluation that they have done that shows for this design it looks like it is below the PAGs?

MR. KANTOR: Well, for this one particular accident sequence, we did evaluate it, and for the assumptions, it was based on the assumptions they used. I think we came out in agreement with the calculation they did, but, I repeat, it was just one accident sequence in emergency planning. We are accustomed to working with a spectrum of accidents as part of our evaluation. So I think we will agree that the calculation they did appeared to be reasonable, but I think we are still far away from reaching any emergency planning conclusions.

MR. CARROLL: What kind of issues are you going to debate? Do we need sirens after 10 miles?

MR. KANTOR: Well, that would be part of the study. We would be looking at developing technical criteria first and then looking to see if that would allow the methodology for that and if that would allow a combination of reduction and emergency planning size or a reduction in emergency planning requirements within the existing emergency planning zone. That would be the type of considerations, but we still, I would say, are pretty far away from reaching that level of detail in our discussions.

MR. CARROLL: What is your schedule for reaching various milestones in this program?

MR. KANTOR: Well, in December of January, I think we promised the Commission we would be reporting to them in about a year on where we stood in our studies, which is the end of this year. This is now April, and we have gotten off to a somewhat slow start, but we are working on it, and we expect that by the end of the year, we will certainly have something to report to the Commission.

MR. CARROLL: Anyone else have any questions along those lines?

MR. KRESS: Will your deliberations on this extend to the site characteristics themselves, like highly populated areas?

MR. KANTOR: The evaluation I am speaking of, I don't think would take that into account.

Under Part 52, early site permit, the existing emergency planning requirements, that would certainly be a factor, but for the study I am talking about, that would be, I think, a follow-on type of activity.

As I think I indicated, we are working with the industry in developing this plan of action and responding to industry initiative. As it was put, the ball is now in their court.

MR. CARROLL: You guys are good at that.

[Laughter.]

MR. CARROLL: Any other questions of anyone?

[No response.]

MR. CARROLL: Thank you both, and now you get to do your thing.

MR. METCALF: Thank you.

I am not sure where you want to go from here.

MR. CARROLL: I am sure we are interested in steam generator rupture analysis, for certain. I am interested in natural circulation cooldown. I don't know what ASME valve sizing is, but why don't you start with steam generator rupture analysis.

MR. REZENDES: Chapter 5?

MR. CARROLL: Yes. I will find out whether I am interested.

[Slide.]

MR. REZENDES: I will be discussing the special analyses that are in Chapter 5 of CESSAR-DC.

There are three of these. One is the RSB, natural circulation cooldown analysis. Another is the ASME valve sizing, or sometimes called the overpressure protection analysis. The third one is a steam generator tube rupture containment bypass prevention, which is something that was requested by the staff to be evaluated.

[Slide.]

MR. REZENDES: With respect to the natural circulation cooldown, the intent is to demonstrate that after a loss of off-site power, the NSSS can be cooled and depressured from full power conditions to shutdown cooling system entry conditions using only safety grade equipment.

[Slide.]

MR. REZENDES: Here are some of the ground rules of the analysis, and I am not going to go through each one of them, but the second bullet does identify RSB 5-1 as the guideline.

[Slide.]

MR. REZENDES: The natural circulation cooldown to shutdown cooling entry conditions was achieved within 10 hours under RSB 5-1 restrictions. We assumed the loss of one diesel generator was the worst single failure. We did get a steam void formed in the upper head, but it is easily controlled, monitored, and collapsed, and the total emergency feedwater usage during the transient was 240,000 gallons, which is less the 35 percent of the total, which is 700,000 gallons.

MR. CARROLL: How do you know there is a steam void in the upper vessel head?

MR. REZENDES: Well, we computed it.

MR. CARROLL: How would the operator know that he should take action?

MR. REZENDES: Well, the operator has indications. I think Mike Cross, yesterday, discussed the heated junction thermocouple clusters in the upper head. So, actually, there are two pairs of those. You have inadequate core cooling instrumentation as well.

MR. CARROLL: Then he would use the vent system?

MR. REZENDES: Yes. It would be a cycling between the pressurized event and the upper head vent. by using upper head vent, that would help collapse the bubble in the head and bring in cold water into the head to cool it off.

Then, as you depressured through the pressurized event, then the bubble would expand again. So it would be a cyclic process.

MR. CARROLL: Have those sort of tests been run on, say, System 80?

MR. REZENDES: We are going to run some sort of test.

MR. CARPENTINO: I can answer that. Fred
Carpentino, ABB.

No. We have not done depressurization test on System 80. We are planning to do that sort of a test on our Korean units in the near future, however.

MR. REZENDES: You were saying System 80+. Are we planning on doing it on System 80+, was that your question?

MR. CARROLL: No. Have you done it on 80?

MR. REZENDES: Oh, on 80. I see.

MR. CARROLL: I guess he answered that, right?

MR. REZENDES: Yes.

MR. CARROLL: How about planning to do it on 80+?

MR. REZENDES: Fred, what about 80+? Is that in Chapter 14?

MR. CARPENTINO: Yes. There is a planned test for System 80+ to check the depressurization capability.

MR. CARROLL: You keep saying depressurization. I want to say natural circulation. Are we saying the same thing?

MR. CARPENTINO: It is pretty much the same. We are testing the steam venting capability under similar circumstances that would be used during the NCC cooldown.

MR. CARROLL: Maybe you haven't answered my question. Have you done natural circulation cooldown on System 80? Is that what you are going to plan to do in

Korea?

MR. CARPENTINO: We have done a natural circulation cooldown of the System 80 unit. We have tested it.

. The difference is that during the cooldown, pressure control was achieved by use of auxiliary pressurizer sprays.

MR. CARROLL: Right.

MR. CARPENTINO: In this unit, in the System 80+ units, we would count on using the strictly safety grade systems which drove us to use the vent system as opposed to the ox spray.

We will be testing System 80+ in a natural circulation mode, but we would be doing separate effects testing of the vent system, so that we didn't have to run the plant through a post-core venting of the radiation into the RWST.

MR. CARROLL: You have clarified that just fine.

[Slide.]

MR. REZENDES: The next transient overpressure protection, ASME valve sizing.

Overpressure protection is provided by the primary safety valves, secondary safety valves, and reactor protection system. The RPS contains two separate safety grade high pressure trips to mitigate overpressure transients. That is a standard RPS trip as well as the CPC auxiliary trip.

The criteria in here is to keep the maximum primary and secondary pressure below 110 percent of design during the most severe abnormal operational transient in conformance with the ASME pressure vessel code.

[Slide.]

MR. REZENDES: Again, here are some of the ground rules.

We did this analysis per the standard review plan Section 5.2.2. We don't credit control systems, and we didn't credit the first high pressure trip. We credited the second trip.

[Slide.]

MR. REZENDES: In general, the results were that the maximum primary and secondary pressure is less than 110 percent for the ASME code and the SRP, and the primary and secondary safety valves pass only steam after opening, since they are not qualified for two-phased flow.

The parametric evaluation of safety valve area verus peak primary pressure shows a linear function with modest slope. That picture is in the SSAR, but, essentially, are our design capacity, it shows a peak pressure of about 107 percent of design.

[Slide.]

MR. REZENDES: The next item is the steam generator containment bypass. The issue here is the capability of System 80+ to minimize the potential for containment bypass during steam generator. Containment of bypass is achieved by lifting the secondary safety valves.

[Slide.]

MR. REZENDES: We have N-16 monitors in our plant for detection, and we determined that with our current design features, which there is a slide here that outlines the current design features to help prevent lifting the main steam safety valves.

An example would be the component cooling water design permitting operation of the bypass system after SIAS. This would allow the instrument air system to continue to operate, and, thus, we can use the term "bypass valves" to relieve the condenser rather than through the atmosphere.

[Slide.]

MR. REZENDES: Generally, the results that we achieved were that, as a function of the No. 2 tubes ruptured, we have an MSSV lift time of up to five tubes, like about 30 minutes, and, for one tube, we have all the way up to 10,000 seconds. So there is a sufficient time for the operator to take action to help prevent lifting the secondary safety valves. In general, our conclusions were that where the current system made a design features, we reduced the risk for incurring an SGTR by, for example, the use of Inconel 690 and prove the event diagnosis in mitigation in, for example, N-16 monitors and accommodate the multiple two ruptures using automatic means. Thus, we don't have to rely on quick operator action.

[Slide.]

MR. REZENDES: That is all I have to say on Chapter 5. I guess I will continue on to Chapter 6 into the containment analysis.

[Slide.]

MR. REZENDES: The NRC approved codes we use for containment analysis, CEFLASH-4A for LOCA flowdown mass and energy release. During the LOCA reflood and post reflood states, we used the FLOOD-MOD2 code. The containment pressure and temperature analysis utilized CONTRANS code, and the main steamline mass and energy release used SGNIII.

[Slide.]

MR. REZENDES: Our results, we analyzed LOCA in the hot leg, suction leg, discharge leg, with maximum and minimum safety injection flow.

The main steamline break cases, we looked at with MSIV failure and containment spray failure at four different power levels. The results were for the LOCA, maximum pressure was 46.72 Psig. For the steamline break, it was 48.11 Psig, and the internal design pressure was 53 Psig.

So we maintained a 10-percent margin between the peak pressure and the internal design pressure.

[Slide.]

MR. REZENDES: Now I would like to progress to Section 6.3 which is the ECCS performance evaluation.

Included in this presentation in addition to ECCS is the post-LOCA boron dilution evaluation we did. So I will be discussing the ground rules for the safety analysis, the NRC approved codes, some of the design parameters affecting the safety analysis that have been changed due to the power upgrade, and the results for the large break, small break, and as I mentioned before, the post-LOCA boron dilution scenario.

[Slide.]

MR. REZENDES: The ground rules for ECCS analysis was to use existing NRC-approved models. We used the draft NUREG-1465 source term, as Jim Metcalf just mentioned, utilized the EPRI URD atmospheric dispersion factors. We used 18-month fuel cycle data, accommodated a 10-percent steam generator tube plugging margin, and upgraded the power level to 3914 megawatts.

[Slide.]

MR. REZENDES: My next slide here just lists the NRC-approved codes that we use for both the large and small break LOCA analyses.

[Slide.]

MR. REZENDES: The design parameters affecting the safety analysis, just for a summary, there are a couple of important things here. First of all, we have upgraded the power to 3914 megawatts, and the other thing is that we have changed the fuel design, such that we now have an integral and burnable poison, in which case the number of fuel rods has been increased due to the poison locations of the fuel rods.

This table, again, will show it in the Chapter 15 work because most of the parameters here really have a strong impact on Chapter 15 as opposed to the ECCS.

[Slide.]

MR. REZENDES: With respect to the large break LOCA, we evaluated various break sizes and locations in the primary coolant piping. The limiting large break with the double-ended guillotine in the pump discharge and the standard review plan acceptance criteria we used was the 10 CFR 5046 criteria of the peak cladding of less than 2,200 degrees, core wide oxidation not exceeding 1 percent, and the local cladding oxidation not exceeding 17 percent. The radiological consequences meet 10 CFR 100 guidelines.

[Slide.]

MR. REZENDES: This is a summary of the large break LOCA results. As you can see, we meet the peak clad temperature for the 3914 and the oxidation percentages. The thyroid dose dropped significantly due to the use of the NUREG-1465 source term. The peak clad temperatures increased mainly because of the power level and the change in fuel design.

[Slide.]

MR. REZENDES: With respect to the small break, again, we looked at various break sizes and locations in the RCS. The limiting small break turned out to be a .1-square-foot break in the DVI line. The biggest break in the DVI line that you can have is a .4-square-foot, just for the sake of comparison.

[Slide.]

MR. REZENDES: The summary of the small break evaluation, as you can see, because of the direct vessel injection, the peak clad temperatures are fairly low. However, they were increased from the original analysis mainly due to the higher power level.

[Slide.]

MR. REZENDES: Now I would like to talk about the post-LOCA boron dilution scenario.

This is a case where steam condensed in the RCS loop seals and caused an unacceptable reactivity change if swept into cores as an unborated slug. This scenario is only applicable to a certain break size in the range of 1 to

3 inches in diameter, since the larger breaks tend to remove steam to the containment and the small breaks don't void the RCS piping.

[Slide.]

MR. REZENDES: Here is just a picture of what I just mentioned. During the reflux cooling stage, there will be some steam condensing on the hot side of the tubes and draining back into the reactor vessel which is at a high boron concentration. However, there is also some steam that will be condensing on the cold side, and the condensate will tend to collect 'n the loop seals. This condenser, as it turns out, is fairly low in boron concentration.

[Slide.]

MR. REZENDES: So what we did is we demonstrated that only a small volume, about 375 cubic feet maximum per cold leg could collect in the loop seals.

We did a conservative analysis that demonstrates adequate core cooling as provided, even if a pure water slug is injected into the core.

The RCPs are soon to be stopped by the operators during a LOCA.

The EOGs were modified to minimize the likelihood of premature RCP restart. However, even though we did a realistic analysis, a mixing analysis, to show that if you did start up an RCP that you don't go critical.

MR. CARROLL: What is the function of the loop seal? Why do we need one?

MR. REZENDES: Excuse me. Could you repeat that, please?

MR. CARROLL: What is the loop seal there for? Why do we need it?

MR. REZENDES: Why do we put it in our plants in general? I am not really sure. Maybe somebody in the audience can help me there.

MR. RITTERBUSCH: This is Stan Ritterbusch.

The loop seal is there to get access to the reactor coolant pump.

MR. CARROLL: All right.

[Slide.]

MR. REZENDES: I guess we will continue on now to Chapter 15. We have gone through 5 and 6.

I will be discussing, as I did for LOCA, the safety analysis ground rules, the NRC-approved codes, and, again, the design parameters affecting safety analysis as well as the analysis presented in Chapter 15.

The ground rules, again, to use existing NRC-approved models using the draft NUREG-1465 source term for dose calculations, the EPRI URD atmospheric dispersion factors, the 18-month fuel cycle data, 10-percent steam generator tube plugging margin, what we did is consider lots of off-site power as part of moderate frequency events without reclassification. This was a GDC-17 issue we went through the staff on, and they decided they needed to impose that on us for GDC-17 to be satisfied.

We also used the zero-time delay for loss of off-site power subsequent to turbine trip. Way back a few years ago when we did the safety analysis, we had a 3-second delay. So we eliminated that, and we upgraded the power to 3,914 megawatts.

[Slide.]

MR. REZENDES: Here are the NRC-approved codes. CESEC, TORC, CETOP. TORC and CETOP are the DNBR codes. HERMITE is a 1D space time kinetics code. COAST is for the reactor coolant pump closedowns, and STRIKIN is a fuel performance code we use for CA injection.

[Slide.]

MR. REZENDES: Again, this chart on design parameters affecting safety analysis, the implications of the change in burnable poison from rods to integral is that it lowers the core average heat flux for us and, thus, gives us more thermal margin. So we are able to increase the power without really losing thermal margin.

We have increased the uncertainty on the PSV opening to 40 PSI. Due to a redesign in the main feedwater system, max and main feedwater flow increase from 140 to 160 percent.

[Slide.]

MR. REZENDES: We increased the letdown line K factor. This was really due to our original analysis, having doses too high, and so we did some work on the letdown line to restrict the mass release.

The reactor coolant pumps have been redesigned, and the surge line length has increased, which the significance there is that it can increase peak RCS pressures with some events.

[Slide.]

MR. REZENDES: Now I would like to go through some events. We will go through the seven categories, as identified in the standard review plan.

MR. CARROLL: The letdown K factor is simply an indication of how much flow can come out of a break in the letdown line?

MR. REZENDES: Essentially, that is the overall result, yes.

MR. CARROLL: So, by increasing the K factor, moire flow can come out?

MR. REZENDES: No, it decreases it. It decreases the flow.

In the original analysis, we credited the decontamination factor for doses and the nuclear annex, should I say, and the staff didn't want us ot do that. So we changed that to a DF-1, and we had imposed this restriction.

MR. CARROLL: This is accomplished by more or tighter orifices?

MR. REZENDES: Yes. Orifices, right.

MR. CARROLL: Okay.

[Slide.]

MR. REZENDES: Now I would like to start increase in heat removal events in the secondary system.

The format of what I am doing here is, essentially, I will identify the events, identify the limiting events, show you the acceptance criteria, and show you what we came up with.

In 15-1, the limiting modern frequency event was the inadvertent opening of the steam generator ADV with the loss of off-site power. As I mentioned, the loss of off-site power is part of our event.

Limiting infrequent event is that same event with a single failure added on, and the limiting accident are steamline breaks, since they are the only accidents in 15-1.

MR. KRESS: The moderate frequency event is one that is expected to occur in --

MR. REZENDES: Once per a reactor year.

MR. KRESS: Once per a reactor year.

MR. REZENDES: Yes.

[Slide.]

MR. REZENDES: Here are the acceptance criteria for the moderate frequency events, pressures less than 110 percent of design. The SAFDL is 1.24 for this plan. So the DNBR needs to remain above that.

The infrequent, we are allowed to have fuel failure, but we do have an off-site dose limit of 10 percent in 10 CFR 100.

For the accident, it depends on whether or not you include a pre-existing iodine spike, have fuel failure, or whether you have a generated iodine spike.

[Slide.]

MR. REZENDES: For the ADV event, we used what we believed to be the most negative MTC during the cycle. Although that is not currently in the tech specs, only the positive MTC is in the tech specs. The single failure was the loss of feedwater control system, reactor trip override, which results in excess feedwater flow upon reactor trip. So it accentuates the cooldown.

For the two events, the DMVRs are certainly above the 1.24 limit, although the event with the single failure is slightly lower than the event without the single failure.

[Slide.]

MR. REZENDES: With respect to steamline breaks, the limiting event was the steamline break outside containment during full power operation with loss of off-site power concurrent with turbine trip.

Again, we used the MTC of -3.5. There was no single failure to make the event more adverse. We did have a minimum DMVR above the SAFTL of the 1.25. However, we assumed for our dose calculation that it was a half-a-percent of fuel failure, mainly because I believe that wa the same number we had for System 80. So we included it, just for conservatism.

To our thyroid dose, the EAB was 70 rem.

[Slide.]

MR. REZENDES: The next set is the decrease in heat removal by the secondary system. The limiting event here is the loss of condenser vacuum by itself. There really was limiting infrequent event. Again, the loss of condenser vacuum by itself was still limiting, and, of course, the limiting accident is the feedline break, since that is the only accident in that section.

[Slide.]

MR. REZENDES: I will just point out for the acceptance criteria on the accident, we have two acceptance criteria. On the pressure one, it is less than 120 percent of design, and one is less than 110 percent.

The staff imposed that on us depending on whether or not we had loss of off-site power in the event.

[Slide.]

MR. REZENDES: With loss of condenser vacuum, we assume the MTC was zero. The single failure, as I mentioned, there was none. It may be a bit more adverse. We had a minimum DMBR of 1.26. Thus, we didn't have any fuel failure. Our peak RCS pressure was 27.26, and the limit being 27.50 for this event.

[Slide.]

MR. REZENDES: With respect to the feedwater system pipe breaks, the limiting break was a 0.6-square-foot break. The major assumptions was MTC of 0, and we credited the low-level trip to the case with off-site power available.

[Slide.]

MR. REZENDES: Continuing with the feedline break, the single failure was a failure of the emergency feedwater pump. The peak TCS pressure with loss of off-site power, I gave a peak pressure of 2793. For no loss of off-site power, it was 2676. the minimum DNBR with the loss of off-site power is 1.17. We achieved .22-percent fuel failure, and I came up with a thyroid dose at EAB of 19.5 REM. That was the case with the preexisting iodine spike.

The reason that had a higher dose in the case with fuel failure is that, when we did the calculation, we assumed that the break was outside contaminant as opposed to inside contaminant, which was done by SWEC for the fuel failure calculation.

[Slide.]

MR. REZENDES: The next section is the decrease in the reactor coolant flow rate events. This includes the total loss of reactor coolant flow nad our limiting accidents which is the rotor seizure event with loss of off-site power and a stuck-open atmospheric dump valve. As it turns out, that event bounds the shaft break event, just because the coast down is somewhat more severe with the locked rotor event.

MR. CARROLL: The coast down is somewhat more severe?

MR. REZENDES: For the locked rotor. Not much. Not much. You know, it is the thickness of a line. It is real close.

[Slide.]

MR. REZENDES: The acceptance criteria for the frequency event is less than 100 percent of design, and the DMVR above the STAFDL.

For the accident, the pressure is below acceptable design limits, such as chosen of 110 percent of design. The off-site dose is less than 10 percent of 10 CFR 100.

[Slide.]

MR. REZENDES: For the loss of reactor coolant flow, we assume the most positive MTC, and this is in the tech specs.

There was no single failure that made the event more adverse, and the minimum DNBR was 1.27. Thus, we had no fuel failure, and the peak RCS pressure was less than 110 percent of design.

[Slide.]

MR. REZENDES: The locked rotor event, as I said before, we assumed a single failure of an atmospheric dump valve to close. The minimum DNBR here was 1.09. We had 1.2-percent fuel failure, and our EAB dose was 3.18 REM.

[Slide.]

MR. REZENDES: Getting into the 15-4 events, the reactivity events, our limiting event for moderate frequency was the uncontrolled CA withdrawal at power with a loss of off-site power. The infrequent event was inadvertent loading of the fuel assembly, and that was the only one. The limiting accident was the CEA ejection.

[Slide.]

MR. REZENDES: As we take a look at the acceptance criteria, for the rod events, the only acceptance criteria is this DNBR above the STAFTL. For some of the other events, the pressure must be less than 110 percent of design.

For the fuel assembly misload event, if there was fuel failure, the limit is less than 10 percent of 10 CFR 100, and the accident for the ejection is the radially averaged enthalpy of less than and equal to 280 calories per gram, RCS pressure less than the service level C limit, which I believe is 3200 PSI. The off-site dose is well within 25 percent of 10 CFR 100.

[Slide.]

MR. REZENDES: For the withdrawal event, I just stated the reactivity insertion rate, which is based on a maximum withdrawal speed of 30 inches a minute, and our DMBR was above the SAFDL.

The inadvertent loading of the improper position, we were above the SAFDL and the off-site dose. Because of that, there really was, essentially, no release, and we are less than 10 percent of 10 CFR 100.

MR. CARROLL: What limits at the 30 inches a minute?

MR. REZENDES: Our rod system has two speeds, just 30 and 3 inches per minute, and that is the maximum speed. Maybe that doesn't answer your question.

MR. CARROLL: Why is it the maximum speed?

MR. REZENDES: I can't answer that question. I don't know if we have a mechanism person in the audience.

The maximum withdrawal speed of our reactor regulating system, why is it no greater than 30?

MR. SCAROLA: I think I can help. Ken Scarola.

The mechanisms will actually function a little bit faster than 30 if we allow them. They are basically limited by the magnetic field strength that we can actually induce around that pressure housing.

That field strength is a function of the voltage load current and is really limited by the amount of space that we have and the actual wire size that is being used. If we had more voltage, more current, we could move the latches faster, and then we could step the rods faster, but it has basically been optimized at 30 inches a minute for as long as I can remember.

MR. MATZIE: Regis Matzie.

The maximum speed is -- for reasons of rod withdrawal accident -- not inserting too much reactivity as a rate of time.

On a similar vein, there is a minimum speed. Typically, I believe, that was set by burnout of xenon. So you have to have enough ability to accommodate that, too. So these are the requirements functionally, and then Ken is telling, sort of, the electrical requirements on the speed.

MR. CARROLL: So it would be difficult to postulate a failure that would make them go faster?

MR. MATZIE: I think the answer is yes. The only other one, I think, that is postulated is a severance of part of the mechanism. So you get a rod ejection, but not rod withdrawal.

MR. CARROLL: No, that is a separate action that we are going to get to.

MR. MATZIE: Right.

MR. CARROLL: Okay.

[Slide.]

MR. REZENDES: With respect to the rod ejection accident, we assume the minimum delay neutron fraction either to impose the maximum rate of power increase during the ejected rod. The CEA ejection time, we assume, was .05 seconds, and the ejected CEA worth was .15 percent delta-rho.

The peak RCS pressure was less than 110 percent of design.

Our radially averaged enthalpy met the acceptance criteria at 280, and we did achieve 6.8 percent fuel failure.

MR. CARROLL: Why is that the ejected rod worth?

MR. REZENDES: Why is that the maximum?

MR. CARROLL: That was a number somebody gave you?

MR. REZENDES: Unfortunately, yes. That was a number our physics department --

MR. MATZIE: Regis Matzie.

I can answer that. We have rod insertion limits on the plant, and with those rod insertion limits in the analyzed reactivity of the worst rod, that is the maximum total reactivity that is available to be ejected.

[Slide.]

MR. REZENDES: The doses for the CEA ejection event come from two sources, the containment, 69.8 REM, and the secondary, 17 REM.

[Slide.]

MR. REZENDES: The next set of events is the increase in RCS inventory events which is the inadvertent operation ofd the ECCS and the CVCS malfunction pressurizer fuel event.

The limiting event is the CVCS malfunction with loss of off-site power, and I will be showing you the results of that event with a single failure.

[Slide.]

MR. REZENDES: Essentially, the acceptance criteria, the pressure is less than 110 percent of design and DNBR above what is applicable, and the off-site dose would be less than or equal to 10 percent of 10 CFR 100 in the infrequent event.

[Slide.]

MR. REZENDES: The maximum travel flor to the RCS based on CVCS is 150 gallons a minute. The single failure, we assumed was the failure of the proportional heaters to turn off. Peak RCS pressure was 2682, and the minimum DNBR was 1.62. The pressure increases during the events. So you really don't degrade your DNBR.

[Slide.]

MR. REZENDES: With respect to 15-6 events, we have an inadvertent opening of the pressurized safety/relief valve. It is really a spring-loaded safety valve and not a PORV as covered by Section 6.3, ECCS performance analysis; the double-ended break of the letdown line outside containment and the tube rupture events with loss of power with a single failure.

I will just mention the loss of coolant accident dose. I think Jim has been through that already. The acceptance criteria is depending on what the event is, either less than equal to 10 percent of 10 CFR 100 or the 10 CFR 100 guidelines themselves.

[Slide.]

MR. REZENDES: For the tube rupture event with loss of off-site power and a single failure, the single failure here was the failure of the ADV to close. For this event, we used the emergency operating guidelines, which are consistent with CEN-152.

The doses are as stated. Our limit here is 300 REM which is 10 CFR 100. So our maximum dose is the 93.1

for the preexisting iodine spike.

[Slide.]

MR. REZENDES: The loss of coolant accident, as Jim mentioned, some major assumptions are the NUREG-1465 source term. We have a containment leak rate of a half-a-percent per day to meet the EPRI requirement. We didn't credit the annulus and ESF charcoal filters, and the portion of containment leakage that bypass the annulus building was 10 percent. Thyroid dose was 171.7 REM.

[Slide.]

MR. REZENDES: The last section is the radioactive material release from a subsystem or component. The events are postulated releases due to liquid-containing tank failures, fuel-handling accident, spent-fuel cask drops. For the cask drops, we are not required to do an analysis if our drop height is less than 30 feet, and we meet that criteria.

MR. CARROLL: Why is that?

MR. REZENDES: We have limiters to prevent the height of the crane, I believe, from being lifted.

MR. CARROLL: Why did somebody say you don't have to do an analysis if it is less than --

MR. REZENDES: Oh, it is stated in the SRP.

MR. CARROLL: Why?

MR. REZENDES: It is stated.

I am not really sure. I can guess, and my thought would be that there is some other regulation defining how you design a cask.

MR. SEALE: The 30-foot drop test is a part of the criteria.

MR. REZENDES: It is?

MR. CARROLL: That is right.

MR. REZENDES: Okay.

MR. CARROLL: Or to a hard unyielding surface.

MR. SEALE: That is right.

MR. CARROLL: I remember that.

MR. REZENDES: It sounds familiar.

[Slide.]

MR. REZENDES: The major assumption on the tank failure is that it is a limiting tank failure with boric acid storage tank, and that is because it is the biggest tank and the one with the highest concentration of radionuclides.

The concentration, what we have done here is, normally, when you build a plant, you calculate your radio isotope concentration of potable water supply, but since we don't have a site, what we did is assumed we were at the limit and back calculated what we call a maximum dilution fact. Thus, we assumed the concentration at the potable water supply was equal to the 10 CFR 20 limit.

There is a definition of dilution factor, which is a very simple equation. If you take the concentration for a given isotope at the potable water supply, that is just equal to the dilution factor times the concentration of that isotope within the tank.

[Slide.]

MR. REZENDES: For the fuel handling accident, we assumed that for the dropped assembly, all rods failed, and our two-hour thyroid dose met the limit, which is 75 REM, being 53 REM.

That concludes my presentation. I think we have gone through 5, 6, and 15.

MR. CARROLL: I understand you had somebody who was going to tell us about the progress of the negotiations on CTG?

MR. TJADER: Good afternoon. I am Bob Tjader with the Technical Specifications Branch of NRR.

There was a question yesterday concerning the credit provided by the CTG and the Technical Specifications. The NRC Technical Specifications staff and the CE owners group representatives have agreed upon a 14-day AOT when one diesel is inoperable. That is provided that within 24 hours, the second diesel is verified that it is not subject to a common mode failure, and within 72 hours, it is verified that the CTG is available.

MR. DAVIS: Excuse me. On the first part, what is an acceptable way to verify that the second diesel is not subject to the same failure? Do you start it?

MR. TJADER: That is a possibility. It could either be an obvious analysis that would determine it or perhaps a test, a maintenance test, or, if necessary, start the diesel.

MR. DAVIS: I am thinking of the case where you attempt to start the first one and you don't know why it didn't start, and now the question is how do you verify that the second one is not subject to the same failures.

MR. TJADER: If you don't know, then I imagine when you get close to the 24 hours and you haven't determined yet, then I guess you would have to start the second.

MR. DAVIS: If you start it, is it unavailable for service?

MR. TJADER: The second diesel, you mean?

MR. DAVIS: Yes.

MR. TJADER: For service? By service, you mean serving its function?

MR. DAVIS: Yes.

MR. TJADER: I wouldn't see why it wouldn't be unavailable for providing it service. If you start it, it should be ready to be loaded, if procedures are followed.

MR. DAVIS: The CTG has to be available within 72 hours?

MR. TJADER: That is correct. That is based upon the fact that originally what CE provided us was a 72-hour AOT without any consideration for the CTG.

If we are granting now a consideration for the CTG, we think that within that 72 hours, it ought to be verified available.

MR. DAVIS: How do you do that?

MR. CARROLL: Fire it off.

MR. TJADER: Start it, I would think. I mean, it depends. Perhaps verification that maintenance was provided, if it had been started relatively recently, its maintenance performed, perhaps that would not be necessary. I haven't figured that out. I haven't determined that. It might well involve starting the CTG.

This was based on some PRA data. In a nutshell, with one diesel inoperable and a three-day AOT without any external event, such as a tornado, there was a core damage frequency of 1.6 times 10 to the negative 6 versus a 14-day AOT without external events was 1.74 times 10 to the negative 6, a 4-percent increase in that extension of AOT.

MR. CARROLL: That is when you go 3 days to 14?

MR. TJADER: Three days to 14 without external events was a 4-percent increase, 1.67 to 1.74 times 10 to the negative 6.

MR. DAVIS: Yes, but that external analysis does not include seismic.

MR. TJADER: It does not included seismic. However, a seismic margin assessment was performed, and that assessment determined that there was a high confidence of a low probability of failure of the CTG at a .36G, which from my understanding is fairly good.

MR. DAVIS: But it is not seismic?

MR. CARROLL: No. That is the HCLPF.

MR. DAVIS: Yes, I know.

MR. TJADER: A 14-day AOT was the maximum that was considered by the Tech Specs Branch. This was due to the fact that all maintenance, preventative and corrective, for the most part, virtually all maintenance can be conducted within that 14-day time period and that there was no need to consider any greater time limit such as 30 days.

MR. CARROLL: How about a bus crank shaft?

MR. TJADER: I don't see why that couldn't be repaired within 14 days.

MR. CARROLL: If you had the parts, I guess.

MR. TJADER: I think if you have the parts, that would be the thing.

I was on a submarine that had a broken crank shaft, and we did it within 14 days. So I think that it can be done.officers

MR. DAVIS: That would be an interesting case for the common cause failure. How would you know that the second one -- I think in that case, you would want to start the second diesel.

MR. TJADER: Common cause for a crank shaft?

MR. DAVIS: If you have a common defect in the manufacturing of the crank shaft.

MR. TJADER: That, hopefully, would be caught upon initial startup, not during operations perhaps.

MR. RITTERBUSCH: This is Stan Ritterbusch.

I just wanted to add one comment with respect to 30 days. Staff has not precluded us from asking for 30 days on any specific repair.

MR. TJADER: That is correct. If 14 days was not sufficient, then 30 days could certainly be requested.

MR. CARROLL: I would have thought that in this prescription, there would have been some consideration, you know, as a tornado circling the plant.

MR. TJADER: Yes. There was PRA done with tornado considerations. With a 3-day AOT with a tornado, there was a core damage frequency of 2 times 10 to the negative 6. A 14-day AOT with tornado was 2.62 times 10 to the negative 6, a 1-percent increase.

MR. DAVIS: I think Jay's concern is different.

MR. CARROLL: There is a tornado warning.

MR. DAVIS: There is a tornado warning.

MR. SHACK: If there is a tornado warning, what happens?

MR. TJADER: You get a tornado warning, I think that would be comparable to a hurricane. You would put the plant in the most stable, reliable configuration at the time, and perhaps that would be starting the diesels in advance to verify that they are operable.

MR. CARROLL: I got one diesel tore up.

MR. TJADER: Start the CTG. Make sure it is ready to go.

MR. CARROLL: Yes, but the CTG could get wiped out by the tornado, and now all I need is a single failure, and I am in real trouble.

The way I would have written the tech spec would have been sort of the way you did except if there is an immediate threat to the plant due to a tornado or a hurricane. Then you couldn't take credit --

MR. TJADER: Oh, okay. I see what you are saying.

MR. CARROLL: -- for the gas turbine, and then you would have to probably shut down in that event.

MR. DAVIS: That doesn't really help yhou much because if the tornado hits, you still need emergency power even if you are shut down.

MR. TJADER: It doesn't alter the situation either.

MR. CARROLL: You don't need as much.

MR. DAVIS: Well, I know, but you have got one diesel, and you have got to have it even if you are shut down. You don't have to fast start it.

MR. CARROLL: The other thing I would have thought in there was that since the gas turbine takes two minutes to crank up that you probably would have required them to have it reserved and running during this extended period.

MR. TJADER: Perhaps. I am not sure what is magic about two minutes. I am not sure that is critical.

MR. CARROLL: Well, we require the diesels to start in 20 seconds because of large break LOCA considerations.

MR. RITTERBUSCH: This is Stan Ritterbusch again.

I can answer that based on previous meetings with the staff. Their consideration was that, essentially, we would be leaving the maintenance and starting of the combustion turbine alone, and because we weren't placing additional requirements on the combustion turbine, we were limited to 14 days. So the staff made the judgment that by restricting us to 14 days, the two-minute start time would be acceptable.

MR. CARROLL: I think it is, anyway, because I think the 20-second start time is a bunch of nonsense. So that is for a large break LOCA, and you are not going to have one.

Any more?

[No response.]

MR. CARROLL: Well, I am glad to see we made progress on that issue.

MR. TJADER: I think we are near resolving all issues on the tech specs, and they are very near completion. They are working on them now.

Thank you.

MR. CARROLL: Thank you.

Looking at the agenda, it looks like what we have left today is -- did we do HVAC?

MR. RITTERBUSCH: No.

MR. CARROLL: We can't do HVAC without Carl.

MR. DAVIS: Yes, we can.

MR. SEALE: Only if you want to do it twice.

MR. CARROLL: Let's take a break now. Come back and we will hold off HVAC until Carl gets back, but we will look at some of the questions that we have that don't involve Carl or Ivan. Let's come back at a quarter of 4:00.

[Recess.]

MR. CARROLL: Let's reconvene. We're just going to try to pick up Bill's since he has to leave.

We were just talking about Staff 15. Bill is happy with the response he received there? Are we just going to get rid of Bill's?

MR. COE: Yes, he had 14 as well.

MR. LINDBLAD: I don't see 14 in here. Is that Staff?

MR. COE: It was a Staff -- no, I'm sorry. It should be in this.

MR. LINDBLAD: I don't find the No. 15, is my problem.

MR. SHACK: It's the last two digits.

MR. LINDBLAD: Okay. Page 2. I'm happy with the response on Tornado design.

MR. COE: There should be a portion that the staff answered and a portion the CE answered on that question. Have you seen the staff answer?

MR. CARROLL: Yes. He's happy with the Staff answer.

MR. COE: Have you seen the Staff answer?

MR. CARROLL: That's called 14, also?

MR. COE: No, it's 15. They give you the table with the wind speeds. And 14 is just in front of it. It's a CE response.

MR. CARROLL: Did you have any, Tom?

MR. COE: None for Tom.

MR. SEALE: Which ones are we looking at?

MR. COE: We are on 14 and/or 15 at CE.

MR. CARROLL: 14 has to do with max precipitation and roof design.

MR. COE: They provided a CESSAR table and indicated it's a revision.

MR. LINDBLAD: They've clarified the structural loading for precip on the structures, and I'm satisfied with that. It looks good.

MR. COE: Okay. 16 and 17.

MR. CARROLL: 15, isn't it?

MR. COE: 15 was the next one. I think you may have already looked at that.

MR. LINDBLAD: Yes. I think the issue on 15 was just a wording clarification. There were some ambiguities there, and while they have attached a lot of paper --

MR. CARROLL: Paper to confuse you.

MR. LINDBLAD: -- I think the staff's wording is really the responsive thing.

MR. COE: Okay. Then in the CE responses, Item 16.

MR. CARROLL: I guess in 16 I'm not sure.

MR. LINDBLAD: It seems to be silent of the turbine building siding.

MR. COE: Would CE like to comment?

MR. MATZIE: Certainly. We could add something about the siding, because it has been sided to get all safety-related equipment out of the turbine-missile zone.

I guess my question is, will the turbine-building siding stay on or stay off in high winds?

MR. RITTERBUSCH: It may come off. I believe our statement indicates that the -- the statement indicates that we believe the spectra of missiles that we include in our envelope covers the siding.

MR. LINDBLAD: Yes, I think it does too. As I was trying to speculate what an equipment design feature was that would minimize sources of missiles, all I could think of is one that would maximum turbine-building siding coming off to take the loads off the vents, which is done in some designs.

Instead of design features that minimized, I got a maximization in my example in my head, so yes, I know you're protected, even if it does come off. Thank you.

MR. CARROLL: I guess when that subject came up, I got worried about turbine-building siding ending up in switch yards and things like that.

MR. LINDBLAD: But we're supposed to live through that.

MR. CARROLL: Yes, I guess.

MR. LINDBLAD: And that happens regardless of whether it's turbine-building or whether it's a piece of construction warehouse.

MR. RITTERBUSCH: Is the wording of the response satisfactory? Is there a revision you would propose?

MR. LINDBLAD: When I think of equipment, I think of not bricks and mortar but machinery. I was rather interested in what machinery you had that was going to minimize missile generation, and I thought you were going to tell me something about the combustion gas turbine blades that wouldn't provide for a missile, and I didn't hear that in your response.

Is the failure of a combustion gas turbine blade considered one of the missiles to be protected against?

MR. RITTERBUSCH: I don't know. I believe the statement about reducing their likelihood of creating a missile is based on statements we made in Section 3.5, additional bolting on bonnets and multiple protection against things breaking loose.

I'm not aware of specific comments on the turbine blades.

MR. CARROLL: But that gas turbine is located out in the yard structure, a long way from anything.

MR. LINDBLAD: I'm not troubled by this answer, no.

MR. CARROLL: Okay. Thank you.

MR. RITTERBUSCH: Thank you.

MR. LINDBLAD: I have one other. Which is it, Doug?

MR. COE: The next one, 17, and then there's two from an earlier. We'll get to those in just a second.

MR. LINDBLAD: What about reactor coolant pumps running at 95 percent frequency?

MR. COE: That was an old question from February. We'll get to that.

MR. CARROLL: That was really my question, not yours, but okay.

MR. COE: The next one on March was Question 17. We might as well pick that up. That's the last one for March.

MR. LINDBLAD: Yes. I think the answer says yes, it is covered by the text specs limiting condition of operation. That was basically the question I had.

MR. COE: Okay. The two questions from February were 3 and 8.

MR. CARROLL: Do I have that someplace?

MR. COE: You have it right here.

MR. CARROLL: All right.

MR. LINDBLAD: Question 3 from February, I guess.

MR. CARROLL: That was Ivan's question. Do you have Lindblad for that?

MR. COE: Yes. Actually, 3 had to do with the lower grid flow plate, sizing of the holes. Then Question 7 from February had to do with the 95 percent.

MR. CARROLL: I swear 3 was Ivan's question.

MR. COE: Mr. Lindblad had a question --

MR. LINDBLAD: But my question is, when you have safety injection with an upstream strainer that strains out things that might plug the containment spray or the pumps, or something like that, does it pass material that could plug the lower debris traps on fuel?

MR. CARROLL: Good question.

MR. RITTERBUSCH: I guess we don't know where little bits of debris come from. I suppose it's conceivable that some could come in from the safety injection. However, the debris that we're most concerned about and the debris that we catch with this grid, I believe is from possibly maintenance activities in the primary system itself, and bits of material that are generated from within the reactor cooling system.

MR. LINDBLAD: And that's in normal operation -- normal power operation --

MR. RITTERBUSCH: Yes.

MR. LINDBLAD: -- where would we see a starvation in temperatures and the like, and we could monitor the performance of that, normally.

MR. RITTERBUSCH: Correct. And there is --

MR. LINDBLAD: But now I'm talking about the safety case where there might be disruption of materials that might pass through whatever strainers safety injection systems have.

MR. RITTERBUSCH: It is possible that some material could get in there. What our analysts have shown through other questions is that you would have to plug off a very, very large area at the bottom of the core before you would get into any additional fuel melt or cladding failure.

The reason is is that the fuel assemblies are open, and if you starve flow in one area, that will tend to draw in flow from surrounding areas. That's an inherent, I guess, benefit of having the open fuel assemblies.

MR. LINDBLAD: Okay. So you think yes, during a safety injection, the debris system may collect addition debris, but you've done an analysis that says it's not serious to cladding damage?

MR. RITTERBUSCH: We did a review of what would be required to cause some additional problem in removing heat from the core, and their deduction was that it would be a very large amount of plugging. They did not specifically say where that material came from.

MR. LINDBLAD: Are there places, such as tank linings or insulation, or whatever, that --

MR. CARROLL: Beer cans.

MR. RITTERBUSCH: I'm not aware of it.

MR. CARROLL: Bill, we're going to probably have at least part of a day meeting in May. Would you like them to go back?

MR. LINDBLAD: Would you close that loop? It sounds like you've got 99 percent of an answer there.

MR. RITTERBUSCH: We will go back and ask specifically about the situation of what we assume during these safety injection operational mode.

MR. LINDBLAD: Fine. Thank you.

My other thing about reactor coolant pump speed, off standard speeds, it seems to me that what we've read is that there is a single-element trip that is based on frequency only.

It would just seem to me that if there were a sudden dip in recovery that went past five percent under frequency, that that might be acceptable if pumps had moments of inertia to coast through it.

Isn't there a time element involved in this?

MR. CARPENTINO: This is Fred Carpentino, ABB.

I think the answer we've given you is that there is a reactor trip that would be activated on the basis of pump rotational speed not frequency.

MR. LINDBLAD: I see.

MR. CARROLL: They don't use frequency like Westinghouse does.

MR. CARPENTINO: Right. Now, there are very large flywheels on the pumps which would allow the pumps to ride through brief interruptions or reductions in frequency.

However, I would have to guess at this point. I think we're talking about several second degradations in frequency that you can ride through, based on rotational inertia, and not trip.

MR. LINDBLAD: So by relying on pump speed, you say it is appropriate just to use a single-element speed alone rather than some function of speed and time?

MR. CARPENTINO: Right.

MR. LINDBLAD: All right. Thank you.

That takes care of my questions, thank you.

MR. COE: Okay. I guess we can move onto the March questions that you had expressed, Mr. Chairman.

MR. CARROLL: All right.

MR. COE: Starting with Question No. 18, responded to by CE.

MR. CARROLL: All right. 18.

MR. SEALE: Shoulders your backseats on bonnets.

MR. CARROLL: I notice you've been asked to comment on the FSER at this point. Did you correct that in the FSER, or ask the staff to correct it? I don't have that with me. In fact, I don't know where this CE review of the FSER stands. Is it underway?

MR. GERDES: This is Lyle Gerdes, ABB-CE.

The review of the staff's FSER is undergoing at the present time. If I recall correctly, the comment that was expressed at last meeting, was that the statement would be that there could be no missiles, or something to that extent.

MR. CARROLL: It says: ABB states that no missiles are postulated from valves because all valve stems are provided with a backseat or shoulder that is larger than the valve's bonnet opening.

MR. GERDES: That is what is stated in the SER. A copy on the response: There are no missiles postulated from valves for the following reasons, and then it gives the reasons. Page 3.5-3 of the SER, which is attached to the response to that question.

MR. CARROLL: I see. Are there some semantics I don't understand? Your response says: C does not state that there are no missiles from valve stems.

MR. RITTERBUSCH: Lyle is reviewing that section of the Safety Analysis Report, and he will be providing proposed words to make the FSER consistent with our statements in CESSAR-DC.

MR. CARROLL: I don't know that you need to do anything.

MR. GERDES: I believe that is correct.

MR. SEALE: Just modify the CESSAR.

MR. CARROLL: They re not inconsistent, I don't think.

MR. GERDES: If you will note, we did add the COL action item as part of the response that the applicant will ensure that the As-built conditions provide the Category 1 structure systems and components protection from credible, potential missiles. We did not have that COL action item.

MR. CARROLL: Okay. I guess I'm happy. Okay.

MR. COE: No. 19, the next one.

MR. SEALE: What's next?

MR. COE: No. 19 is the next question. This concerns the depth of the CTG building foundation and the height of the building aboveground and the seismic qualifications of the fuel tanks.

MR. CARROLL: I guess the response doesn't tell me anything about seismic qualification of the fuel tanks.

MR. GERDES: Again, Lyle Gerdes, ABB-CE.

The combustion turbine generator, again, is a non-seismic Category 1 turbine. We have made a commitment under the seismic margin assessment that it would be demonstrated to have a HCLPF value of .36g, or be demonstrated that the earthquake would not cause damage to the turbine.

We assume that that would mean that the fuel tanks would also have a HCLPF value of .36g.

MR. CARROLL: I think that was what precipitated my question. Nobody could tell me that before.

MR. GERDES: We will modify the response before the official transmittal, to include that.

MR. CARROLL: Okay.

MR. DAVIS: On that response, by the way, the last sentence says that the maximum possible flood elevation will be a minimum of one foot below the lowest CTG operating component.

Do you mean maximum probable flood, or do you really mean maximum possible?

"Maximum probable" has some regulatory connotation, but I don't know what "maximum possible" is.

MR. GERDES: That will be changed to "probable."

MR. DAVIS: Thank you.

MR. CARROLL: 20 is the next.

MR. COE: The next question is 20, and that one was for the staff.

MR. CARROLL: That should be on the staff response.

I'm satisfied with the staff's response. That's what I wanted them to say. Okay.

MR. COE: The next one is Question 21.

MR. CARROLL: And that's for the staff.

MR. COE: That's for CE. I'm sorry, you're correct. It's for the staff.

MR. CARROLL: Why don't I find 21.

MR. COE: It's the first question on the package. It's labeled 13. It must have been misplaced. It's the first question.

MR. CARROLL: It's a staff response.

MR. COE: It was mislabeled as 13. It's actually 21.

MR. CARROLL: Okay. That helps explain it. It's in the casks.

MR. COE: The last one for Mr. Carroll is Question 22, directly to CE.

MR. CARROLL: Did I really ask that? Okay.

Have you looked at it, Pete?

MR. DAVIS: Yes. I don't think you asked the right question. You should have asked why is it so low compared to those other studies, but I think we've gotten the answer in the discussion on the PRA.

MR. CARROLL: All right.

MR. DAVIS: Incidentally, I had asked a question that I don't see the answer to in any of this. If we're finished --

MR. CARROLL: No.

MR. COE: There's one last question that --

MR. DAVIS: You said the last one was the last question.

MR. COE: I'm sorry. That was the last one for Mr. Chairman here. You've got one, Question No. 24, which is the last question in the package that was directed to CE for the March time frame. This had to do with the fire barrier failure probability. Is that the one?

MR. DAVIS: I'm satisfied with that.

MR. COE: Okay. Was there any other question?

MR. DAVIS: I had one from the last meeting that I expected to find in the package, and it may be my fault because I didn't really ask it clearly.

You may recall there was a question I had, or a concern, about the extremely low frequency that was used for the loss of off-site power frequency in the PRA.

The answer I got at the time is that that number was low because you have separated and redundant switch yard feeds coming into the plant, and you also have the ability to run back the turbine.

It looks to me like --

MR. CARROLL: Independence switch yards, right?

MR. DAVIS: But not diverse. It looked to me like, in looking at the event tree in the PRA, those things have been counted twice, because the low initiating event frequency was used as the input to the event tree, and then those things were counted again as it was processed through the tree.

Whoever was making the presentation, at least didn't clear it up to my satisfaction. Do you recall that discussion now?

MR. RITTERBUSCH: This is Stan Ritterbusch. I do recall the question. I thought we had provided a response.

MR. DAVIS: You mean in this material or during the meeting?

MR. RITTERBUSCH: No, in this material, in the written response.

MR. DAVIS: I didn't see it. Could you point it out to me?

MR. RITTERBUSCH: That's what I'm trying to do.

What I remember is a challenge to one of the PRA assumptions, and we had to provide a response. I'll look at it and find the response that I remember, and we'll see if it matches your question.

MR. DAVIS: Okay. I couldn't find anything even remotely resembling the question.

MR. RITTERBUSCH: I found the response. It's not related to the loss of off-site power assumption, I was thinking of the response that we provided in Item 24.

MR. DAVIS: Okay. So that's one that you owe us?

MR. RITTERBUSCH: Yes, we owe you a response.

MR. DAVIS: We can pick that up at the May meeting. That's really all I had, in addition to what's been provided.

[Discussion off the record.]

MR. SHACK: Just one comment, in your section there on Erosion/Corrosion, 10.3.6.2.g.5.

MR. CARROLL: You're getting to sound like Ritterbusch.

MR. SHACK: The third sentence isn't a sentence. It's clear enough what it wants to say, but it doesn't say anything at the moment. It's a grammatical error.

[Laughter]

MR. CARROLL: How did they do on hyphens and apostrophes?

MR. SEALE: And colons.

MR. SHACK: I didn't worry about any grammatical errors where I could make sense out of it, but grammatical errors where the sentence isn't a sentence poses a problem.

One thing I did note, in the FSER here, it says that: ABB-CE proposed that engineering evaluations would be performed on a case-by-case basis, using industry accepted methods.

I really couldn't find that statement anywhere in the CESSAR, and if you're changing 10.3.6.2.g.5, you could just add a sentence that you would analyze these things on a case-by-case basis using industry-accepted methods, and it would make me happy.

MR. BRUSTER: This is Larry Bruster.

I'll do that for you, but right now, in Section 3.6.2.1.2.1, is where we've discussed the erosion/corrosion and how we'll do it, and it'll be in accordance with industry-accepted standards.

MR. SHACK: I know, but then you have another -- it's addressed in a couple of places, but I'm trying to figure out where the maximum place was.

MR. BRUSTER: I'll make that consistent for you.

MR. CARROLL: Bill, did we get through all of the material issues that you had an interest in?

MR. SHACK: Yes. I think basically we addressed them, yes. Again, I would like to see this limit on lower sulfur applied to other pressure vessels, like the steam-generator shell, too, since it won't cost you anything.

At the moment, it's stated, really, as only -- you know, your specs, even now, are really applying only to the RPV, and nobody says anything about the shell, but it would be nice to have essentially high toughness and low crack growth rates in that shell, too.

MR. CARROLL: I guess Seale and I still have a question -- the vessel reminded me of it, on fluence.

I think the answer we got yesterday was on NDT shift.

MR. SEALE: Yes. We talk about a temperature difference.

MR. CARROLL: It's just a curiosity kind of question.

MR. RITTERBUSCH: It was my understanding that that had been clarified earlier this morning, and that the answer was that we didn't perform a fluence calculation at the top of the vessel.

Our people were trying to indicate that even if you assumed the fluence at the top of the active core, at the well location, was equal to what it would be at the mid-plane, we would still pass the RTND test, and therefore we didn't do the detailed calculation.

MR. CARROLL: Okay. I guess that makes me happy.

MR. SEALE: It's a reasonable way to avoid the question.

MR. CARROLL: Or to do a fluence calculation, yes.

Okay. What are we going to do now?

MR. WAMBACH: HVAC.

MR. CARROLL: We still have Mr. Janck sitting back here. I think we better wait for Carl to get back because he's going to have a lot of questions.

Shall we take a break, then.

What's the combustion situation? Would you guys like to wait around a few minutes and see if they come back or would you like to --

MR. CROM: This is Tom Crom. I will be giving the HVAC presentation. I'm scheduled to be here through tomorrow, right now, so I can either do it late this evening or whenever. I've got a lot of time.

MR. CARROLL: Okay. We've stalled long enough.

We have two items left this afternoon, a presentation on HVAC and the questions. You look like you'd just as soon go home. Why don't we do the HVAC presentation, and then we'll the Catton/Michelson questions.

MR. CARROLL: Tom wanted to do it without you, Carl, but we pointed it out to him he'd just have to do it twice.

MR. CROM: I'm Tom Crom from Duke Engineering.

Let me just put up this slide here.

[Slide]

MR. CROM: This is a slide of all of the HVAC systems that are in the System 80+ Standard Design. You can see that there's a lot of those. It's typical. Nuclear plants have a considerable amount of different HVAC systems.

Of course, the annulus ventilation, control complex, subsphere, fuel building, and diesel building are also safety-related systems, the other ones are all non-safety.

MR. MICHELSON: Why is the annulus ventilation safety?

MR. CROM: Because it is what is credited for the secondary containment for pulling the negative pressure.

MR. MICHELSON: You're using it for gas treatment as well?

MR. CROM: It's for filtering your leakage to your secondary containment.

MR. MICHELSON: Yes.

MR. CROM: One thing I am going to mention here is most of our HVAC systems are pretty much traditional from what you see in plants. I'm going to go through a slide that tells the differences of what we have in our designs first.

You may ask the question as to whether you really want to go through all these HVAC systems because it can take a considerable amount of time or it is one that you may particular want to hit on. I'll leave that to your discretion.

[Slide]

MR. CROM: Some of the major features that we have in our HVAC designs is, first of all, all HVAC cooling is provided by chilled water. Of course, the major difference being that a lot of current designs have it on service water, particularly the containment cooling, but a lot of them have had to backfit to chilled water. I know McGuire and Catawba had to do it in lower compartments and things like that, due to high temperatures.

As we discussed yesterday on the chilled water, all cooling is done by the -- HVAC cooling is provided with chilled water.

Another feature that is different is we provide redundant recirculating air conditioning units, are provided for the following areas, and those are all of the safety-related equipment rooms in the control complex. We provide two, 100-percent units for each area in that particular division to address the concern if it runs out.

MR. MICHELSON: Let me make sure I understand that.

If I have a division -- I guess it's Division 1 that you call it?

MR. CROM: Yes.

MR. MICHELSON: You have in Division 1 a Division 1 and a Division 2 air conditioning?

MR. CROM: No, sir. What I'm saying is, in Division 1, in for example the central electrical rooms, each one of those particular rooms have two, 100 percent recirculating units powered from the Division 1, diesel generator.

MR. MICHELSON: So it's not redundant --

MR. CROM: That's correct.

MR. MICHELSON: -- in the sense of auxiliaries required for its functioning and that sort of thing?

MR. CROM: That's correct.

MR. MICHELSON: Power and stuff is not redundant.

MR. CROM: It's basically if you have one unit out for maintenance, you have one there that continued to operate.

MR. MICHELSON: These redundant active components are something.

MR. CROM: Yes.

MR. MICHELSON: Some people think redundant means really redundant.

MR. CROM: Okay. The next one, as you have heard, in the Chapter 15 analysis, carbon adsorbers are only credited in the control room ventilation system for accident analysis. However, all of our systems that are filtration systems do still have the carbon adsorbers in it. The reason for that is we still need to credit carbon for the normal release limits for 10 CFR 20, Appendix I, particularly with the one percent failed fuel. We had a very stringent Chi over Q for the standard plant to meet those particular limits.

The big advantage that we get out of not crediting them in accident analysis is they're no longer text speced.

If you should fail the particular tests on the carbon for red guide 1.52 and now not in immediate LCO.

MR. MICHELSON: Did I understand that all of the systems have carbon adsorbers?

MR. CROM: That's correct. Anything that has a filter in it, we still purchase a Red Guide 1.52 filter with the carbon adsorber.

[Slide]

MR. CROM: Of course, we design HVAC systems such that flow is from clean areas to contaminated areas for radiation protection reasons. Again, like I say, these are the traditional once-through systems: the nuclear annex ventilation system; subsphere; fuel building; radwaste, and containment purge, and those are almost all traditional, except for the nuclear annex and subsphere, as we talked about previously, and fire protection do not have any cross connects between the two divisions, as far as the HVAC is concerned.

MR. MICHELSON: How did you divisionalize the -- what is that, inside the shield building -- the annular space?

MR. CROM: The annulus is not -- the actual annulus itself is not divisionalized. It's considered like it's part of the containment.

MR. MICHELSON: But you do have two different trains of equipment, then?

MR. CROM: Yes, outside.

MR. MICHELSON: One side of the annulus, and the other over on the other side?

MR. CROM: The actual fans and filter units are outside of the annulus and separated by the divisional wall.

MR. MICHELSON: But duct work comes in 180 degrees apart or something?

MR. CROM: The duct work is actually common for the two units.

MR. MICHELSON: Okay. So you're using --

MR. CROM: Yes. Common header with both being located up above and down below.

MR. MICHELSON: Not real physical separation, then?

MR. CROM: That's correct.

MR. MICHELSON: All right.

MR. CROM: On all of our systems we have normal releases monitored upstream of filters and at the unit vent, which was discussed in our radiation monitoring sections.

Of course, we say that nuclear annex ventilation and subsphere ventilations are division specific and have no duct penetrations through the divisional wall.

[Slide]

MR. CROM: Let me start with the safety-related systems. I'm going to start with the annulus ventilation system, real quickly.

The main design bases is to collect and filter containment leakage following a LOCA to meet 10 CFR 100 release limits.

Design Summary: The system consists of two safety-related divisions. Each division consists of a filtration unit, fan, dampers, ductwork, and associated instrumentation. Again, each filtration unit meets Regulatory Guide 1.52.

The system is automatically started. This is typically just a standby system. It's only needed for a LOCA situation, and is automatically started on containment spray actuation signal.

MR. MICHELSON: Is that a non-ventilated area, normally?

MR. CROM: That's correct.

MR. MICHELSON: You don't have a heat build up or anything like that to worry about?

MR. CROM: No. The heat is removed by the containment coolers through the steel shell.

It's traditional. McGuire and Catawba do not run those systems the same way.

MR. MICHELSON: Yes. But you have hot pipes running through it. They are insulated and so forth --

MR. CROM: That's correct.

MR. MICHELSON: -- but they're still heat sources, and there's no heat removal capability, other than the heat transfer back through the walls.

MR. CROM: That's correct.

The dampers are modulated to exhaust and return flow to maintain the annulus pressure at a -0.5 inches water gauge.

MR. MICHELSON: Actually, I guess your walls aren't the heat sinks, they're the source, because the containment's hotter inside than the annulus, normally.

MR. CROM: That's correct.

MR. MICHELSON: So you're heating the annulus, and you're hopefully now transferring that heat on out through the shield wall out there.

MR. CROM: Yes. You're maintaining the annulus below, essentially, 110 degrees, or somewhere in that range based on the containment cooling.

MR. MICHELSON: You've done the calculation. That's when we had come up with that answer. You don't have any direct cooling of the annulus.

MR. CROM: That's correct. That's traditional for all secondary containments. McGuire and Catawba have secondary containments to provide no cooling in the annulus area.

MR. MICHELSON: You have ice condensers and stuff, too.

MR. CROM: Okay.

[Slide]

MR. CROM: Just a slide on ITAAC, items that we cover in the ITAAC. Most of the items I've covered previously in the SAR. Just a picture of the system. Again, the lower annulus being the return headers and the pressure control, and of course the suction coming up from the upper annulus area.

[Slide]

MR. CROM: Of course, probably one of the most difficult systems and has the most to it is, of course, the control complex ventilation.

Design bases is, of course, to maintain acceptable temperature limits in the control complex both for operator comfort and for equipment qualification; to maintain continuous pressurization of the control room in the tech support center; to maintain the control room operators within regulatory limits; and, also to protect the control room personnel from effects of toxic chemicals, smoke, or effects from high-energy line ruptures.

MR. CARROLL: I'm surprised at the control room temperatures. Those seem high to me.

MR. CROM: Control room temperature between 73 to

78?

MR. CARROLL: Yes.

MR. CROM: That is the EPRI URD requirement that we set it to.

MR. CARROLL: What do the human factors people say about that?

MR. MICHELSON: That's hot.

MR. SEALE: This will let them snooze all day.

MR. CARROLL: I'd be interested in where those numbers came from. They seem higher than I would have expected.

MR. MICHELSON: Yes.

MR. CARROLL: I know you can't comment on this from a human factor point of view, because you don't have a degree in human factors.

[Laughter]

MR. DAVIS: I don't either, Mr. Chairman, but I do know that there are studies showing that human performance begins to degrade measurably after about 90 degrees.

MR. CARROLL: Oh, yes, I know that.

MR. DAVIS: This is considerably above.

MR. CATTON: Also studies that show if you're a little bit uncomfortable you do a better job.

MR. DAVIS: But if you're a lot uncomfortable, you don't do a better job.

MR. CARROLL: I would have guessed the numbers would have been 68 to 70, or something like that -- or 72.

MR. MICHELSON: We don't have enough computers around to keep the rooms cool. If you have computers around, then they'll keep the rooms cool.

MR. CARROLL: Okay. Just a curiosity question.

[Slide]

MR. CROM: As far as the design summary, as far as the main control room, it consists of two safety-related divisions. Each division provides 2000 CFM intake air for pressurization; and 4000 CFM is recirculated for cooling and air cleanup.

Of course, we talked about each division is provided with a Regulatory Guide 1.52 filter. In this one, of course, we did credit the carbon filters for the accident analysis.

Filters are normally bypassed and are automatically aligned on safety injection actuation signal or high radiation signal.

Outside air for pressurization can be taken from either of the two intakes which are on opposite sides of the control complex.

MR. MICHELSON: Is the control room air conditioning completely isolated from the balance of the control complex air conditioning?

MR. CROM: Yes.

MR. MICHELSON: Are they using common inlets and common aisleways?

MR. CROM: Yes. We have separate intake headers.

MR. MICHELSON: And separate exhausts?

MR. CROM: There is no exhaust on the control complex. This is a --

MR. MICHELSON: Oh, you're just recirculating.

MR. CROM: Recirculating air.

MR. MICHELSON: So you have to make up from --

MR. CROM: That's right, but the intakes are separate. That is correct.

MR. MICHELSON: But the battery rooms, which apparently are nearby, at least they were listed on the previous slide, that air never mixes with the control room?

MR. CROM: That's correct.

MR. MICHELSON: Okay.

MR. CROM: That's correct.

Also, the intakes are automatically isolated on detection of smoke or toxic gases.

Upon detection of radiation in the intake, the intake having the higher radiation dose closes automatically and will realign such that the intake with the higher radiation closes and the one with the least radiation opens.

That was based on the Chi over Q for the control room to get it to acceptable control room doses to keep the control room pressurized at all times.

[Slide]

MR. CROM: The technical support center air conditioning receives outside air from the control room air conditioning system intake ducts. This is one that is on the same intakes as the control room itself.

It also consists of a single, non-safety division with pressurization fan, filtration unit, and air conditioning unit supplied from normal chilled water.

The balance of the control complex, supplied from a separate intake, as we said, from the control room, the tech support center. We provide, as I said earlier, redundant recirculating units for all of the safety-related areas.

MR. CARROLL: What are the differences between the tech support center and the main control room in terms of habitability under accident conditions?

MR. CROM: The habitability, we consider to be the same. It's just that we're using a non-safety unit doing the same functions for the tech support center.

MR. CARROLL: What about the safe shut down panel room?

MR. CROM: As far as accident scenarios, we don't provide any pressurization filtration, because it's not considered in that scenario. However, as far as the cooling is concerned, it's the same habitability.

MR. CARROLL: Okay.

[Slide]

MR. CROM: Going on with the balance of control complex, we also provide redundant recirculating air conditioning units for the non-safety computer rooms, because those are also important for plant operation.

However, we only provide single, recirculating units for the operation support center, non-essential electrical rooms, non-safety battery rooms, and other non-essential areas.

MR. MICHELSON: Where's the Technical Support Center located?

MR. CROM: The Technical Support Center?

MR. MICHELSON: Yes.

MR. CROM: Is right behind the control room where the viewing screen is up one level, so that you can view down onto it.

MR. MICHELSON: I don't see it. Maybe I'm not looking right. Is it labeled?

MR. CROM: Which?

MR. MICHELSON: Oh, yes. TSC Area. All right.

MR. CROM: Yes.

MR. MICHELSON: Okay. That's where it is.

MR. CROM: Yes.

MR. MICHELSON: All right. Thank you.

MR. CROM: Okay.

Each battery room has an exhaust fan taking suction, near the battery room ceiling. Smoke removal for each area is accomplished by smoke purge fans, as we discussed this morning.

MR. CARROLL: So you had just a single fan in each battery room?

MR. CROM: That's correct.

MR. MICHELSON: That exhausts to a common duct that goes out to the atmosphere?

MR. CROM: When you say "common duct," do you mean --

MR. MICHELSON: If they're common with anything else, the discharge.

MR. CROM: No. No. It has a separate exhaust.

MR. MICHELSON: Where does it exhaust to?

MR. CROM: It exhausts -- I'm not sure of the exact location, but it exhausts out the roof. I'm not sure of the exact location on the building.

MR. MICHELSON: I guess I have a small question; that is, is that going to be a security vulnerability to have the exhaust coming out the roof of the control of the Nuclear Annex?

MR. CROM: Is that going to be a security problem?

MR. MICHELSON: Yes, yes. You know what I mean.

MR. CROM: Yes. No, we're going to have to design anything for security.

MR. MICHELSON: You're going to have to make sure you can come down in the ductwork.

MR. CROM: Yes, you have to put the appropriate bars and stuff in so a saboteur can't come crawl through those, yes.

MR. MICHELSON: Yes.

MR. CARROLL: I wouldn't imagine the ducts are that big.

MR. MICHELSON: They don't have to be very big. You know, to get into a battery room, what do you think they have to drop in? Not much.

MR. CROM: Yes. We do have a requirement in CESSAR that all of those penetrations will have the bars to prevent saboteur.

MR. MICHELSON: This is a serious weakness that some people have, and that is, running a shaft straight up to the roof.

MR. CROM: I understand.

MR. MICHELSON: Then the helicopter comes in handy.

MR. CROM: I understand.

[Slide]

MR. CROM: I'm going to skip over the ITAAC slides and then just show the -- this is the control room ventilation system; the two units for the control room and, of course, a similar type unit. This doesn't really show it for the Tech Support Center.

Also, having the smoke purged for the control room there; and also the isolation dampers that alternate between, depending on which has the least dose.

MR. CARROLL: Some utility -- I wish Lindblad were here so I could needle him -- make the mistake of having some hydrogen vents on the roof, just adjacent to the control room outside air intakes. You're not going to do anything dumb like that, are you?

MR. CROM: No. You're talking about --

MR. CARROLL: Trojan.

MR. CROM: Yes. We h some interface requirements, you know, when we talked about compressed gas systems and location of hydrogens, that they're away from control room vents and stuff.

[Slide]

MR. CROM: These are, again, ITAAC figures. They're just the balance in the control room. They do state that in ITAAC we have two recirculating units. Of course, like I say, they're into a once-through system. They're just cooling with air intakes on those.

MR. MICHELSON: How exactly is the chilled water arrangement for the control room? You've got separate compressors that are circulating the chill water over to what you call the AC unit? Is that what you're doing?

MR. CROM: Yes. We talked about chilled water yesterday.

MR. MICHELSON: Yes, but in a different context.

MR. CROM: I'm not sure I'm following your question, then.

MR. MICHELSON: Where are you getting the chilled water for the air conditioning unit?

MR. CROM: Of course, it comes from the control chilled water system. Let me go back. You're talking about the control complex.

MR. MICHELSON: Yes.

MR. CROM: We show that this is supplied by a central chilled water into the air conditioning.

MR. MICHELSON: Is that the one we talked about the other day?

MR. CROM: Yes.

MR. MICHELSON: That essential one?

MR. CROM: Yes, that's correct.

MR. MICHELSON: That's what I wanted to make sure. Okay. Thank you.

MR. CROM: Okay.

MR. MICHELSON: For a formal operation, you're always using the essential. The way that thing was arranged --

MR. CROM: That's correct. You're always running through the heat exchangers.

MR. MICHELSON: -- you had the two in parallel, but you're always running the essential.

MR. CROM: That's correct.

I'm going to go on to subsphere building ventilation.

[Slide]

MR. CROM: The design bases is, of course, maintain mechanical equipment rooms less than 100 degree for equipment qualification; maintain a negative pressure for airborne contamination control; and, finally, to filter and collect airborne leakage following a LOCA to meeting 10 CFR 100 release limits.

[Slide]

MR. CROM: As far as design summary, all area cooling is maintained by recirculating units in each room supplied by the essential chilled water system.

Ventilation supply air also provides cooling; during normal, when the pumps are not running, you don't need a lot of heat removal when there's not water going through the system; through cooling coils located in the air handling units with the cooling water supplied from normal chilled water, so we do have some redundancy there for normal operation when pumps are not running.

Then the recirculating cooler supplied by the essential chilled water will come on in high temperatures to supplement that normal cooling.

MR. MICHELSON: What material are you going to use to pipe the chilled water?

MR. CROM: Chilled water would be carbon steel.

MR. MICHELSON: Have you specified what the nil ductility has to be on that carbon steel?

MR. CROM: No, not in the SSAR.

MR. MICHELSON: You're dealing with temperatures, I thought I heard you say yesterday, 38, 39 degrees Fahrenheit.

MR. CROM: It was 42, wasn't it? 42 degrees.

MR. MICHELSON: I thought one of them was 42 and the other was 39, but I may have misunderstood. Even 42 degrees, not all 106 pipes are real good at 40 degrees, even, unless you buy the ductility requirement, put in the spec.

Is there a requirement that these keep a reasonable margin to nil ductility, like 60 degrees?

MR. CROM: There's not a regulatory requirement, no.

MR. MICHELSON: Well, there doesn't have to be.

MR. CROM: No.

MR. MICHELSON: It is a seismically-qualified piping.

MR. CROM: That's correct.

MR. MICHELSON: It has to be sufficiently ductal when the earthquake occurs, then it's not so ductal.

MR. CROM: Larry.

MR. BRUSTER: This is Larry Bruster from Stone & Webster.

The piping will be stress-analyzed with seismic events and thermal loads with whatever the appropriate equations are. I think that would be --

MR. MICHELSON: The question is is it ductal?

MR. BRUSTER: That would be show in that analysis, would it not?

MR. MICHELSON: That 39, or 40 degrees or 42 degrees Fahrenheit.

MR. BRUSTER: Wouldn't that be shown in that analysis?

MR. MICHELSON: No. No. Not that analysis, I don't believe will show it. You have to get the characteristics and the materials to put into the analysis, and that comes from knowing what the characteristics are at

42 degrees Fahrenheit, not at room temperature.

MR. CARROLL: Through that heat of --

MR. MICHELSON: And you would like a margin to where it really gets fragile. You know all about nil ductility for main loop piping on boilers, I'm sure. Same principle.

MR. CARROLL: And liberty ships.

MR. MICHELSON: Yes. And liberty ships and whatever. They did crack up in the North Sea.

But it's a simple question. I know from experience you do have to check into it, because when you buy 8106 Grade B, which is probably what you would use, you will get what is left over from the people who bought nil ductility and specified it, and you get what's left over.

Apparently, the test data I had showed ranges up to in the plus 10, 15 degrees Fahrenheit range. You don't want to be that close, so you have to specify it, and then you'll get it, and then somebody else will get it that doesn't care about nil ductility, uses it only for steam pipe or something. High temperature pipes.

MR. CARROLL: Shall we make that a --

MR. MICHELSON: I think next time you should come back just with a position on whether or not nil ductility is a problem and if not, why not.

MR. CROM: Okay.

MR. MICHELSON: One of the things you have to look at is the thickness of the wall you're dealing with, which I have no idea how big a piping you're going to be using on this, and because the code will give you a range. I forget now, but it's around a half-inch or so wall thickness.

MR. CROM: We'll be glad to check it, but I don't know of any time we've ever checked it and passed on current plans for chilled water systems.

MR. MICHELSON: General Electric has checked it and specified it.

MR. CROM: Okay.

MR. MICHELSON: You will want to check for yourselves.

MR. CARROLL: You may have a problem on past plants. You may never have a big earthquake either.

MR. CROM: Going on, the system consists of safety-related air exhaust subsystem, and then a non-safety related supply system. The system again, as I say, is divisionally separated so there's no penetration through the divisional wall.

MR. MICHELSON: Of all of these systems you're talking about, what kind of mode of power are you going to use on your damper controls and so forth?

MR. CROM: On mode of power?

MR. MICHELSON: Yes. Is it going to be air-operated motors or electric?

MR. CROM: It depends on the various situations. Some of them we have air and some we have electric operators on.

MR. MICHELSON: But you have no essential air in the plant.

MR. CROM: That's correct.

MR. MICHELSON: These are essential systems so you have to show --

MR. CROM: It's the same thing as an air-operated valve. If we use an air-operated damper, the failure position with the solenoid defends the air off.

MR. MICHELSON: Because you're going to dump the air pressure and --

MR. CROM: That's correct.

MR. MICHELSON: -- get the preferred orientation.

MR. CROM: That's correct.

MR. MICHELSON: You have to show what that is.

MR. CROM: That's correct.

MR. MICHELSON: Is that shown on any -- I guess you don't have any drawings for heating and ventilating, do you?

MR. CROM: We show the dampers, yes.

MR. MICHELSON: Do you show what the failure mode of the damper has to be?

MR. CROM: Yes. We say they're fail open or fail closed, yes.

MR. MICHELSON: Do we have a typical one I can look at in the SAR, then?

MR. CROM: The control complex has several air-operated ones on there.

MR. MICHELSON: It shows that detail.

MR. CROM: Yes.

MR. MICHELSON: Okay. I'll look it up. Thank you.

MR. CARROLL: You can probably see it on this, can't you?

MR. CROM: Yes. It's even on the ITAAC drawing that I showed previously.

MR. MICHELSON: It shows air operators?

MR. CROM: Yes. There were several on those.

MR. MICHELSON: ITAAC drawing previously. You don't show the failure mode.

MR. CROM: You're absolutely right. We did not on the ITAAC show those, but they are in the SSAR.

MR. MICHELSON: But they're in SSAR. Okay.

MR. CROM: They are in the SSAR.

MR. MICHELSON: One of them I see you show fail open.

MR. CROM: Yes.

MR. MICHELSON: The other ones have nothing indicated, which I assume interprets as fail as is?

MR. CROM: That's correct.

MR. MICHELSON: Which is a little strange.

MR. CROM: Those particular ones may be motors, because they have a particular safety function that they have to reposition.

MR. MICHELSON: You put a "P" in there if it's a pneumatic drive. That must be it. Those probably are electric motors.

MR. MATZIE: Regis Matzie.

One of the rules on ITAAC, if I recollect right, is if you used a pneumatic operator, you had to show the failed position. It was not true on any type of other --

MR. CROM: That's correct. And we also had to do the failure test on loss of air.

[Slide]

MR. CROM: The air supply system consists of air-handling units with two 100 percent capacity fans, dampers, and associated ductwork for each division.

The air exhaust system consists of a filter train with two 100 percent capacity fans and associated ductwork for each division.

Also, each filter train has a Regulatory Guide 1.52 filter in it.

MR. MICHELSON: On your heating and ventilating, how do you heat the air?

MR. CROM: How do we heat the rooms?

MR. MICHELSON: Yes. You have rooms that you're going to have to heat.

MR. CROM: On all of the supplied air, we have electrical-resistance heaters.

MR. MICHELSON: You what?

MR. CROM: Have electrical-resistant type heaters.

MR. MICHELSON: Are they in the local air handling units or back in the duct, way back somewhere?

MR. CROM: They're in the local --

MR. MICHELSON: In the air handling.

MR. CROM: Let me show you an example on the subsphere here. I'm not sure it shows ITAAC figures. It probably doesn't.

MR. MICHELSON: No, those wouldn't.

MR. CROM: It's in the air supply units, and if you'll look in the SSAR, we always have electrical heater downstream of a pre-filter.

MR. MICHELSON: How do I know whether you require essential power for heating or not?

MR. CROM: Essential power is not required for heating.

MR. MICHELSON: For any heating?

MR. CROM: That's correct.

MR. MICHELSON: Even though it might be in the middle of a winter in Siberia when this thing gets in trouble?

MR. CROM: Typically, in any of your accident conditions, you're going to have plenty of heat.

MR. MICHELSON: Depends on --

MR. CROM: No, I'm serious.

MR. MICHELSON: I'm serious. It depends on where this air-handling unit is. A pump hose is one thing.

MR. CROM: The one that does control, when we talk about diesel generator, we changed the flow of the speed of the fans and also the veins, because that is an area that you can overcool and get into problems.

MR. MICHELSON: You can overcool.

MR. CROM: That's correct.

MR. MICHELSON: The pump house is another area which you can, because you have no heat sources and cold in the middle of the winter.

MR. CROM: The pump house, of course, is not in scope, as far as ventilation system is concerned.

MR. MICHELSON: Yes. Are there criteria for it? Interface requirements?

MR. CROM: I believe there's interface requirements for the --

MR. MICHELSON: For heating and ventilating, that is.

MR. CROM: Yes, there is, for the pump house.

MR. MICHELSON: I'll read them.

MR. CROM: Okay. In fact, I believe we give a conceptual description also in 9.4 for the pump house.

[Slide]

MR. CROM: I only throw that slide up for the subsphere.

Again, this is basically for each division. This is one division with the non-safety, two 100 percent supply fans. Reg Guide 1.52 filter; and two 100 percent exhaust fans go to the unit vent.

[Slide]

MR. CROM: As far as fuel-building ventilation system, design bases, again, to maintain suitable environment for operations, maintenance, and testing, between 40 to 104 degrees; maintain a negative pressure for airborne contamination control; and, finally, the safety design basis mitigate the consequence of a postulated fuel-handling accident.

[Slide]

MR. CROM: The system consists of one non-safety air supply subsystem and two safety-related divisions for air exhaust.

Air supply subsystem consists of one 100 percent capacity ventilation supply air-handling unit, and associated dampers and ductwork.

The air exhaust consists of two 100 percent capacity exhaust systems complete with the filter trains and associated dampers, ductworks, and control systems.

MR. CARROLL: Now you're moving into the non-safety related HVAC?

MR. CROM: Yes. I have one more slide on fuel building, and then the only other safety-related one will be the diesel room. If we just want to cover safety-related ones, the rest are non-safety and pretty much traditional. It's up to you how much you want to cover.

MR. CARROLL: I think my preference would be just the safety-related.

MR. CROM: That'll be fine.

MR. CARROLL: We can read the rest of it.

MR. CROM: That sounds good.

[Slide]

MR. CROM: Of course, again, we have each of the filter trains consisting of Reg Guide 1.52 filter for the fuel-handling accident. During normal operation, the filters are normally bypassed and are automatically aligned on high radiation signal.

We do have a technical specification that requires a system to be put in the filter mode before fuel handling so it can mitigate any fuel-handling accidents.

[Slide]

MR. CROM: I have just a picture of the unit, single supply fan, two safety-related divisions with the filtration units and two 100 percent exhaust fans. As we stated earlier, since this is a common area, we did have to penetrate the wall, and provide the appropriate fire damper through that divisional wall penetration of the exhaust unit.

Let me skip the radwaste building ventilation and go to the diesel. That is the last safety-related system.

MR. MICHELSON: I want to hear about your containment purge and vent, also.

MR. CROM: I'll be glad to cover that one also.

[Slide]

MR. CROM: Of course, the design bases for this system is to maintain the diesel generator air temperature between 48 degrees Fahrenheit as a minimum and 120 degrees when the diesel is not operating and 122 degrees maximum when the diesel is operational.

I will mention that there is a recirculating unit in a small control room that keeps the temperature lower for the electronics in there as well, below the equipment qualification temperatures.

[Slide]

MR. CROM: As far as design summary, each diesel generator room is provided with a dedicated ventilation system. The system consists of supply air intakes, a normal ventilation fan, emergency ventilation exhaust fans, and associated dampers and controls for each diesel generator.

There's two 50 percent safety-related exhaust fans equipped with a two-speed motor and the fan speed and modulating inlet vanes are controlled based on room temperature, basically, so you don't overcool it and get it at low temperature.

MR. DAVIS: Why did you raise the maximum to 120 degrees for the diesel generator area?

MR. CROM: From 120 to 122, is that what you're asking?

MR. DAVIS: No. The other mechanical areas is 104 degrees.

MR. CROM: Yes.

MR. DAVIS: This is 120.

MR. CROM: That's basically set on the traditional equipment qualifications for the diesel generator itself. Typically, they specify 120 degrees from normal operation, but they do allow it to go up to 122 during the operating conditions.

MR. DAVIS: Theoretically, it could be 120 degrees when maintenance had to be performed on it. That's correct?

MR. CROM: Yes.

MR. DAVIS: Because it could be as high as 120 when it's not operating.

MR. CROM: That's correct.

MR. MICHELSON: How do you normally keep the room cool when there's nothing going on? Everything is shut down? I guess no air circulation?

MR. CROM: No, no. You have a normal ventilation fan.

MR. MICHELSON: Yes?

MR. CROM: Let me put the figure up.

MR. MICHELSON: Okay. That's what I was trying to figure out.

MR. CROM: Okay.

[Slide]

MR. CROM: During normal operation, you're running the normal ventilation fan, which is pulling air in, and it's just exhausting to the outside through the dampers.

MR. MICHELSON: What's the elevation of the inlets and outlets? Where are they located?

MR. CROM: Outlet. They're shown on the general arrangements. I can point to them to you later.

MR. MICHELSON: I think they're both at the top, and they must have some work.

MR. CROM: It's actually just a concrete plenum that goes down in there.

MR. MICHELSON: A concrete plenum would do it also.

MR. CROM: Yes.

MR. MICHELSON: So you're bringing it into a concrete plenum. Is the fan located on the floor then?

MR. CROM: Yes. It's down into the diesel room itself. I can show you the intakes and exhaust on the general arrangements, but they are shown.

MR. MICHELSON: Yes, they should be.

MR. CROM: Yes.

Of course, then you have the two 50 percent emergency ventilation fans that are started on diesel start and controlled speed, and the vanes on the fan are modulated based on the temperature in the room.

MR. MICHELSON: How about the diesel oil storage buildings? That isn't on here.

MR. CROM: As far as that, only has heaters -- you're talking about the fuel oil storage? That has electrical heaters to maintain the temperature during cold conditions above the cloud point.

MR. MICHELSON: Okay.

MR. CROM: You wanted to hear about containment purge and ventilation systems.

MR. MICHELSON: Well, hold on just a moment. I'm trying to catch up with you.

MR. CROM: Sure.

MR. MICHELSON: On the emergency ventilation, those fans are also down on the bottom or are they up at the top or where are they? I can't even find the normal ventilation fan, but it's probably because I don't know how to read the drawings.

MR. CROM: They're not shown on the general arrangements. You're correct.

MR. MICHELSON: Oh, they're not? They're pretty big fans, aren't they?

MR. CROM: Yes.

MR. MICHELSON: Those emergency ventilation fans, in particular, ought to be very large fans.

MR. CROM: I don't recall the exact elevation.

MR. MICHELSON: Are they up at the top ceiling, mounted, or something?

MR. CROM: I don't recall the exact elevation. I'd have to check on that.

MR. MICHELSON: What's the air intake for the diesel compartment? The reason I'm asking is because we might want to do a little fire analysis and I want to make sure we have the right understanding of the arrangement.

MR. CROM: There's a table in there that talks about the ventilation flow rates. I don't recall right offhand.

MR. MICHELSON: Where do we take the air in and where do we exhaust it to, is really the question?

MR. CROM: Okay. The best thing for me is to point it out to you on the general arrangements.

MR. MICHELSON: On the drawings. Okay. I'll do it later, then.

MR. CROM: Okay.

MR. MICHELSON: I see some things up on the roof that look like maybe that's how you do it.

MR. CROM: They're directly above the diesel generator rooms.

MR. MICHELSON: Yes.

MR. CROM: On a certain elevation, they show both the intakes and the exhaust plans.

MR. MICHELSON: That's where the fans are?

MR. CROM: Those are the intakes and the exhaust. The fans are actually in the diesel generator room.

MR. MICHELSON: Down at the floor?

MR. CROM: Yes.

MR. MICHELSON: The emergency ventilation; is it at the floor and ducts back to the ceiling, or are you blowing in at the floor with the emergency?

MR. CROM: No, it's closer to the ceiling.

MR. MICHELSON: Okay. Go ahead.

[Slide]

MR. CROM: Containment Purge. Of course, the design bases is to maintain a suitable environment inside the containment during refueling and maintenance operations; maintain the negative pressure for airborne contamination control during refueling and maintenance operations; to maintain a pressure control during normal operations which is done by the low-volume purge; and, mitigate the consequences of a postulated fuel-handling accident.

The system consists of a low purge subsystem and a high purge subsystem. Of course, the low purge is used for the pressure control and also for airborne contamination cleanup during normal operation, along with the kidney units, or recirculating units, we provide.

MR. MICHELSON: How big is the piping for that?

MR. CROM: It's eight inches.

MR. MICHELSON: So the penetration --

MR. CROM: The penetration is six inches.

MR. MICHELSON: Six-inch pipe?

MR. CROM: That's correct.

MR. MICHELSON: And the piping itself is eight --

MR. CROM: That's correct.

MR. MICHELSON: -- and then the penetration.

You provided, apparently, butterfly type isolation valves?

MR. CROM: Yes. Those valves meet the regulatory --

MR. MICHELSON: Do you think you can specify some that if you have a loss of coolant accident inside a containment that these things will close under that condition?

MR. CROM: Yes.

MR. MICHELSON: You're going to do a test program or something?

MR. CROM: That's correct. We meet the branch technical position and closure times.

MR. MICHELSON: Of course, we don't have as fast a closure times on these valves as the new source term because the release comes a lot --

MR. MICHELSON: The problem is that you've got very large through put of gas when you blow something in the containment and it's blowing out through this pipe.

MR. CROM: Yes. But they are qualified to close against the accident pressures and with the fluid flood --

MR. MICHELSON: Yes, they will have to be, obviously.

MR. CROM: -- for the branch technical position on that.

MR. MICHELSON: Yes. Okay.

MR. CROM: Again, each supply consists of an air supply unit, two 100 percent capacity fans and associated dampers and ductwork. Each exhaust consists of a filter train, one 100 percent capacity fan associated dampers and ductwork; again, containment isolation valves close on containment isolation actuation signal or high radiation signal, and high humidity signal.

Of course, the actual high purge valve, since they are larger tech spec, expect to be closed during power operations.

Again, we provide filter train which meets Reg Guide --

MR. MICHELSON: How large is the high purge?

MR. CROM: I believe they're 20 inch.

MR. MICHELSON: 20-inch. And you're using butterflies?

MR. CROM: That's correct.

MR. MICHELSON: I guess we have a drawing for that. Okay. Okay.

MR. CROM: Of course, each filter train has the Regulatory Guide 1.52 filter.

MR. MICHELSON: This high purge supply side has two butterflies in series, but if you get a loss of coolant accident, the flow will be backwards through the butterflies on the supply side. They'll be in the normal --

MR. CROM: Which one, the high purge?

MR. MICHELSON: Yes. The high purge. That's right. You said --

MR. CROM: High purge or tech --

MR. MICHELSON: -- they will only be --

MR. CROM: -- if you have a tech spec to be closed.

MR. MICHELSON: Okay. They'll only be open 24 hours before shutdown or 72 hours?

MR. CROM: You can't open high purge until you're -- I can't remember what mode the tech spec says that you can open it.

MR. MICHELSON: I thought that was something you could 72 hours before you come dow was start your high purge. Maybe not.

MR. CROM: We can look at the tech spec. I don't recall. I know there's a tech spec to be closed during operations.

MR. MICHELSON: Yes, normally, they're closed. Normally, they are.

MR. CARROLL: Does the staff know?

MR. WAMBACH: I think that relates to boilers for inerting and deinerting, the 72-hour business.

MR. ARCHITZEL: I think Mr. Michelson has the right answer. There's a certain number of hours per hour they're allowed to be open.

MR. MICHELSON: Yes.

MR. ARCHITZEL: There's a limit on the hours, but then it also has to be shown in limit stops that they can close also.

MR. MICHELSON: Yes. Yes, they depending --

MR. CARROLL: I thought I saw in the FSER --

MR. CROM: I think they're required to be closed during power operation. There really is no reason --

MR. MICHELSON: It may be. It may be.

MR. CROM: -- there is no reason to open the system until you've got the containment.

MR. MICHELSON: I don't know much about PWRs.

MR. CROM: The system is only to maintain the habitability for your operators, so if you don't have the containment open there's really no reason to have the system in operation.

MR. MICHELSON: Yes. You've got the low purge system to adjust the pressure and whatnot.

MR. CROM: That's correct.

MR. MICHELSON: Okay. So you think they're never closed until the reactor is sub-critical and perhaps down to some low pressure?

MR. CROM: That's correct.

MR. MICHELSON: Okay.

[Slide]

MR. CROM: This is the diagram of the low purge system. Of course, the supply units and the exhaust being the Reg Guide 1.52 filter. The only thing that's safety-related is the filter, to that we take some credit during the LOCA operation, during the release, until the valves are closed.

MR. CARROLL: Why are you pumping this into the IRWST and taking suction from it?

MR. CROM: That's in order to clean up the gases in the IRWST if you have to go in for maintenance operations, in order to get any fusion product gases out and do some cleanup of it. Just for normal operation and cleanup.

MR. CARROLL: Is that it?

MR. CROM: Just the high purge, just to show that figure.

MR. CARROLL: High purge. Okay.

[Slide]

MR. CROM: Again, that one here. I believe each of these are 20-inch lines. That's my recollection. It is shown in the SER, the size. Again, the two 100 percent supply fans, and again the only thing that's safety-related on this is the Reg Guide 1.52 filter, and of course the ductwork on both these systems, the seismic Category 1, since we do take credit in the fuel-handling accident for the particular filter.

MR. MICHELSON: Inflation valves certainly are safety-related.

MR. CROM: Of course.

MR. CARROLL: Note 1 is interesting. Why is that?

MR. CROM: That is for tornado protection. Again, this is a safety-related system. Is that what you're talking about: dampers manually close during a tornado warning?

MR. CARROLL: Yes.

MR. CROM: As we discussed at the last meeting, we provide a manual damper, and we qualify the ductwork and the damper for the 2 PSI differential pressure for a tornado and close all dampers on a tornado warning for tornado protection.

MR. CARROLL: Okay. Not a hurricane, though?

MR. CROM: Not a hurricane, no.

MR. MICHELSON: Who you not do it on the supply side?

MR. CROM: On the supply side?

MR. MICHELSON: Yes. Note 1.

MR. CROM: I'm trying to remember the reason. I believe the reason for that is -- oh, I know the reason for that.

The reason that the supply side is non-safety-related, we qualified the buildings to be able to handle the differential pressure from the tornado. We discussed that at the last meeting.

MR. MICHELSON: Then you better explain one more time what Note 1 means.

MR. CROM: Note 1 is to protect the safety-related ventilation system itself. The filter unit; that we would shut it on a tornado warning.

MR. MICHELSON: You think you'll potentially damage it?

MR. CROM: That's correct.

MR. MICHELSON: You're certainly going to suck on the whole containment when you get the tornado going by that holds that much pressure, and there's no back dampers on it, that I see.

MR. CROM: Yes, here are back dampers on it.

MR. MICHELSON: Oh, there are? What's the symbol?

MR. CROM: There are back dampers on the supply units.

MR. MICHELSON: That's the funny crosshatch?

MR. CROM: Yes, those are back dampers.

MR. MICHELSON: Okay. That'll take care of it.

MR. CROM: There's two reasons. The main reason was inside the Nuclear Annex we had nothing but structural walls. McGuire and Catawba, we have even recently gone in and qualified block walls for differential pressures. There is a statement that structural sections that we qualify for differential pressure inside for interior walls on tornadoes.

MR. MICHELSON: Those back dampers now won't take the three columns negative or 2.2 or whatever you're using.

MR. CROM: They will. We have tested them on McGuire and Catawba, and they will take up to 2 --

MR. MICHELSON: Well, I don't know. What somebody will buy, won't be necessarily nuc power at all unless you specify what the requirement is.

MR. CROM: It's not a requirement here.

MR. MICHELSON: But it's a requirement for a tornado.

MR. CROM: That's correct.

MR. MICHELSON: Okay. That's probably all right.

MR. CROM: Any questions?

If you need me, I'll show you where the intakes and discharge are.

MR. MICHELSON: Okay. You'll be around.

MR. DAVIS: Good job.

MR. CROM: Thank you.

MR. MICHELSON: That's heating and ventilating.

MR. SHACK: One question related to Carl's question.

How big are those chilled water pipes?

MR. CROM: Chilled water pipes?

MR. MICHELSON: The essential, I guess you're asking.

MR. CROM: Essential chilled water?

MR. SHACK: Yes.

MR. CROM: Those have not really been sized yet. Like I said, the units themselves are 280 tons a piece.

MR. MICHELSON: That's the wall thickness of the pipe, and that's the important parameter.

MR. SHACK: The bigger the pipe, the more you worry about that ductility probably.

MR. MICHELSON: Also the code drew it with a wall thickness, and I don't remember what the code had then.

MR. CROM: Roughly, I think it's probably on the discharge is 8 to 10 inches on the essential chilled water.

MR. MICHELSON: I'd say it's at least that big.

MR. SHACK: That's a pretty good size pipe.

MR. MICHELSON: This chilled water -- this is for every chilled water system, essential chill water load, is going to be off that pipe, if I understand the system.

MR. CROM: Yes. But, again, the size of the system is not any larger than traditional current plans.

For example, McGuire and Catawba is about 300 --

MR. MICHELSON: You might be able to guess that. You said it was a 250-ton compressor?

MR. CROM: 280 tons. McGuire and Catawba is about 300, 320 tons.

MR. MICHELSON: You may get by with six- to eight-inch.

MR. CROM: Yes.

MR. MICHELSON: You might be just within the limits. Five-eighths may be what the limit is.

MR. CROM: The normal chilled water is going to be the one that's big because it has all the containment load.

MR. MICHELSON: Let them do their homework. They'll figure it out first.

MR. CARROLL: Shall we polish off the questions?

MR. MICHELSON: Yes.

MR. CARROLL: Doug, you want to lead us?

MR. COE: Yes. The first question is a question that was delayed from last month. The question was asked in February. I just put out a copy of it in front of everyone. It's Question No. 9. This has to do with the water systems for diesel generator room fires and the droop-proof specification. This was Mr. Michelson's question.

MR. MICHELSON: I need to listen to this, though.

MR. CATTON: I think this was pretty much answered today during the presentations.

MR. COE: We held it for today.

MR. CATTON: I have no more problems.

MR. MICHELSON: Is this No. 9?

MR. CATTON: I'm going to wait until the COL holder comes along and tell us how he's going to do it.

MR. MICHELSON: Your response is not my response. Have we got a different response to look at than the one I have?

MR. COE: No. This was the response that was given to you last month.

MR. MICHELSON: Mine is this long. Is that the right length?

MR. COE: No, I just put this in front of you.

MR. CATTON: No.

MR. MICHELSON: I don't have the right No. 9.

MR. COE: I just --

MR. CARROLL: He just handed it to you.

MR. MICHELSON: Anything could happen. Where is it?

MR. CARROLL: It's in your hand right now.

MR. MICHELSON: Oh, I haven't read it yet. I read the old one, and I had only one question.

MR. COE: This is the same one from last month.

MR. MICHELSON: No, it can't be. There's the old one. It's that long.

MR. COE: It's Question No. 9.

MR. MICHELSON: I'm totally confused.

MR. COE: 94-02-09-9.

MR. MICHELSON: Well, there's more than one dash nine is the confusion.

MR. COE: This is Question No. 9 from February, 02-09 is the February date.

MR. MICHELSON: I was looking at 3-08-9.

MR. COE: Right.

MR. MICHELSON: A different question maybe.

MR. COE: This one you looked at last month and wanted to wait until we had our discussion on fire protection today, in order to --

MR. MICHELSON: See if I can find it. I read it.

MR. COE: -- make a decision on this.

MR. MICHELSON: If I find it, I won't have to read it again.

MR. CARROLL: It's on the top of what he just handed it to you.

MR. MICHELSON: No, I know. I've got it marked up. I assume it's the same one that was out last month --

MR. COE: Yes.

MR. MICHELSON: -- is what you told me.

MR. COE: Yes.

MR. MICHELSON: Now, I just have to find it. Unfortunately, this thing didn't stapled so it's probably gotten all messed up.

MR. CARROLL: There's a stapler right next to your next.

MR. MICHELSON: That's not big enough for this. I don't even have it in this pack. I haven't read it.

MR. CATTON: Maybe while Carl reads it we can go onto the next one.

MR. MICHELSON: Go onto the next one.

MR. COE: All right. All the rest of them are Mr. Michelson's, with one exception. That's Question No. 23 on the package that CE provided for this meeting. That was your question, Dr. Catton.

MR. CATTON: It was?

MR. COE: Yes.

MR. CATTON: What was it?

MR. COE: Question No. 23.

MR. CARROLL: ATHOS. Please provide the code manual.

MR. CATTON: Okay. That has been all taken care of.

MR. COE: No further questions on --

MR. CATTON: I have no further questions.

MR. COE: -- steam generator, fluid elastic instabilities.

MR. CATTON: I'm going to eagerly await the papers that were promised me, but I have no questions.

MR. COE: Okay.

MR. CATTON: I think they did a good job.

MR. COE: You're also still waiting for an answer on one question regarding the staff's SER on the TORC code --

MR. CATTON: That's correct.

MR. COE: -- and whether they had completed the verification as stated in the SER?

MR. CATTON: That's right.

MR. COE: Do we have an answer yet?

MR. WAMBACH: Our reviewers who are here today said they would have to go back and look at the SER which was written in '76 and determine, to get you an answer.

MR. CATTON: What was written in '76, the letter -- cover letter -- to combustion says final approval.

MR. WAMBACH: Right.

MR. CATTON: It's contingent upon satisfactory comparison. I'd like to --

MR. WAMBACH: Right. They understand that, and they're going to go back and check it, and then we'll let you know.

MR. CATTON: Okay.

MR. COE: The rest of the questions are for Mr. Michelson.

MR. MICHELSON: Are these out of the April 4th letter?

MR. COE: There's only this one question -- I'm sorry. We have a number of questions from the April 4th letter, that respond to your questions.

MR. MICHELSON: Those I have read. I haven't read any others.

MR. COE: The other one was the February question, and No. 9, which I gave you.

MR. MICHELSON: I didn't see that. I guess it looks all right. It's three pages long. It must be all right.

[Laughter]

MR. RITTERBUSCH: We have the new technique.

MR. CATTON: We discussed the elements of this, I think, at length. Things about location of the sprays, and everything else.

MR. MICHELSON: Sure.

MR. CATTON: We're assured that further analysis would be done when it comes time to fish or cut bait.

MR. COE: Shall we go through each of the issues on the April 4th date?

Question No. 1 had to do with the seal ratings, hydrostatic pressures --

MR. MICHELSON: 3-08-1.

MR. COE: 3-08-1.

MR. MICHELSON: All right. I didn't have any question on it.

MR. COE: Okay. Question No. 2.

MR. MICHELSON: No question there either.

MR. COE: That was the tornado wind-loading question. Okay.

MR. MICHELSON: Maybe it would be easier just to go to the one I had a -- I'll go to mine and somebody else can go to theirs.

MR. COE: You're it.

MR. MICHELSON: I mean, I don't have any problem with anything except -- and I'll give you the exception -- and then we can save a lot of time.

MR. COE: Okay.

MR. MICHELSON: The first one I have an exception to is 3-08-9. Here, the question talks about doors and seals, and the answer only talks about doors.

MR. CARROLL: 3-08-9.

MR. MICHELSON: Yes. What are the requirements for doors and seals. The answer talked about doors, unless I'm missing something in the answer.

MR. COE: Does CE want to clarify that answer?

MR. CARPENTINO: I think the response omitted seals because there are no seals in that particular room.

MR. MICHELSON: Okay. That might have been well to place the response that there are no penetrations to that valve room at all.

How do you get the steam pipe into the valve room, for instance? You have to seal it. I guess you're going to seal it as you go through the room -- into the room. I don't know. You've got about 12 pounds of pressure that'll blow back into the building if you don't.

MR. CROM: The guard pipe will go through the wall itself.

MR. MICHELSON: Okay.

MR. CROM: The guard pipe will be the opening.

MR. MICHELSON: How are you going to seal between the steam pipe and the guard pipe? When you have 11 pounds in the room, it's going to blow that seal. If you have one, unless it's qualified, it'll just blow back into the building, as it will out of the steam.

That was a question that wasn't answered. Next time. Go back and look at it.

MR. CROM: Yes. We need to address that.

MR. MICHELSON: Okay. Next. No. 11 -- 3-08-11. It talks about performing a COL action item, is to perform a walk-down to verify the assumptions of high-energy line break analysis. My question is, how is that going to be specified? Is that just an SSAR COL action item? Is that the way you're suggesting?

MR. GERDES: Section 3.6.2, there is a requirement in there that COL applicant provide the final design of high and moderate fluid systems; final design and results of high and moderate energy piping analysis, will be documented in the pipe break analysis report.

MR. MICHELSON: Are you going to do with that report, if anything? Particularly, I'm interested here. This is really a staff question.

MR. GERDES: There has been an additional addenda that will go in Amendment V, which the staff saw before the SER was written that identifies in more detail what that report shall confirm, and that is that it will confirm piping stresses and the containment penetration are within their allowable stress limits.

Pipe whip strengths and jet shield designs are capable of mitigating pipe break loads, and loads on safety-related systems, structures, and components are within their design load limits, so it does specify what that represent must identify -- what it must include.

MR. MICHELSON: You refer here to Table 3.1-1, Item 4: and the certified design material further documents a requirement for this report. Can you tell me what that

Item 4 says? Do you have a copy of it? I didn't have a copy of it.

MR. GERDES: Again, I believe this is a modification that is not -- wait a minute.

MR. MICHELSON: Let me ask you --

MR. GERDES: The acceptance criteria is pipe break analysis report exists and concludes that seismic Category 1, structure, systems and components remain functional after postulated pipe breaks.

MR. MICHELSON: Okay. How about the walk-down? Is that going to be done in conjunction with the verification, as required by the CDM?

I guess, really, the staff should answer this. You're undoubtedly acquainted with this question for ABWR and what the resolution was. We got into the ITAACs, the right words, to look at the report, verify the walk downs that have been done and so forth, as part of the CEM. I don't find that here, but I'm not sure. Item 4 sounds like a piece of it but not as complete.

Could you go back and look at what you prescribe for ABWR and the next time explain why you don't have to do it here, or if you are, explain to me how it's being done here. Do you follow?

MR. WAMBACH: Yes. Would you identify the question number again? I'm sorry.

MR. MICHELSON: This was Question 3-08-11.

I was expecting that what the staff would probably do the same as they did for GE.

MR. ARCHITZEL: Mr. Michelson, it was referred to as 2 over 1 walk-down for ABWR?

MR. MICHELSON: No, it wasn't really a 2 over 1, no.

MR. ARCHITZEL: We had conversation about it. We'll go back.

MR. MICHELSON: Yes. This one here was -- you go back and look at your CDM. It's mostly in the piping CDM. It's all in there. It's nice, just the way it should be, but I don't find it done in this case.

MR. CARROLL: So what you're arguing, Carl, is that the combustion piping DAC should have this.

MR. MICHELSON: I thought it would be similar, without even asking. Maybe there's a reason why not. If there is, come explain why you don't it in this case and you did it in the other case.

MR. CARROLL: One of the issues I recall from DAC, I kept asking the question, who does this? It is the COL holder.

MR. MICHELSON: Yes.

MR. CARROLL: Even though it says things like something will be inspected, I wondered who did the inspecting, but it's the COL holder.

MR. MICHELSON: The COL holder. Yes. Yes.

MR. CARROLL: It doesn't have to say that because that's inferred, and the staff simply confirms --

MR. MICHELSON: They look at the CDM and find out if they had done what the CDM said.

MR. CARROLL: That's correct.

MR. MICHELSON: If the CDM doesn't say it, then it doesn't necessarily get done.

MR. CARROLL: Okay.

MR. MICHELSON: Having it buried back in the tier two material really isn't quite good enough, and I think everybody agreed, we got it all fixed, it's all put to bed, but I don't see the same thing here, and I thought I would, or have a reason why not.

MR. CARROLL: Okay.

MR. MICHELSON: That's the question.

MR. CARROLL: All right.

When I see marked up pages in these responses, these are things that we'll find in Amendment V. Is that correct?

MR. COE: There were two more questions Mr. Michelson had last month, 12 and 13.

MR. MICHELSON: I passed those up. I don't have any problem with those. I do have another question on 3-

08-24. 3-08-24 deals with fire barrier failure probabilities. The question was why are they so low.

The response comes back sounding like walls are great, concrete's no problem. Of course, that wasn't the question. Really, the issue is, how about the doors? The doors failing is the real problem, not the concrete failing.

The doors are first priority for failure; the second priority would be the seals. The last priority would be the concrete.

Unless I'm not reading it correctly, it appears to address only the concrete. Am I reading it right? I want to know the failure probability of the doors not the concrete, if there are doors in the barrier.

MR. CARROLL: Actually, this was Pete's question.

MR. MICHELSON: It might well have been. I only had a comment on it.

MR. DAVIS: I already passed on it.

MR. MICHELSON: Why? They answered only the concrete.

MR. DAVIS: I know it, but the concern -- as I recall, the only real concern was between the two diesel generator rooms.

MR. MICHELSON: No, no. There could be other concerns as well.

MR. DAVIS: And there are no doors between those rooms.

MR. MICHELSON: Actually, as a matter of fact, the two don't adjoin, but there is a door between the Nuclear Annex and the diesel compartment, and it's going to be a roll-type door, if I understand one of the other answers.

I'd like to know the failure probability of a roll-type door for these conditions. Not concrete. I think the concrete would be the last thing for this.

MR. CATTON: It says: This failure rate was used to represent the failure of reinforced concrete wall between the diesel generator rooms. That's what it was used for.

MR. MICHELSON: Yes. Maybe, then, they didn't answer all the rest of it.

MR. CATTON: The real question --

MR. MICHELSON: Your question was answered. Okay.

I'll ask a new question, then.

What's the failure probability of the doors in the concrete walls? And you do have a roll-type door in the diesel compartment, for instance.

MR. CATTON: And maybe treat the diesel compartment separate from any other doors.

MR. MICHELSON: Yes. They'll be more severely challenged.

MR. CATTON: The insult is quite a bit different.

MR. MICHELSON: Yes.

MR. CARROLL: What is it we're concerned about?

MR. MICHELSON: Go back to CESSAR, pages 19.7-31 and 32. The original question asked was: What's the basis for the fire barrier failure probability being 1.2E -3.

The answer came back that that basis is that concrete's good.

MR. CATTON: What fire are we worrying about, a fire in the diesel compartment?

MR. MICHELSON: I assume it's a fire in the diesel compartment, yes.

MR. SHACK: He explained today you needed two doors to fail, basically, before you could get to anything, and I think that was the basis for --

MR. MICHELSON: Yes.

MR. CATTON: You had to go clear across the plant to get --

MR. SHACK: You had a long way to go.

MR. MICHELSON: But that's not the numbers that seem to be in the PRA, unless I didn't understand the PRA numbers right. It was for the barrier, not for multiple barriers. It wasn't a multiple barrier probability. It was a single barrier probability.

MR. CATTON: If 10 to the minus 3 is a probability of failure of all four doors, I'd like to hear that too.

MR. MICHELSON: Yes. Why don't we just ask them to come back next time and look more carefully at what kind of answer one would give considering that there are doors, if there are doors, in the barrier, which there are in this case.

MR. CARROLL: What's the scenario we're concerned about?

MR. DAVIS: I think that has to be part of the answer. That number may include the probability that it doesn't get suppressed and that it lasts longer than 20 minutes.

MR. CARROLL: Is it a fire in the diesel room we're worried about?

MR. MICHELSON: I suspect it was.

MR. CARROLL: Or a fire in a room outside the diesel room, that gets to the diesel room?

MR. MICHELSON: It's a barrier failure probability, and the barrier is, I thought, the diesel barrier.

MR. CARROLL: If it's not, maybe they ought to clarify that, too.

MR. MICHELSON: Go back to whatever it says on that page. That's the way the question is. Whatever scenario it is, the challenge was with the low probability. It wasn't my question.

MR. GERDES: Mr. Michelson, if we could go back to

11 on the ITAAC acceptance criteria where you were talking about walk down, we do not specify walk down specifically, but we identified the pipe break analysis report includes the results of inspections of high and moderate energy pipe break mitigation features, including special separation. That would be from the walk down.

MR. MICHELSON: That could be. What I'm asking, though, in this case, the staff should come back and tell me look at what we did on ABWR and tell me why that isn't here as well or, if it is, tell me that it's there. I didn't find it, but maybe I didn't look carefully enough. I can easily stand corrected.

MR. CARROLL: Okay. A piece of data from where I'm sitting, it appears that the temperature is 71 degrees, and I'm warm.

MR. MICHELSON: You got a good thermometer?

MR. CARROLL: I think so. It also shows that Bill Shack is almost due west of me.

[Laughter]

MR. MICHELSON: That's a really good thermometer.

MR. CARROLL: Where do we stand. We have some wrap-up questions that we want to ask.

May 4th is, what, the Wednesday before full committee?

MR. COE: Yes.

MR. CROM: Excuse me. This is Tom Crom. There's a couple things I'd like to clarify from my HVAC presentation.

MR. CARROLL: Sure.

MR. CROM: I did look at the tech spec on the high purge valves, and they are required to be closed during all modes, 1, 2, 3 and 4.

The diesel generator -- both supply fans and exhaust fans -- are shown on the general arrangement drawings at Elevation 919, and I will show those to you as well.

MR. MICHELSON: Show me how to read the drawing.

MR. CROM: Okay. I sure will.

MR. MICHELSON: I saw those funny symbols, but I didn't relate them to ventilation fans.

MR. CROM: I'll show them to you.

MR. CARROLL: I almost forgot, we have Ken Scarola.

MR. SCAROLA: I don't know the answer until I know the question.

MR. CATTON: My question is really short.

In the fiber optics, if you have a temperature gradient along the fiber, what kind of impact does that have on the transmission characteristics?

MR. SCAROLA: I don't think I really know the answer, unfortunately, after all this time. I know that we have done is we have done some radiation hardening of fibers, and we have seen that sort of degradation over time with radiation.

MR. CATTON: That's a little different.

MR. SCAROLA: As far as temperature, we will certainly ensure that the fiber optic that we use is fully qualified for this environment. We're doing that today.

MR. MICHELSON: We were worried about fire.

MR. CATTON: It came from fire, but I'd like to pose it as a more general question.

In acoustics, when you have a temperature gradient, you reflect back the signal in a strange way. I'm not sure what the transmission characteristics of the fiber will do if you have a temperature gradient. That could come from going from one room to another.

MR. SCAROLA: So your concern would be in the case where you have a fire in one room, that's getting very hot, and then you have the other end of the fiber cable in another room, and is there any attenuation of that signal?

MR. CATTON: Yes. Or a hotspot in the middle of it somewhere.

MR. MICHELSON: Or if you lose the jack around cable.

MR. SCAROLA: For normal temperature gradients, we will be fully qualified.

MR. CATTON: Are you going to actually --

MR. SEALE: This is basically the question of the impedence of a fiber -- it's just a question of the impedence of a fiber optic element.

MR. CATTON: Some of it's reflectivity.

MR. CATTON: It's a spatially-dependent impedence that sits in the cable somewhere. That's quite different.

MR. SCAROLA: For the normal range of operating temperatures, which the low range I think we qualified down to the 50-degree range and the high range, up to about 120 degrees F., or something, we will be fully qualified for any appropriate attenuation there.

For a fire situation, we're now looking at failure conditions, and that's really outside the qualifications base. So, under that condition, yes, it may fail.

I can't stand here and say it will or it won't, but it's outside the qualification space. That's now a single failure, and we now accommodate that through another channel, the remote shutdown room, whatever. So it's outside the qualification space.

MR. CARROLL: I think it sort of started with me asking the question, is failure in the fiber bimodal. I mean, it either works or it failed. There's nothing in between that could throw in some spurious signals.

MR. SCAROLA: Spurious signals, no, but degradation over time, yes. We have to qualify for the appropriate life of the fiber, and that's something that we do.

MR. CATTON: My interest is more curiosity.

MR. CARROLL: Okay.

MR. MICHELSON: I believe Ken was going to answer Questior 3-08-12 for me. I didn't ask it earlier because I knew you were coming up afterwards. Do you have a copy of 3-08-12.

In the response, you talk about 95 percent of the power distribution cable and wiring is at 5 to 24 degrees volts --

MR. SCAROLA: Volts DC.

MR. MICHELSON: -- DC. Could you explain what kind of power distribution cabling system that is, that distributes at 5 volts to 24 volts?

MR. SCAROLA: Okay. Inside the control panels themselves, we have power supplies. Those power supplies are located right near the equipment, and that's where we do an incoming 120 volt AC down to 5 volt DC conversion, and then we simply run that within the panel section.

It's not very long lengths of cable, probably less than 6 or 8 feet.

MR. MICHELSON: I doubt most people would ever consider that power distribution cable. The 120 coming into the power supply is definitely power distribution.

MR. SCAROLA: Right.

MR. MICHELSON: The control power coming out of that power supply is control power distribution, is the way I understand what you're saying. This is really just control power.

MR. SCAROLA: All of the devices that work on the surface of the panels -- the electro-luminescence or the flat screen displays, the switches, the incandescent, or the light-emitting diodes inside the switches, are all running at these low voltages.

MR. MICHELSON: 24 volts, probably.

MR. SCAROLA: Whereas the power supplies are in the back of the panels.

MR. MICHELSON: Of the same panel. Right.

MR. SCAROLA: Of the same panel.

MR. MICHELSON: Yes. And the power distributed to it is going to come in on the 110 -- I asked the other day, maybe you know. What is approximately the distribution current ratings of most of these 120 volt systems? How big an amperage are we dealing with in individual cables?

MR. SCAROLA: In answering that, I think it's first important that we realize that we are dealing with rapidly-evolving technology here.

MR. MICHELSON: Yes.

MR. SCAROLA: If you remember, back in November we brought in a panel section.

MR. MICHELSON: Yes.

MR. SCAROLA: That panel section had hardware in it that was actually selected about four years ago, and the average of one of those devices on the panel is about 300 watts, for a flat screen display.

Now that same thing would be about half of that, and if you look at the evolution that we're seeing in things like flat screen displays on notebook computers, we're down at less than 50 watts.

MR. MICHELSON: Let me ask, the 110 --

MR. SCAROLA: This is evolving all the time.

MR. MICHELSON: -- there's 110 volt lines coming into the power supplies. What kind of fusing do you have in mind? Is this going to be 5 amp fusing, 20 amp fusing, 30 amp, or what?

It makes a big difference, because that sets the energy I have available to start something going. If you tell me it's in the milli amp range, of course, I wouldn't worry about it.

MR. SCAROLA: No.

MR. MICHELSON: If you tell me it's a 30 amp distribution circuit, I can get you a lot of things going with that at 120 volts.

MR. SCAROLA: Okay. If you look at that panel that was here back in November, that panel had about 25 amps inside that panel.

MR. MICHELSON: Okay.

MR. SCAROLA: But from --

MR. MICHELSON: Three or four supplies.

MR. SCAROLA: -- four different power sources. So it's roughly maybe 8 to 10 amps for any individual power source.

MR. MICHELSON: Most distribution could be fused down quite a ways then.

MR. SCAROLA: Well, it'll be circuit-breakered on the wall and then fused inside the panel itself --

MR. MICHELSON: I hope it's fused --

MR. SCAROLA: -- or a circuit breaker inside the panel.

MR. MICHELSON: -- at the wall. Of course, I don't imagine the staff has ever gotten to these protection -- in the control room, we're just about claiming there's no way you can burn a control room, and if you're going to take that position, that's fine. Now you design for that.

I don't think you want to use circuit breakers at the wall to protect the distribution circuits. I would imagine you would require double-fusing, one at each end, but I don't know. If it was truly -- I mean, in cases of containment penetrations, that's the way they've been protected.

They've been double-protected because everybody worries about putting too much into a containment penetration and blowing it out. Well, I'd worry a little about the control room too, since it's a non-fire area.

MR. SCAROLA: Fuses have historically been viewed as something that have lower reliability than circuit breakers.

MR. MICHELSON: That's quite right.

MR. SCAROLA: Right now, we are using circuit breakers on the wall and a second set of circuit breakers inside the panel section.

MR. MICHELSON: You're going to double-breaker, one on each end.

MR. SCAROLA: We're double-breakering.

MR. MICHELSON: And you're going to put in 10 amp breakers then and 15 amp breakers.

MR. SCAROLA: That's a detail that's not available right now, but historically you size the circuit breaker based on the load with some margin so it doesn't inadvertently open.

MR. MICHELSON: I'm still grasping for something really very simple. Are there any energy sources in the control room that can ignite a pretty good fire? If I know that there's a 30 amp branch circuit of 120 volts, I know I can ignite a good fire with it. If it's a 5 amp circuit, I know it gets a lot tougher. If it's under 1 amp it gets almost impossible.

MR. SCAROLA: It is probably not 1 but probably less than 10, and I do not know if I can give you any more detail right now. It's really going to depend on the evolving technology.

Right now, the biggest load inside that panel section is a CRT display at a little less than 3 amps, 120 volts.

MR. MICHELSON: Well, you can break up the distribution with a lot of small circuits and protect them appropriately, or even put it into a couple of big circuits, take it over to the panel, and then distribute it. Of course, now you've put the ignition source right in the proximity of where you don't want it.

MR. SCAROLA: I think it's also important, though, to realize that we are using this low voltage DC power distribution for most of the panel and, even though there is a heat source, there's very low voltage for flash over.

When you have these low voltages, the likelihood of flashover or sparking that would even start a fire is really minimal.

MR. MICHELSON: Yes, but none of that is true for 120 volt, 30 amp branch circuits. That's quite true for 5 to 25 volt DC. I didn't even raise that question. That's the answer I got but I didn't raise the question.

I was looking for the energetic sources. Are there any? It depends on how you're going to design, and if you don't know how you're going to design, you can write some design rules, some so-called interface requirements, if nothing else, specifying certain limits as to how energetic the power supplies can be within the cabinet.

MR. CATTON: The low voltage doesn't do it by itself. 5 volts and a short wire, you can explode it.

MR. MICHELSON: Yes, but you can't put much energy into the area.

MR. CATTON: We've done it.

MR. MICHELSON: Theoretically, yes, I can ignite with amp circuits, but it's going to be very special.

MR. SCAROLA: Realize, though, that the 5 volt circuits are going to have fuses on them for each individual load that's on that circuit, and those will be on the order of 1 amp, 2 amp fuses at most.

MR. MICHELSON: Yes, at most.

MR. CATTON: It's not the voltage that does it by itself.

MR. MICHELSON: You have to have an energetic source. I'm not sure I'm completely satisfied. I don't know if the staff is concerned or has looked at care in the control room to make sure that we don't put in too high an energetic source inside these panels.

MR. SCAROLA: I think it's important, though, that we have done what we can and we will do to minimize the fire potential inside the control room. But fire inside the control room is a design-basis event, that we do have accommodated in other places.

There's full fiber optic isolation from the control room into the other places, so faults will not propagate. we have master transfer, and we have a remote shutdown panel.

MR. CARROLL: I have a hard time envisioning a fire behind a panel someplace that the operator isn't going to put out in very short order.

MR. MICHELSON: Oh, he'll try to put it out.

MR. SCAROLA: There's another level of protection here that's also important. There are three panel sections inside the main control room, and if you have a fire in one, the assumption is that the operators will likely stop the fire.

Even if there is damage, all of the information as well as all of the active controls are accessible on another panel inside the control room.

MR. MICHELSON: I guess I had a problem with the response, simply because you told me 95 percent of it was going to be low voltage and you never told me what the other 5 percent was going to be on. I think it's going to have to be 120 volt with fairly high amperage, and the arguments are quite different.

I didn't get those -- you didn't give me a comfortable feeling that you really responded to that part of the question and showed how you handled it. There's lots of ways of handling it -- conduit protection, and so forth. It's all part of it. But I don't know what's going to be done in the case of your 120 volt distribution. Is it going to be in individual conduits or armored cables or how are you going to do it?

MR. SCAROLA: Basically, spatial separation, to the extent that we can, inside the panels. There is no intention right now to put things in metal conduit, with the exception of where we need it for physical barriers between safety channels.

MR. MICHELSON: Yes. This is where I would spend some of Charlie's armored cable money, on the 120 volt portion only of the power distribution.

MR. CARROLL: Okay. What else do we have for Ken? Anymore for Ken?

MR. MICHELSON: No, I'm all done.

MR. CARROLL: All right.

MR. SCAROLA: Thank you.

MR. CROM: I wanted to clarify for Mr. Michelson, on your Question No. 9, that was the question you had on the seals. What we're going to do is just modify that response. If you look at the insert we have on 3.84.3.i-1, that was the insert that was going into the --

MR. MICHELSON: We can find things easier by page number when I just have a page at a time. I have a page 3.8-32.

MR. CROM: Right behind that we had an insert.

MR. MICHELSON: Okay. All right.

MR. CROM: We're going to say: Access doors and seals are designed for subcompartment pressures when there's a potential effect of safety-related equipment if the door or seal fails to retain pressure boundary.

MR. MICHELSON: That'll take care of it. That's it. Thank you.

MR. CROM: Thank you.

MR. CARROLL: Okay. Where are we? Are we done? Pete/

MR. DAVIS: I had one. Based on the Palo Verde tour, Doug Coe and I noticed that the steamline for the steam turbine-driven emergency feed pump went through the electric motor-driven pump room. That suggests a concern that if the steamline breaks, you lose both pumps.

MR. CARROLL: They had an answer to that this morning.

MR. DAVIS: No, that was electrical wiring.

MR. CROM: This is Tom Crom. Let me answer that.

MR. DAVIS: Okay.

MR. CROM: As we have talked about previously, of course, the motor-driven and turbine-driven pump are separated in the different quadrants.

The tunnel at which that line routes through is from the main steam valve house, directly into the turbine-driven pump room. That is protected as a pressure boundary, all the way from the turbine-driven pump room, into the main steam valve house, so when the line breaks it vents up through the main steam value house. The line does not run anywhere except for that pipe tunnel.

MR. DAVIS: Thank you.

MR. CARROLL: Where are we? I guess we finished the agenda we set out on yesterday. We've got a few more questions to be answered. I guess Doug and I feel this completes the formal review of the FSER.

At the May 4th meeting we only need what, a couple hours or something like that?

MR. MICHELSON: That depends on how many more questions you might get between now and then because some of us at least haven't had much time to look at this thing yet, and we intend to look at it.

MR. CARROLL: Time is running out on you, Carl.

MR. MICHELSON: I will between now and next meeting.

MR. CARROLL: Okay. If anybody has questions, get them to Doug and we'll try to get responses, because I hope to close out the questions on the morning we spend on it or half morning or half afternoon next meeting.

MR. MATZIE: Regis Matzie with a question for the subcommittee.

We will have any supplementary questions that weren't raised at these meetings that we've conducted thus far ahead of time so that we can get the right experts here? That's really important.

MR. MICHELSON: That's obviously the fair way to do it, and if we've got any questions we'll give them to Doug and he'll transmit them. He's done this in the past.

I don't know. I just haven't had much time to look yet. I've been busy doing a few other things.

MR. CARROLL: Yes, you have. Let's sort of set a drop dead date for additional questions. Would two weeks from now be satisfactory to you, Carl?

MR. MICHELSON: Two weeks before the meeting? Is that what you're saying?

MR. CARROLL: Yes. Two weeks before the meeting, let's say.

MR. MICHELSON: It depends on what's between.

MR. CARROLL: May 4th.

MR. MICHELSON: Let's see. What date did name?

MR. CARROLL: May 4th.

MR. MICHELSON: The meeting is May 4th, and two weeks before that would be Wednesday the 20th of April. That's kind of soon.

MR. CARROLL: What's the following Monday?

MR. MICHELSON: Yes. Something like that would be fair enough, think. The following Monday would be the 25th of April.

MR. CARROLL: Okay.

MR. MICHELSON: That's enough, I think. Oh, that's a little short. Excuse me. That's a little short. If I have any questions, it'll be by the Friday the 22nd.

MR. CARROLL: Friday the 22nd of April.

MR. MICHELSON: Yes. Yes.

MR. CARROLL: Okay.

MR. MICHELSON: They'll have a week to work on them.

MR. CARROLL: And that's true with anybody else that's continuing to look.

MR. MICHELSON: I may not have any other

questions. I don't know.

MR. CARROLL: All right. After we know what that is, we can schedule an appropriate amount of time.

MR. MICHELSON: Fine.

MR. CARROLL: The other thing we have coming up, of course, is -- what is it, an hour-and-a-half tomorrow morning, full committee presentation on the highlights of the design and our review and so forth.

MR. MICHELSON: For whose benefit will that be? Who hasn't been here?

MR. CARROLL: It was sort of Sam and Dick convincing me we have to have a full committee meeting of some sort. We had a parallel thing that snowy Friday for ABWR.

Okay. Hand me my gavel, and let's get out of here.

MR. MICHELSON: That's just an hour, then, you'll do for that?

MR. CARROLL: I think it was an hour-and-a-half.

MR. MICHELSON: Hour-and-a-half, something like that. All right.

MR. CARROLL: The staff is going to speak and combustion is going to speak.

MR. MICHELSON: Okay. Sounds good.

MR. CARROLL: Okay. I want to thank everybody for their good presentations and patience and whatever for the last two days.

With that, we will adjourn.

[Whereupon, the meeting was adjourned at 6:03 p.m.]

REPORTER'S CERTIFICATE

This is to certify that the attached proceedings before the United States Nuclear Regulatory Commission in the matter of:

NAME OF PROCEEDING: ACRS ABB-CE Plant Designs

DOCKET NUMBER:

PLACE OF PROCEEDING: Bethesda, MD

were held as herein appears, and that this is the original transcript thereof for the file of the United States Nuclear Regulatory Commission taken by me and thereafter reduced to typewriting by me or under the direction of the court reporting company, and that the transcript is a true and accurate record of the foregoing proceedings.

Marilynn Estep

Official Reporter
Ann Riley & Associates, Ltd.

An Assessment of Fire Barrier Standards and the Impact of Smoke Transport

by

James Quintiere

Prepared for The Advisory Committee
on Reactor Safeguards

March 1994

AN ASSESSMENT OF FIRE BARRIER STANDARDS AND THE IMPACT OF SMOKE TRANSPORT

This report presents:

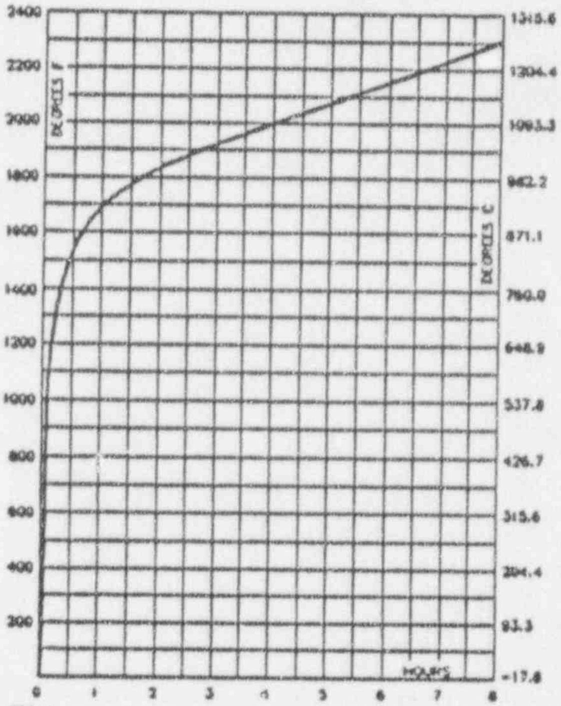
1. a review of the standards used to assess the fire resistance of barriers,
2. their relationship to actual compartment fire behavior.
3. the issue of smoke penetration through fire barriers
4. a model for a diesel fire in a typical generating room.

STANDARDS

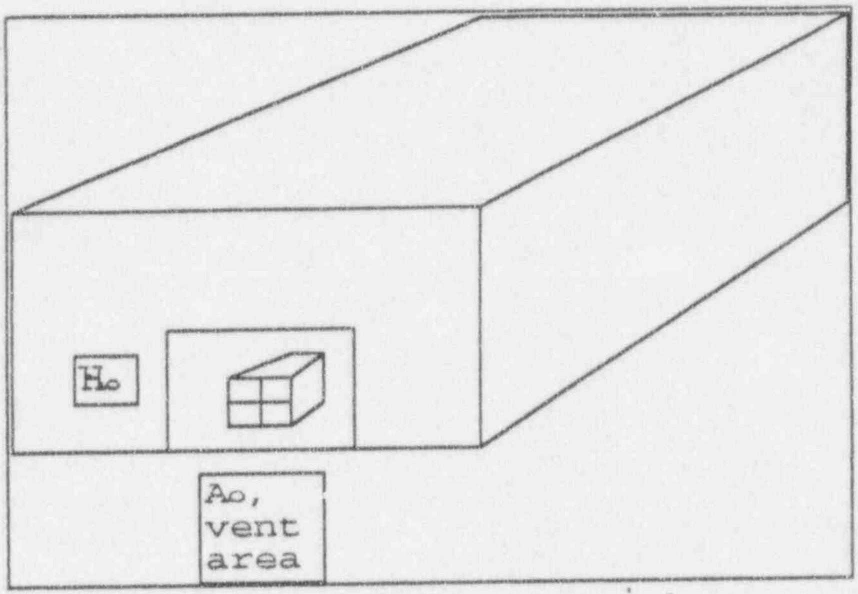
Application:	Construction	Doors	Fire Stops
Standards:	ASTM E 119	ASTM E 152	ASTM E 814
	NFPA 251	NFPA 252	
	UL 263	UL 10 B	UL 1479

ASTM = American Standards for Testing and Materials
NFPA = National Fire Protection Association
UL = Underwriters Laboratory

Figure 3.1
Time-temperature curve



Equivalent Fire Exposure Time



$$\dot{m}/A_o\sqrt{H_o} = f[(A - A_o)/A_o\sqrt{H_o}] \approx 0.1$$

$\dot{m}$ is the fuel mass loss rate, kg,

A_o is the area of the vent, m^2,

H_o is the height of the opening, m,

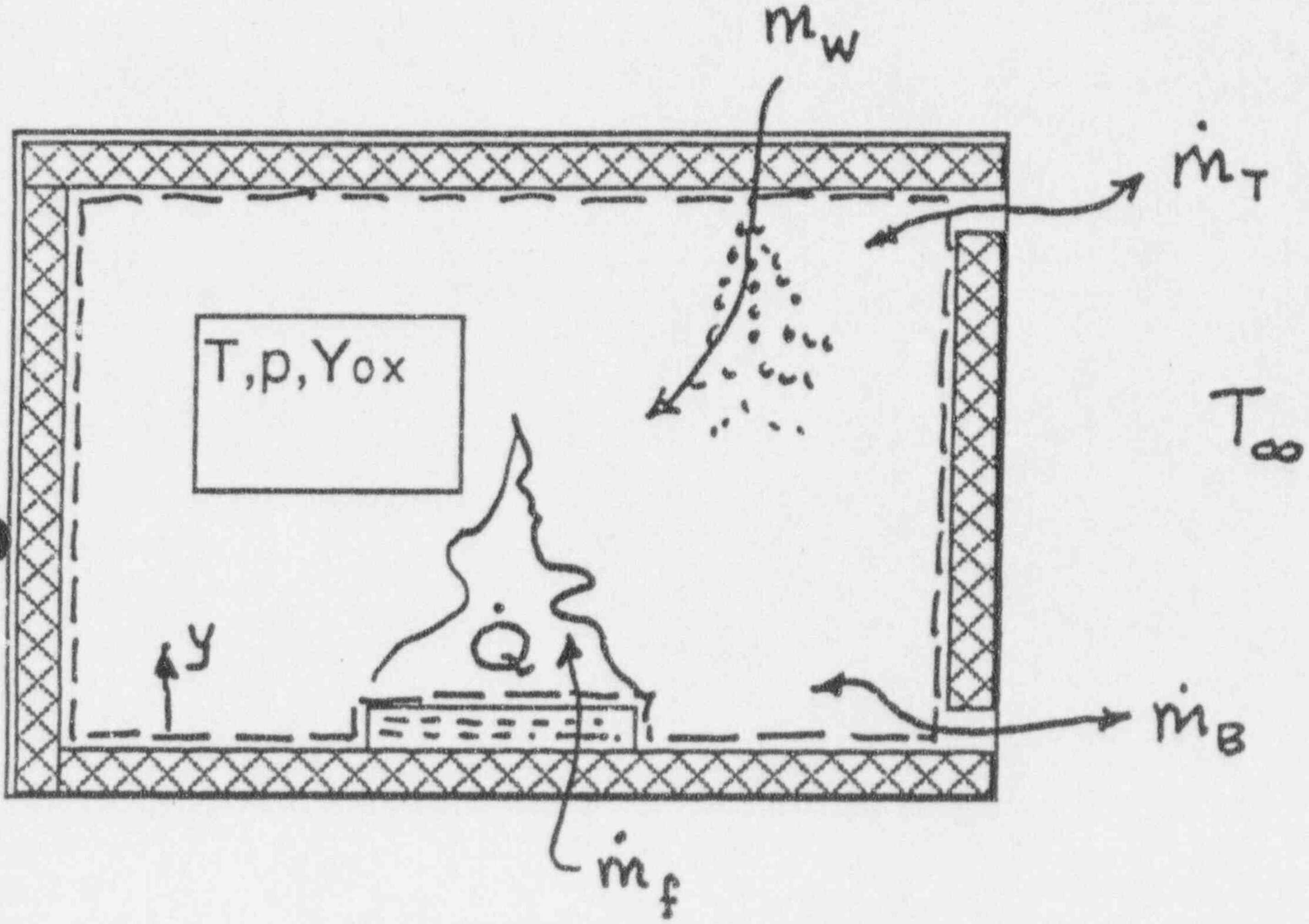
A is the compartment internal envelope area, m^2.

An equivalent time between the furnace test exposure and a ventilated compartment fire

$$t_e = K \frac{L}{\sqrt{A_o(A - A_o)}} \quad \text{(min.)}$$

where L is the wood crib fuel load, kg, and K is a constant, approximately 1.3.

Model



[Conservation of Mass]

$$\frac{dm}{dt} - \dot{m}_T + \dot{m}_B - \dot{m}_w - \dot{m}_f = 0$$

$$\rho_\infty T_\infty V \frac{d(1/T)}{dt} + \dot{m}_T + \dot{m}_B = \dot{m}_w$$

[Water Evaporation Rate]

$$\dot{m}_w = k_w \dot{Q}/L_w.$$

[Vent Flow Rates]

$$\dot{m}_T = \eta(\Delta p_T)\, A_o C \sqrt{2\rho\left|\Delta p_T\right|} - \eta(-\Delta p_T)\, A_o C \sqrt{2\rho_\infty\left|\Delta p_T\right|}$$

$\Delta p_T = P + (\rho_\infty - \rho)gH$

H is the distance between the vents and the height of the room,

$\eta(x) = 1$ for $x \geq 0$, and 0 for $x < 0$.

[Energy Conservation]

$$\frac{dU}{dt} + \dot{m}_T c_P T_T + \dot{m}_B c_P T_B - \dot{m}_w c_P T_w - \dot{m}_f c_p T_f = \dot{Q} - hA_s(T - T_\infty) - \dot{m}_w L_w$$

$$\dot{Q}'' = (Y_{ox}/0.233)\ \dot{Q}_\infty''.$$

$$\frac{V}{(1-\gamma)}\frac{dP}{dt} + \dot{m}_T c_P\left[\eta(\Delta p_T)\,T + \eta(-\Delta p_T)\,T_\infty\right]$$

$$+ \dot{m}_B c_P\left[\eta(P)\,T + \eta(-P)\,T_\infty\right] c_P T_w$$

$$= \dot{Q} - hA_s(T - T_\infty) - \dot{m}_w(L_w + c_P T_w)$$

[Conservation of Oxygen]

$$\frac{d(mY_{ox})}{dt} + \left[\eta(\Delta p_T)Y_{ox} + \eta(-\Delta p_T)(0.233)\right]\dot{m}_T$$

$$\left[\eta(P)Y_{ox} + \eta(-P)(0.233)\right]\dot{m}_B = -\dot{m}_f r = -\dot{Q}/\Delta H_{ox}$$

$h = 0.05$ kW/m^2-K

$T_w = 373$ K

$L_w = 2260$ kJ/kg

$k_w = 0.004$

$H = 8$ m

$W = 9$ m

$L = 16$ m

$V = 1152$ m^3

$A_s = 688$ m^2

$\dot{Q}_\infty'' = 1400$ kW/m^2

	Case 1	Case 2	Case 3
Vent area, A_o (m^2)	1.0	0.5	1.0
Fire area A_f (m^2)	5.0	5:0	10.7
Initial fire size, $\dot{Q}_\infty$ (kW)	7000	7000	15,000

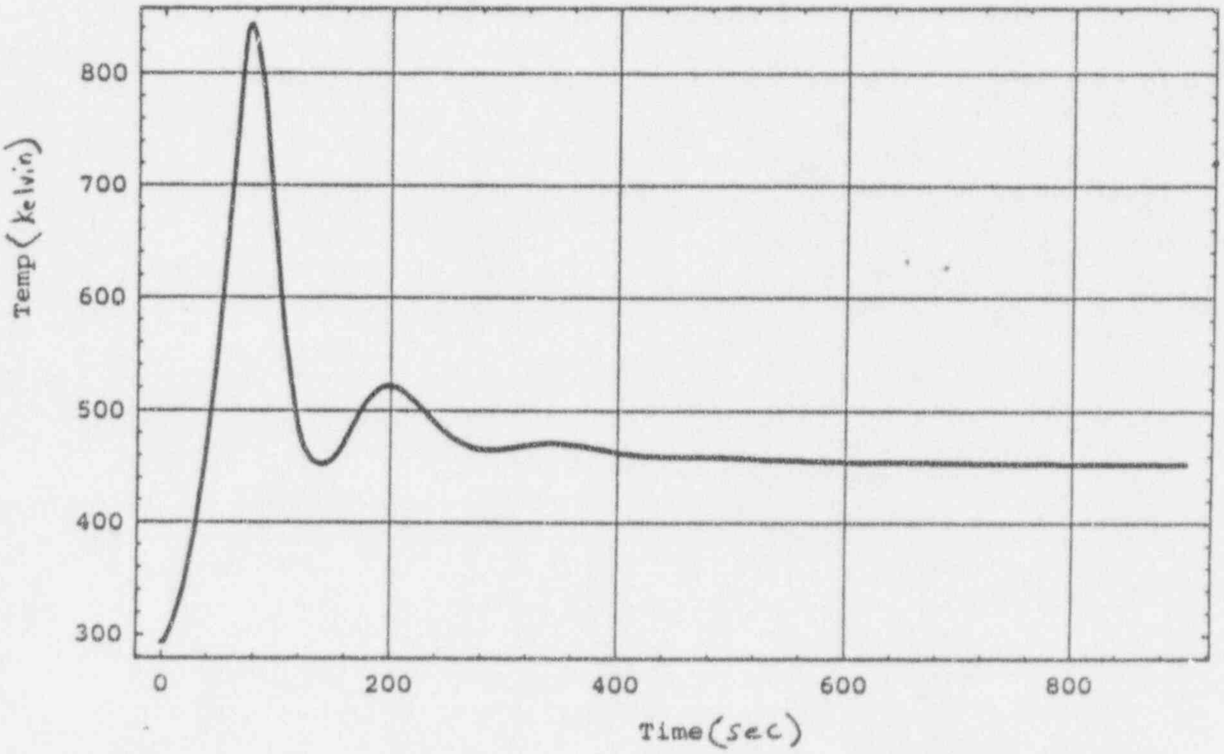


Figure 12. Case 2. Compartment gas temperature.

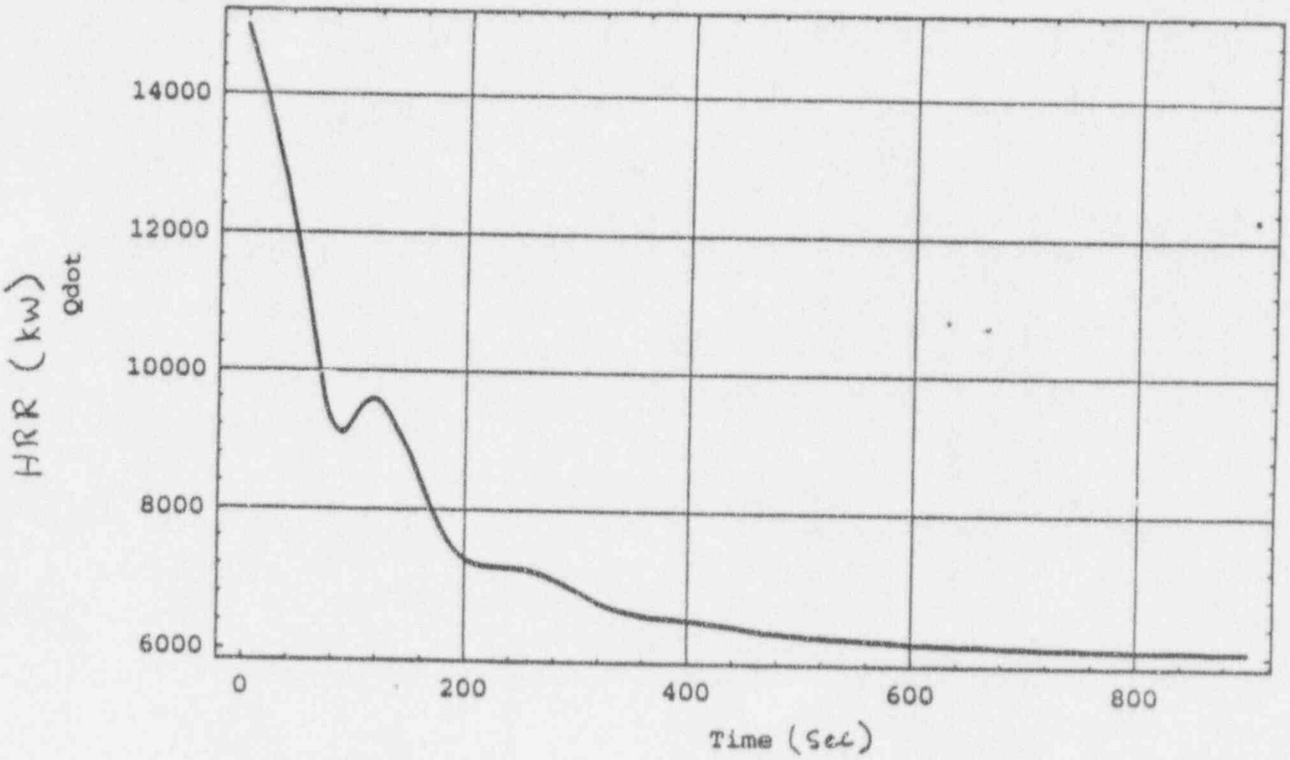


Figure 13. Case 2. Compartment energy release rate.

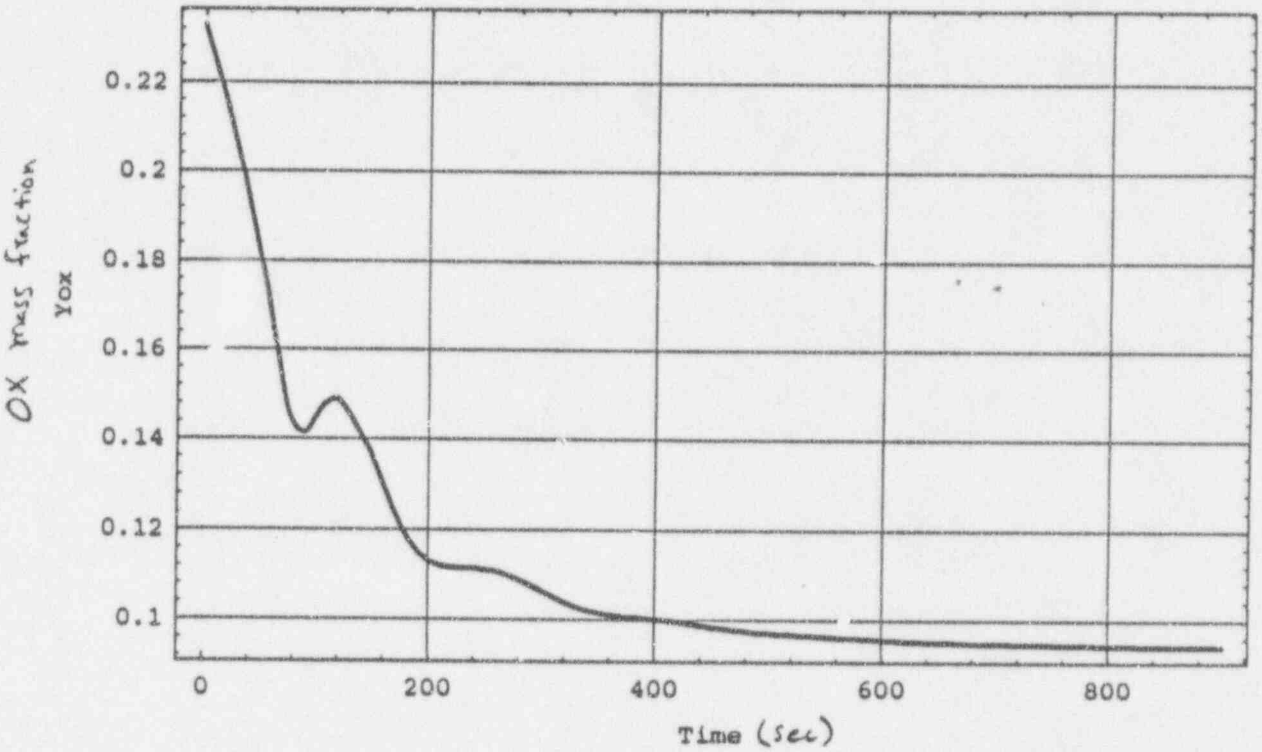


Figure 14. Case 2. Compartment oxygen mass concentration.

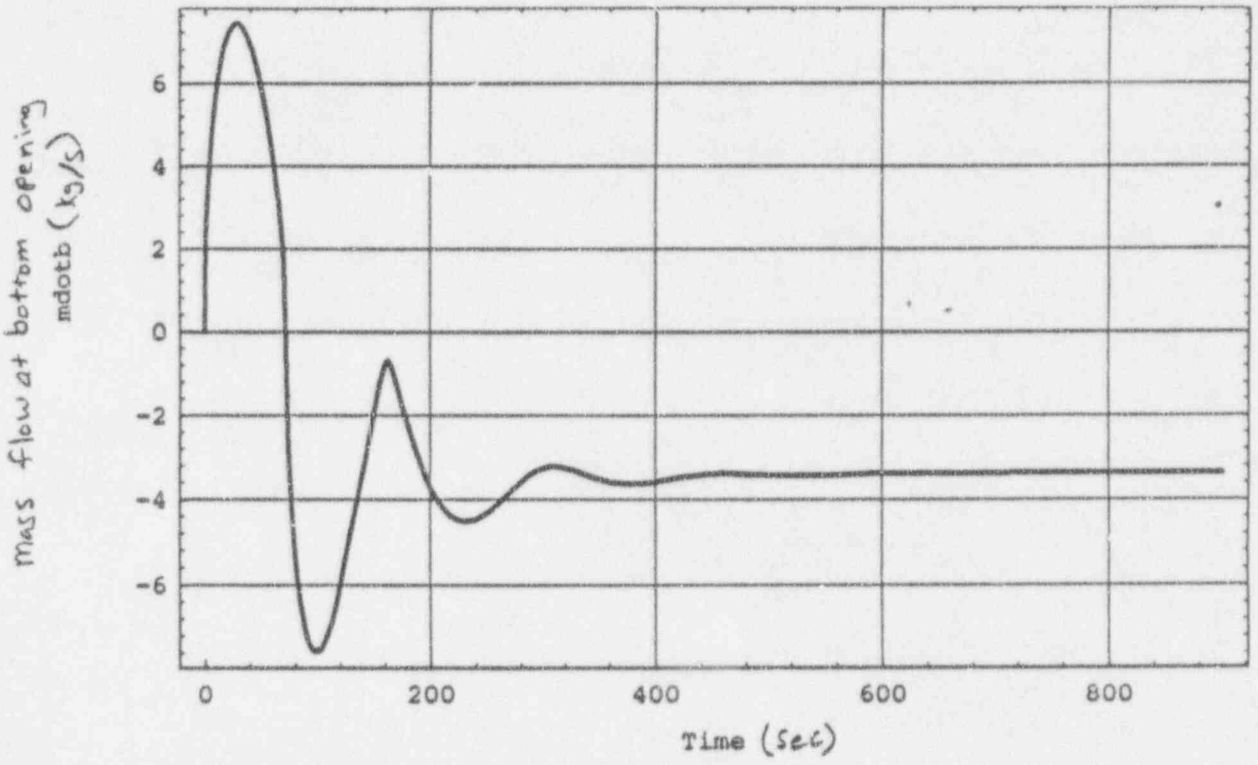


Figure 15. Case 2. Compartment bottom vent mass flow rate.

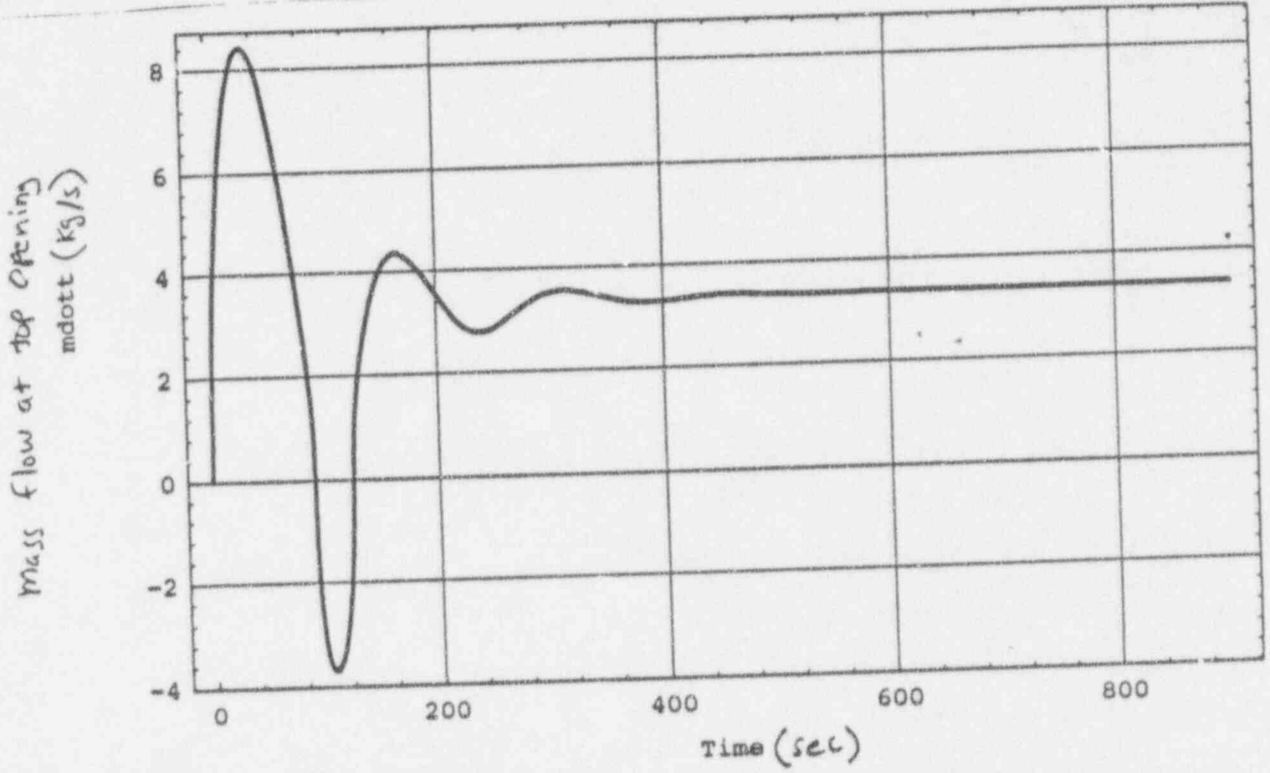


Figure 16. Case 2. Compartment top vent mass flow rate.

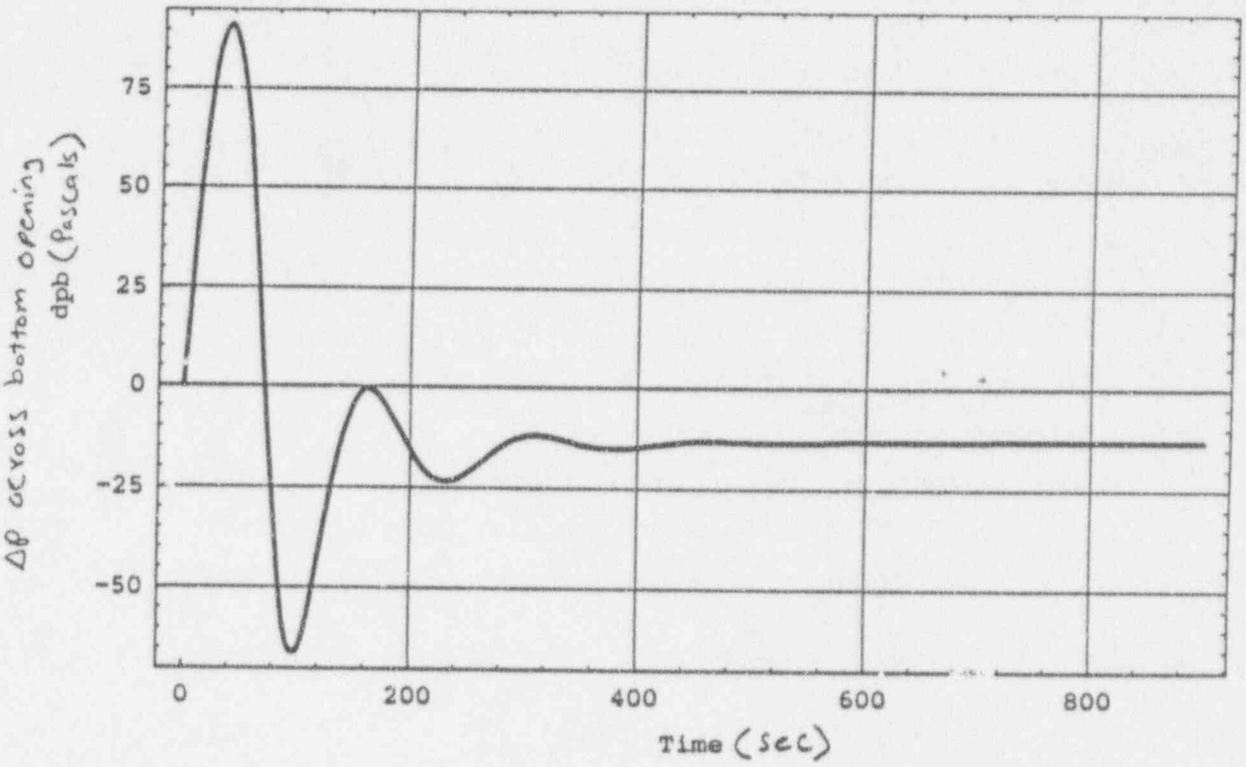


Figure 17. Case 2. Compartment bottom vent pressure difference.

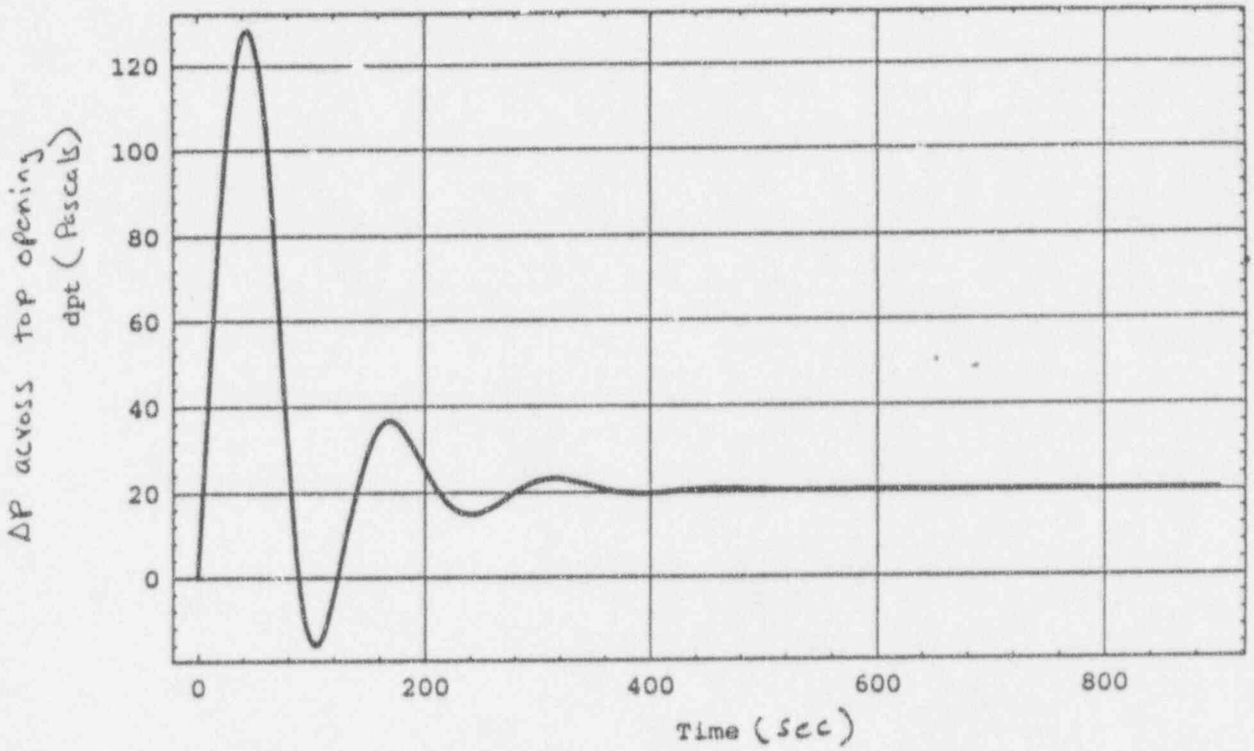


Figure 18. Case 2. Compartment top vent pressure difference.

Smoke Visibility and Damage Estimates

conditions at t = 120 s:

$$L_v = 1.03 \text{ m},$$

and $$m_s'' = 0.79\ \mu\text{g/cm}^2.$$

Conclusions

1. Standard fire resistance test methods represent temperature exposures of fully-developed compartment fires, but do not generally simulate the behavior of fire in a compartment.

2. A diesel spill fire in a nearly closed generator room can have fire behavior much different than that represented by a standard fire resistance test.

3. Fire resistance tests do not address smoke transport, and consequently the hazards associated with smoke visibility and deposition effects on electronic equipment are not addressed by these tests.

4. A model has been presented to illustrate how such a fire might behave, and how smoke would be generated and transported to the surroundings.

ABB Combustion Engineering

System 80+™ Standard Plant
HVAC Systems

Thomas D. Crom
Duke Engineering & Services, Inc.

ACRS ABB-CE Standard Plant Designs Subcommittee
April 5 & 6, 1994

System 80+™ Standard Plant

HVAC Ventilation Systems

- Annulus Ventilation System
- Control Complex Ventilation System
- Subsphere Building Ventilation System
- Fuel Building Ventilation System
- Radwaste Building Ventilation System
- Diesel Building Ventilation System
- Containment Purge Ventilation System
- Containment Cooling Ventilation System
- Turbine Building Ventilation System
- Nuclear Annex Ventilation System
- Component Cooling Water Heat Exchanger Structure Ventilation System

System 80+™ Standard Plant

HVAC Systems

Major Features:

- All HVAC cooling provided by chilled water
- Redundant recirculating air conditioning units are provided for the following areas:
  - Control Room
  - Essential Electrical Rooms
  - Vital Instrumentation and equipment rooms
  - Battery rooms
  - Remote shutdown panel room
  - Computer rooms
- Carbon adsorbers credited only in Control Room Ventilation System for accident analysis

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System 80+™ Standard Plant

HVAC Systems

Major Features (continued):

- HVAC Systems designed such that flow is from clean areas to contaminated areas
- Traditional once-through systems:
  - Nuclear Annex Ventilation System
  - Subsphere Building Ventilation System
  - Fuel Building Ventilation System
  - Radwaste Building Ventilation System
  - Containment Purge Ventilation Systems
- Normal release monitored upstream of filters and at unit vent
- Nuclear Annex Ventilation System and Subsphere Building Ventilation Systems are division specific and have no duct penetrations through the divisional wall

System 80+^{TM} Standard Plant

Annulus Ventilation System

Design Bases:

- Collect and filter containment leakage following a LOCA to meet 10 CFR 100 release limits

---

System 80+^{TM} Standard Plant

Annulus Ventilation System

Design Summary:

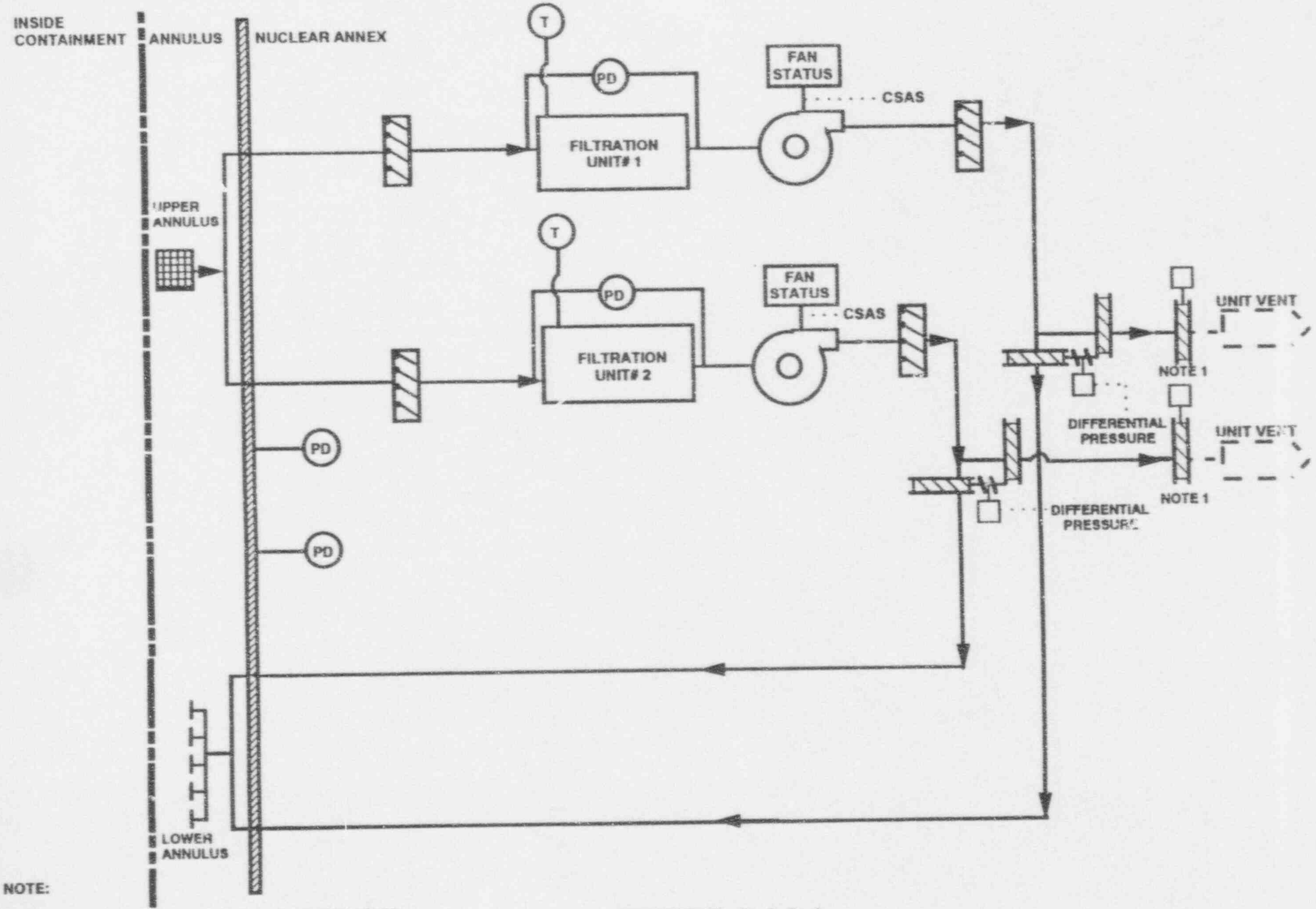
- Consists of two safety related divisions
- Each division consists of a filtration unit, fan, dampers, ductwork, and associated instruments and controls
- Each filtration unit meets Regulatory Guide 1.52 requirements consisting of prefilter, electric heater, absolute (HEPA) filter, carbon adsorber, and post filter (HEPA)
- System is automatically started on containment spray actuation signal
- Dampers modulate exhaust and return flow to maintain annulus pressure at -0.5 in. of water gauge

System 80+^{TM} Standard Plant

Annulus Ventilation System

ITAAC Scope:

- Basic configuration
- Removal of particulate matter
- Negative pressure
- Class 1E power and electrical independence
- Divisional separation
- Activation on CSAS
- Display and controls in the main control room



NOTE:

1. THE DUCT WORK FROM THE BUILDING EXIT UP TO AND INCLUDING THE ISOLATION DAMPER IS QUALIFIED FOR TORNADO DIFFERENTIAL PRESSURE.

FIGURE 2.4.2-1
ANNULUS VENTILATION SYSTEM

System 80+™ Standard Plant

Control Complex Ventilation System

Design Bases:

- Maintain acceptable temperature in the control complex for operator comfort and equipment qualification
  - Control room and other support areas maintained between 73°F to 78°F and 20% to 60% maximum relative humidity
  - Battery rooms maintained at approximately 77°F (60°F minimum to 90°F maximum)
  - Mechanical equipment rooms maintained less than 104°F
  - All other areas maintained less than 85°F
- Maintain continuous pressurization of the control room and technical support center
- Maintain dose to control room operators within the regulatory limits
- Protect control room personnel from the effects of toxic chemicals, smoke, or effects of high energy line ruptures

---

System 80+™ Standard Plant

Control Complex Ventilation System

Design Summary:

- Main control room air conditioning system
  - Consists of two safety related divisions
  - Each division provides 2000 CFM intake air for pressurization, and 4000 CFM is recirculated for cooling and air cleanup
  - Each division is provided with a Regulatory Guide 1.52 filter consisting of prefilter, electric heater, absolute (HEPA) filter, carbon adsorber, and post filter (HEPA) and air conditioning unit supplied by essential chilled water
  - Filters are normally bypassed and are automatically aligned on SIAS or high radiation signal
  - Outside air for pressurization taken from either of two intakes
  - Intakes are automatically isolated on detection of smoke or toxic gas
  - Upon detection of radiation in the intake, the intake having the higher radiation closes automatically and will realign such that the intake with the higher radiation is closed and the intake with the least radiation is open

System 80+™ Standard Plant

Control Complex Ventilation System

Design Summary (continued):

- Technical support center air conditioning system
  - Receives outside air from main control room air conditioning system intake ducts
  - Consists of a single non-safety division with pressurization fan, filtration unit, and air conditioning unit supplied with normal chilled water
- Balance of control complex ventilation system
  - Supply air from separate intake than control room and technical support center
  - Redundant recirculating air conditioning units are provided for the following safety related areas: essential electrical equipment rooms, vital instrumentation and equipment rooms, battery rooms, and the remote shutdown panel room

---

System 80+™ Standard Plant

Control Complex Ventilation System

Design Summary (continued):

- Balance of control complex ventilation system (cont'd)
  - Redundant recirculating air conditioning units are provided for the non-safety computer rooms
  - A single recirculating air conditioning unit is provided for the following non-safety related areas:
    - Operation support center
    - Non-essential electrical rooms
    - Non-safety battery rooms
    - Other non-essential areas with the control complex
  - Each battery room has an exhaust fan taking suction near the battery room ceiling
  - Smoke removal for each area is accomplished with smoke purge fans

System 80+™ Standard Plant

Control Complex Ventilation System

ITAAC Scope:

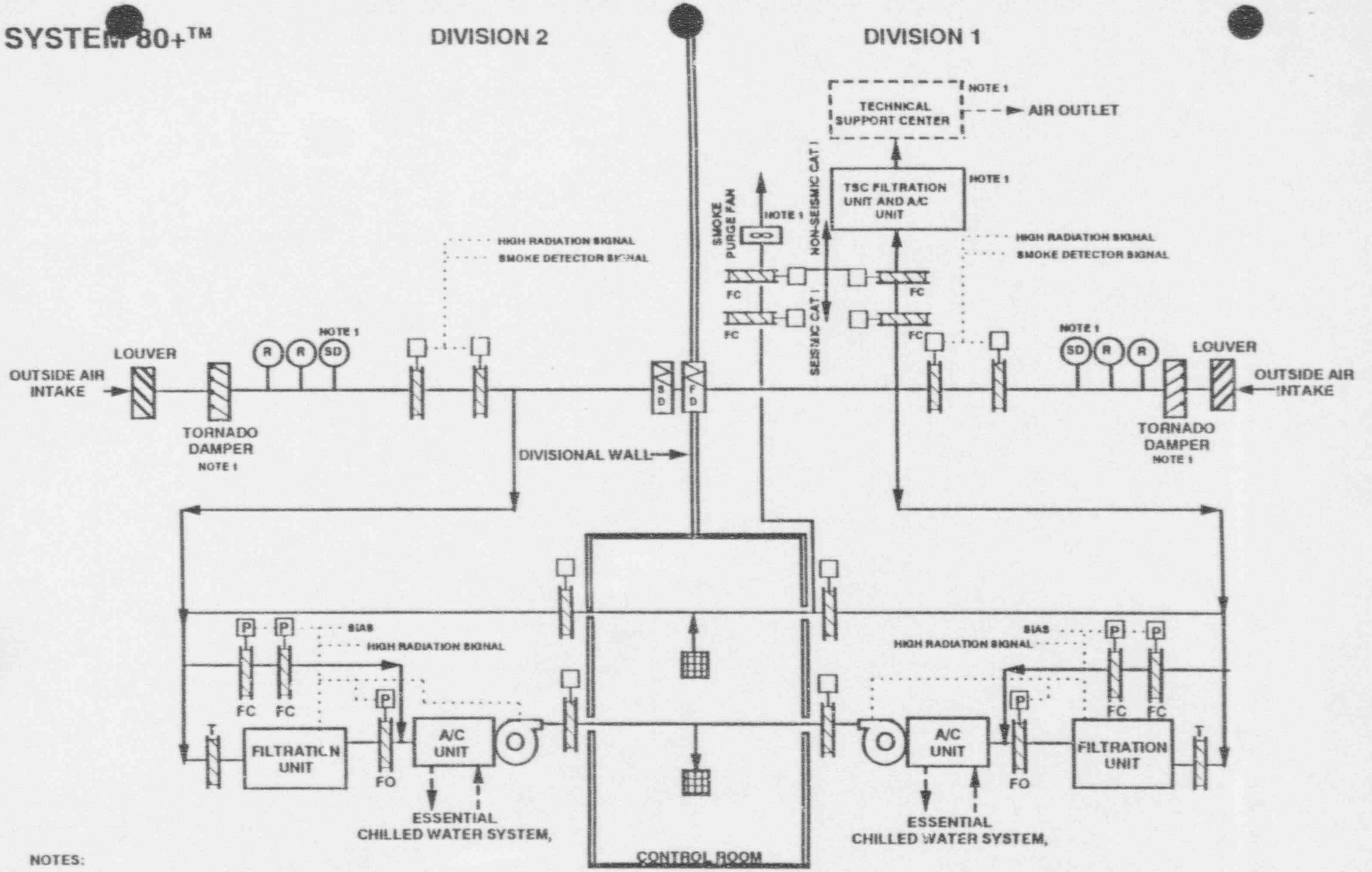
- Basic configuration
- Maintains environmental conditions within the control complex
- Intake isolation damper closure on detection of smoke and radiation
- Filtration of particulate matter and iodine
- Maintains positive pressure in control room and technical support center
- Automatic start and repositioning into filtration mode

System 80+™ Standard Plant

Control Complex Ventilation System

ITAAC Scope (continued):

- Battery room exhaust and hydrogen detection
- Class 1E power supplies and electrical independence
- Divisional separation
- Displays and controls in main control room
- Intake duct leakage
- Fire damper closure

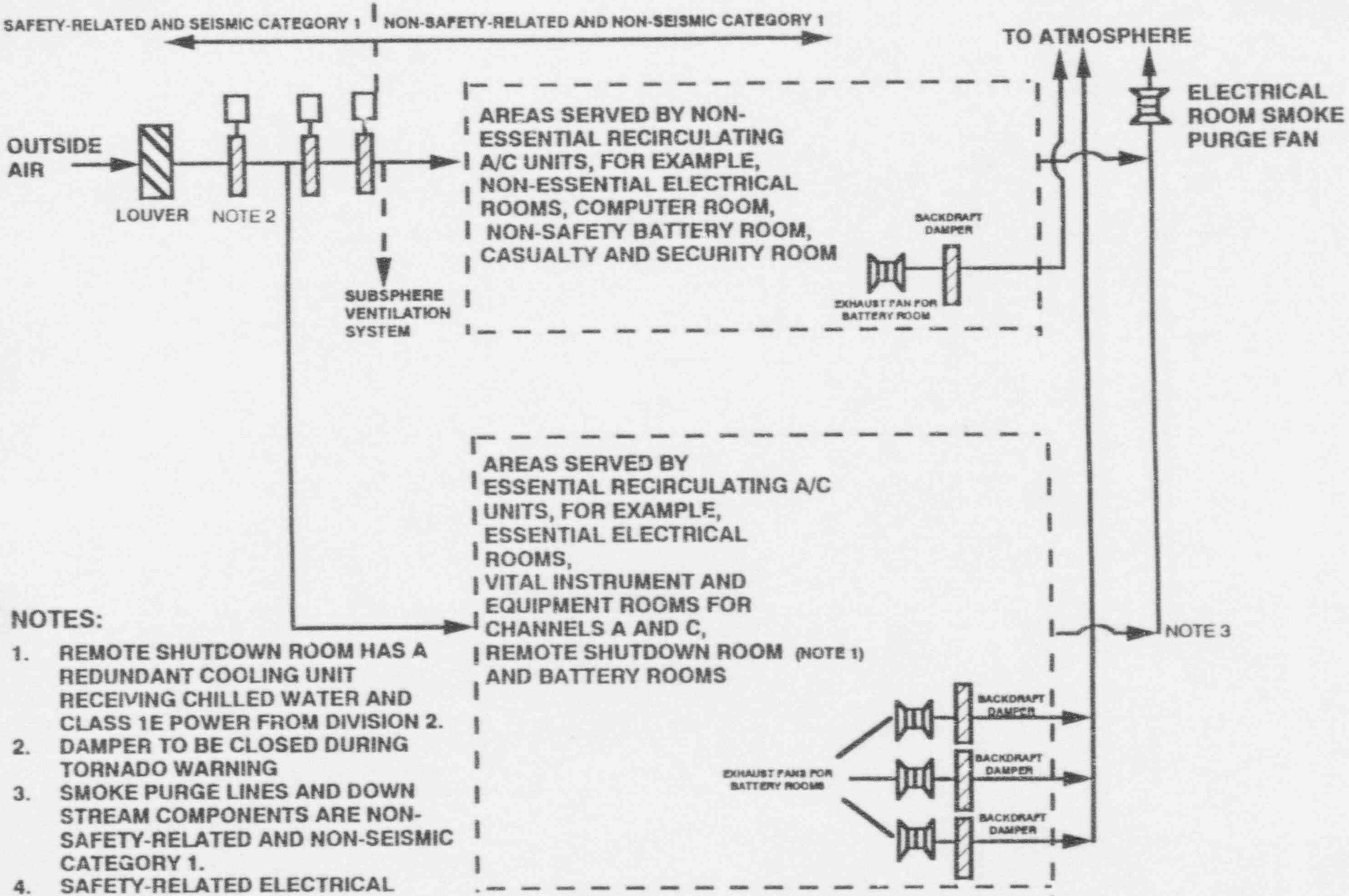


NOTES:

1. NON-SAFETY RELATED COMPONENTS.
2. SAFETY-RELATED ELECTRICAL EQUIPMENT IS CLASS 1E.

FIGURE 2.7.17-1
CONTROL COMPLEX VENTILATION SYSTEM
(MCRACS AND TSCACS)

12-31-93

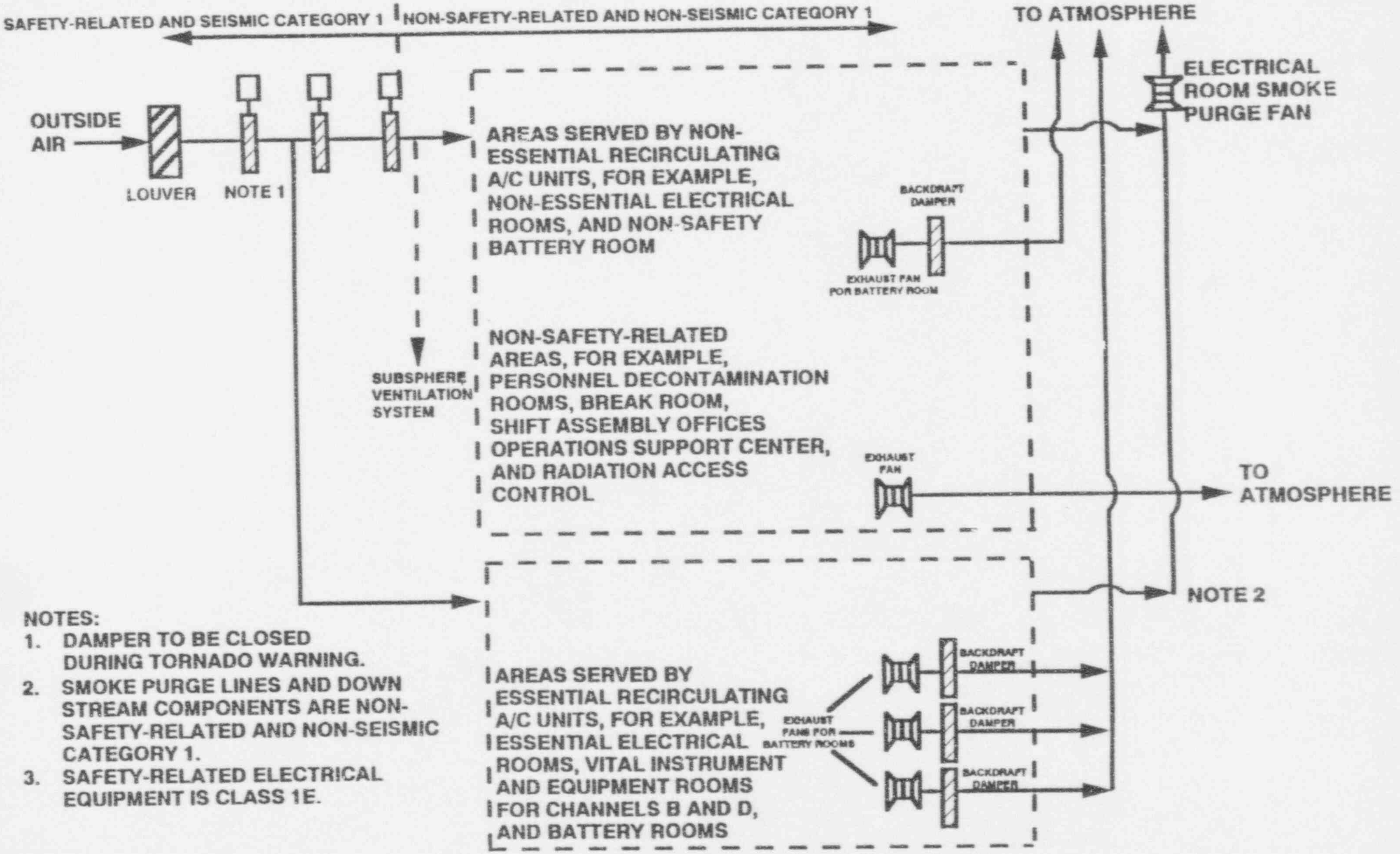


NOTES:

1. REMOTE SHUTDOWN ROOM HAS A REDUNDANT COOLING UNIT RECEIVING CHILLED WATER AND CLASS 1E POWER FROM DIVISION 2.
2. DAMPER TO BE CLOSED DURING TORNADO WARNING
3. SMOKE PURGE LINES AND DOWN STREAM COMPONENTS ARE NON-SAFETY-RELATED AND NON-SEISMIC CATEGORY 1.
4. SAFETY-RELATED ELECTRICAL EQUIPMENT IS CLASS 1E.

FIGURE 2.7.17-2
CONTROL COMPLEX VENTILATION SYSTEM
(BALANCE OF CCVS-DIVISION 1)

12-31-93



NOTES:

1. DAMPER TO BE CLOSED DURING TORNADO WARNING.
2. SMOKE PURGE LINES AND DOWN STREAM COMPONENTS ARE NON-SAFETY-RELATED AND NON-SEISMIC CATEGORY 1.
3. SAFETY-RELATED ELECTRICAL EQUIPMENT IS CLASS 1E.

FIGURE 2.7.17-3
CONTROL COMPLEX VENTILATION SYSTEM
(BALANCE OF CCVS-DIVISION 2)

System 80+^{TM} Standard Plant

Subsphere Building Ventilation System

Design Bases:

- Maintain mechanical equipment rooms less than 100°F
- Maintain negative pressure for airborne contamination control
- Collect and filter airborne leakage following a LOCA to meet 10 CFR 100 release limits

---

System 80+^{TM} Standard Plant

Subsphere Building Ventilation System

Design Summary:

- Area cooling maintained by recirculating coolers of the essential chilled water system
- Ventilation supply air also provides cooling through cooling coils located in the air handling units with cooling water supplied from normal chilled water system
- Consists of safety related air exhaust subsystem and non -safety related air supply system
- System is separated by divisional wall such that there is no duct penetration through divisional wall

System 80+™ Standard Plant

Subsphere Building Ventilation System

Design Summary (continued):

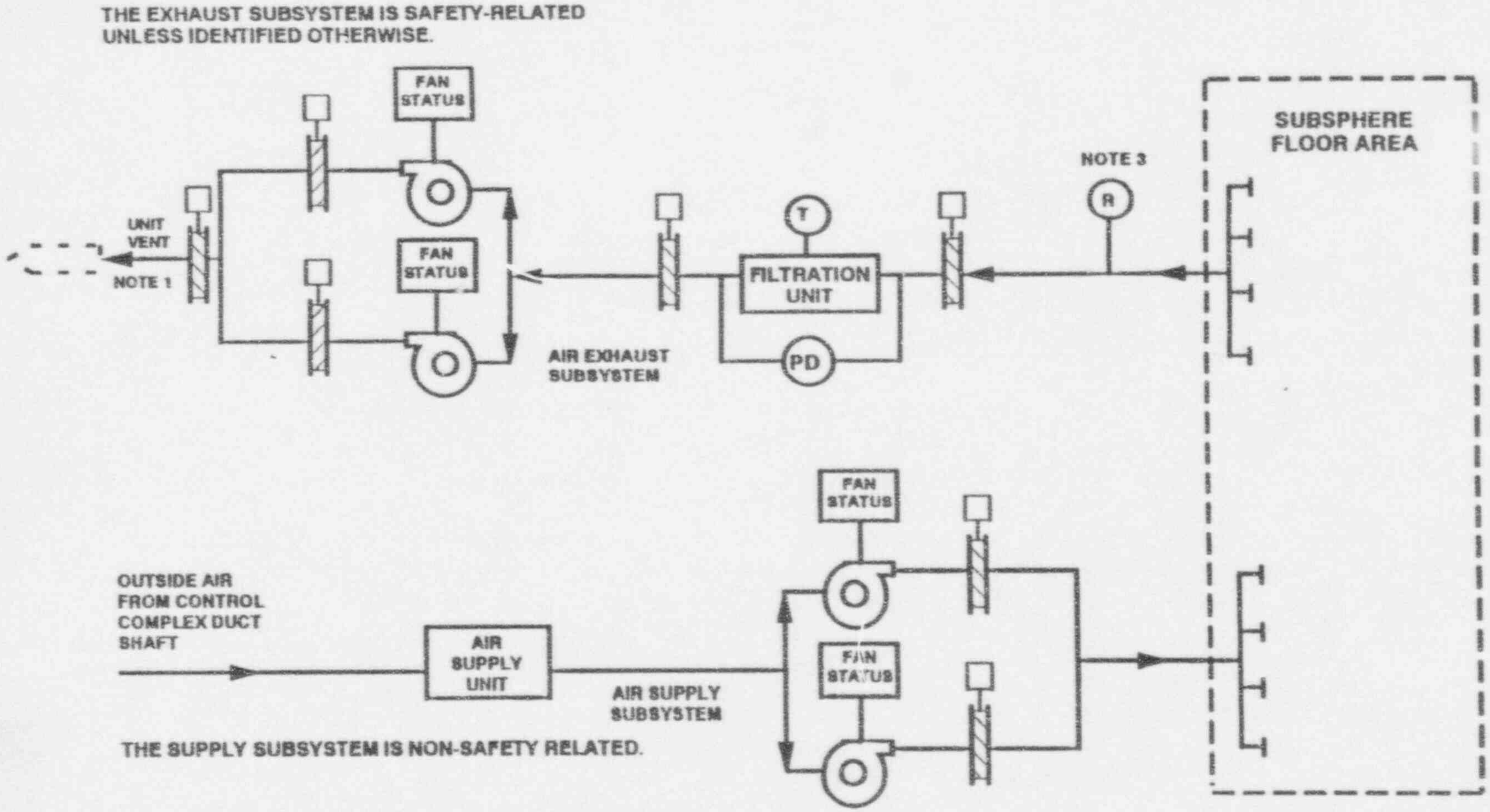
- Air supply subsystem consists of air-handling unit, two 100% capacity fans, dampers, and associated ductwork for each division
- Air exhaust subsystem consists of filter train, two 100% capacity fans and associated ductwork for each division
- Each filter train meets Regulatory Guide 1.52 requirements consisting of prefilter, electric heater, absolute (HEPA) filter, carbon adsorber, and post filter (HEPA)

System 80+™ Standard Plant

Subsphere Building Ventilation System

ITAAC Scope:

- Basic configuration
- Removal of particulate matter
- Maintenance of negative pressure
- Class 1E power supplies and electrical independence
- Divisional separation
- Displays and controls in main control room



NOTES:

1. THE DUCT WORK FROM THE BUILDING EXIT UP TO AND INCLUDING THE ISOLATION DAMPER IS QUALIFIED FOR THE TORNADO DIFFERENTIAL PRESSURE.
2. SAFETY-RELATED ELECTRICAL EQUIPMENT OF THE AIR EXHAUST SUBSYSTEM IS CLASS 1E.
3. THE RADIATION DETECTOR INSTRUMENTATION IS NON-SAFETY-RELATED.

FIGURE 2.7.20-1
SUBSPHERE BUILDING VENTILATION SYSTEM
(ONE OF TWO DIVISIONS)

System 80+™ Standard Plant

Fuel Building Ventilation System

Design Bases:

- Maintain a suitable environment for operations, maintenance, and testing (40°F to 104°F)
- Maintain negative pressure for airborne contamination control
- Mitigate the consequences of a postulated fuel-handling accident

System 80+™ Standard Plant

Fuel Building Ventilation System

Design Summary:

- Consists of one non-safety air supply subsystem and two safety-related divisions of air exhaust
- Air supply subsystem consists of one 100% capacity ventilation supply air handling unit and associated dampers and ductwork
- Air exhaust consists of two 100% capacity exhaust systems complete with filter trains and associated fans, dampers, ductwork, supports, and control systems

System 80+™ Standard Plant

Fuel Building Ventilation System

Design Summary (continued):

- Each filter train meets Regulatory Guide 1.52 requirements consisting of prefilter, electric heater, absolute (HEPA) filter, carbon adsorber, and post filter (HEPA)
- During normal operation filters are normally bypassed and are automatically aligned on high radiation signal
- Technical specifications require the system to be manually aligned to the filtered mode before any fuel handling

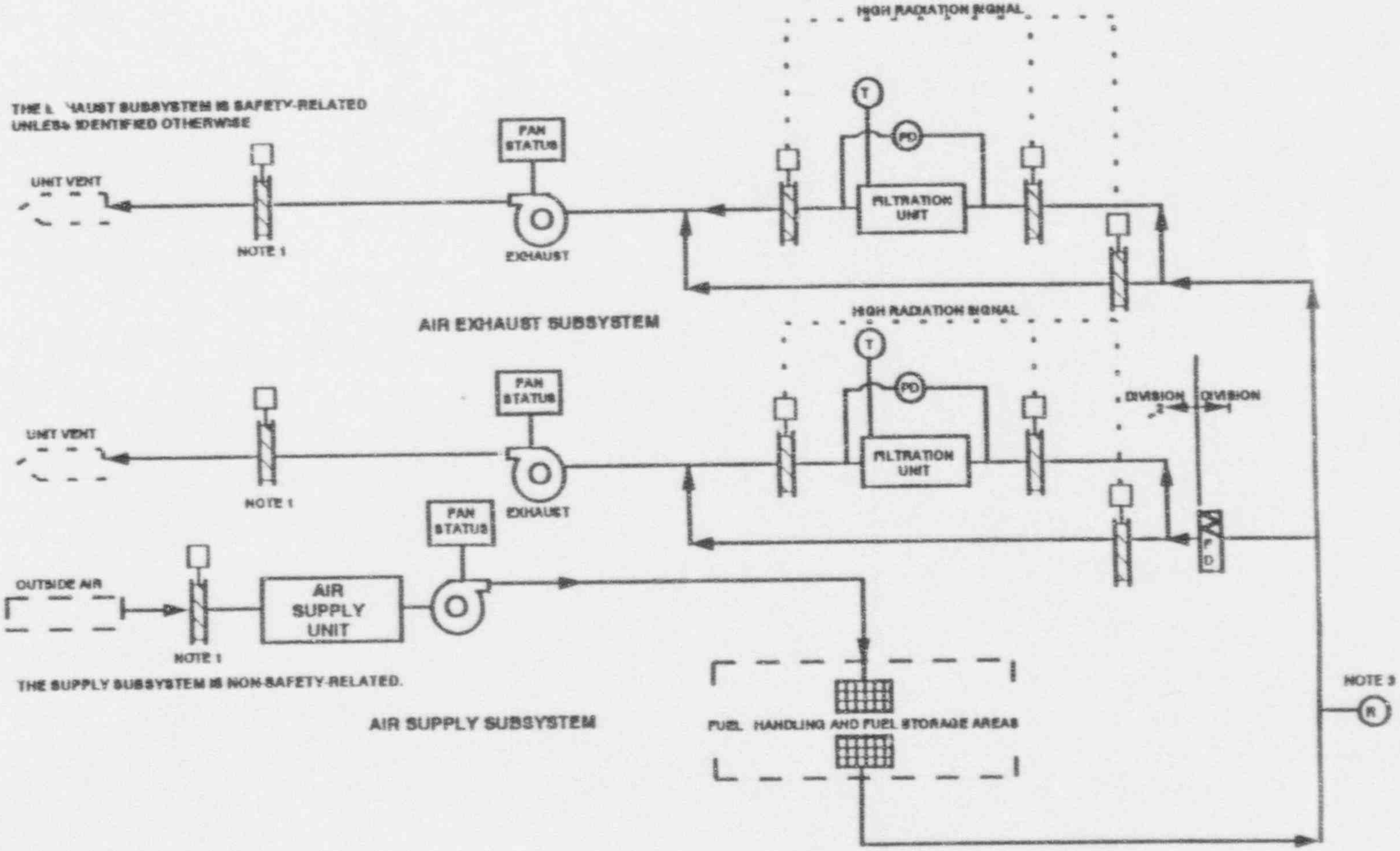
---

System 80+™ Standard Plant

Fuel Building Ventilation System

ITAAC Scope:

- Basic configuration
- Removal of particulate matter
- Maintenance of negative pressure
- Class 1E power supplies and electrical independence
- Divisional separation
- Displays and controls in main control room
- Filter alignment on high radiation
- Fire damper closure



NOTES:

1. THE DUCTWORK FROM THE BUILDING EXIT UP TO AND INCLUDING THE ISOLATION DAMPER IS QUALIFIED FOR THE TORNADO DIFFERENTIAL PRESSURE.
2. THE ELECTRICAL LOADS SHOWN FOR THE AIR EXHAUST SUBSYSTEM ARE CLASS 1E.
3. THE RADIATION DETECTION INSTRUMENTATION IS NON-SAFETY-RELATED.

FIGURE 2.7.18-1
FUEL BUILDING VENTILATION SYSTEM

System 80+™ Standard Plant

Radwaste Building Ventilation System

Design Bases:

- Maintain suitable environment for operation, maintenance, and testing (40°F to 100°F)
- Maintain negative pressure for airborne contamination control

---

System 80+™ Standard Plant

Radwaste Building Ventilation System

Design Summary:

- Non-safety related system consisting of air supply subsystem and air exhaust subsystem
- Air supply subsystem consists of two 50% capacity air handling units and associated dampers and ductwork
- Air exhaust system consists of two 50% capacity filter trains, two 50% capacity fans and associated dampers and ductwork
- During normal operation filters are normally bypassed and are automatically aligned to filtered mode on high radiation signal

System 80+™ Standard Plant

Radwaste Building Ventilation System

ITAAC Scope:

- Basic configuration
- Filter alignment on high radiation
- Fire damper closure

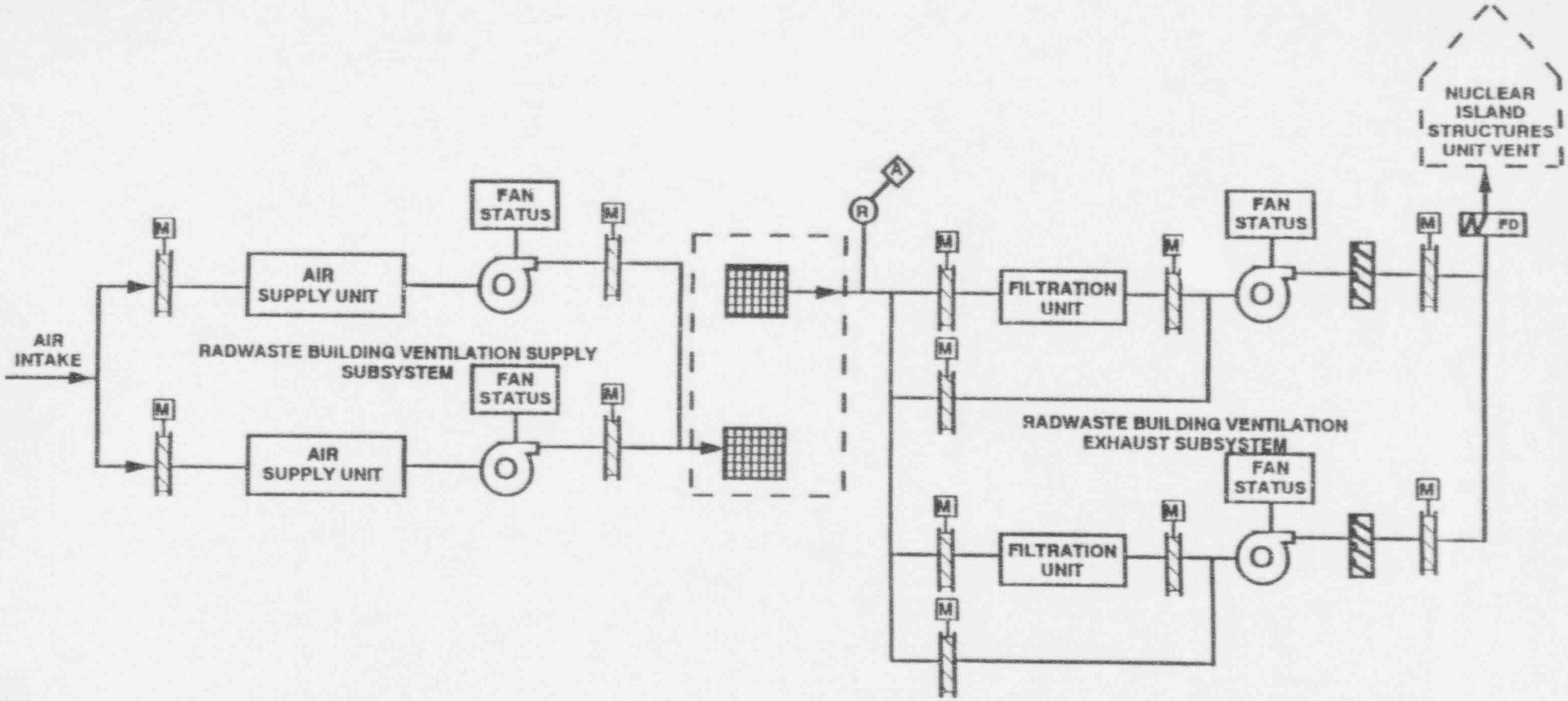


FIGURE 2.7.29-1
RADWASTE BUILDING VENTILATION SYSTEM

System 80+™ Standard Plant

Diesel Building Ventilation System

Design Bases:

- Maintain diesel generator area temperature between 40°F minimum and 120°F when diesel is not operating and 122°F maximum when diesel is operational

---

System 80+™ Standard Plant

Diesel Building Ventilation System

Design Summary:

- Each diesel room provided with dedicated ventilation system
- System consists of supply air intakes, normal ventilation fan, emergency ventilation exhaust fans with associated dampers and controls for each diesel generator area
- Two 50% safety related exhaust fans equipped with two speed motor
- Fan speed and modulating inlet vanes control room temperature

System 80+™ Standard Plant

Diesel Building Ventilation System

ITAAC Scope:

- Basic configuration
- Class 1E power supplies and electrical independence
- Divisional separation
- Displays and controls in main control room

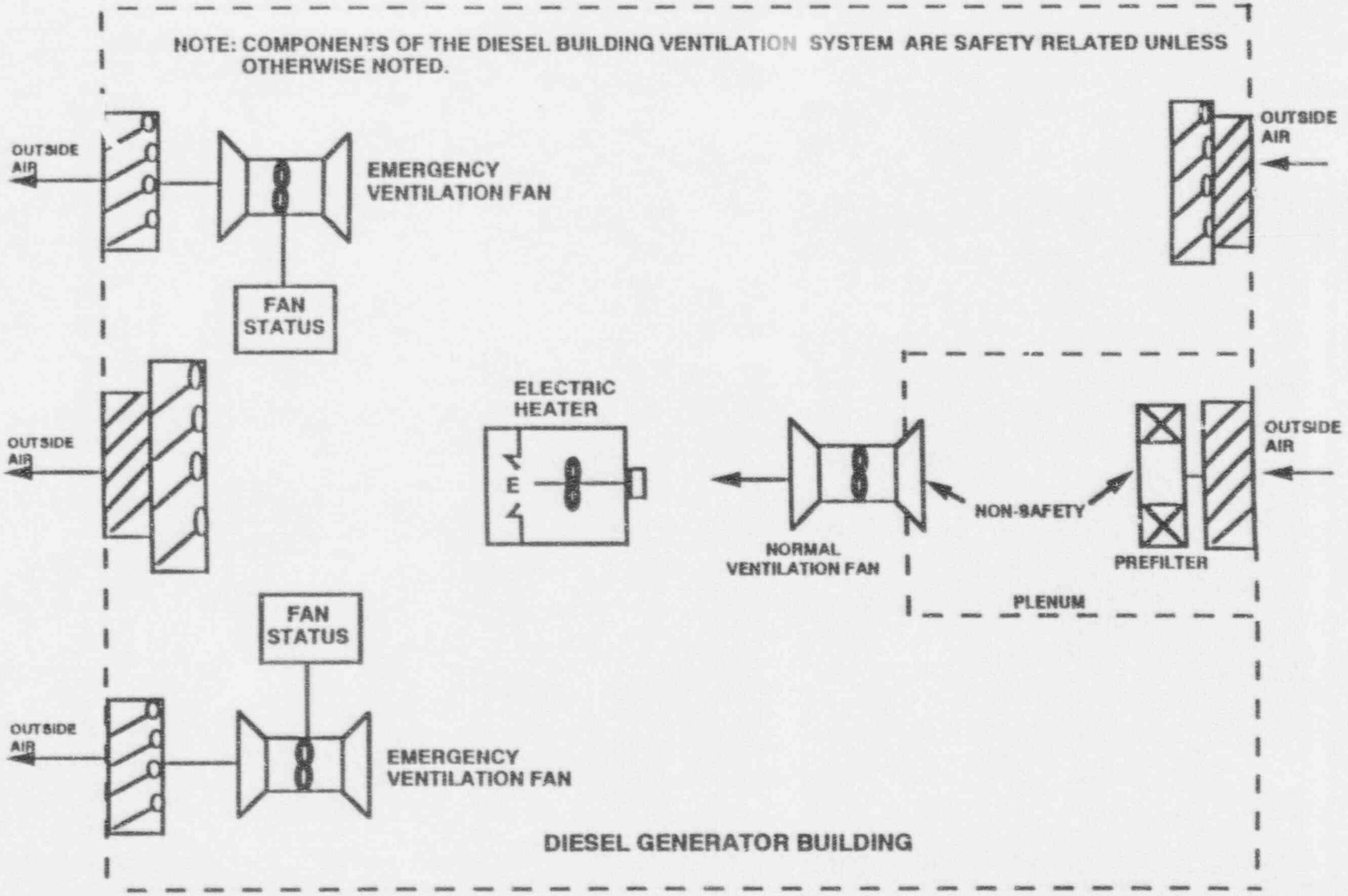


FIGURE 2.7.19-1
DIESEL BUILDING VENTILATION SYSTEM
(ONE OF TWO DIVISIONS)

System 80+™ Standard Plant

Containment Purge Ventilation System

Design Bases:

- Maintain suitable environment inside containment during refueling and maintenance operation
- Maintain negative pressure for airborne contamination control during refueling and maintenance operation
- Maintain pressure control during normal operation
- Mitigate the consequences of a postulated fuel-handling accident

---

System 80+™ Standard Plant

Containment Purge Ventilation System

Design Summary:

- Consists of Low Purge Subsystem and High Purge Subsystem
- Each supply consists of an air supply unit, two 100% capacity fans and associated dampers and ductwork
- Each exhaust consists of filter train, one 100% capacity fan and associated dampers and ductwork
- Containment isolation valves close on CIAS, high radiation signal and high humidity signal
- Filter train meets Regulatory Guide 1.52 requirements consisting of prefilter, electric heater, absolute (HEPA) filter, carbon adsorber, and post filter (HEPA)

System 80+^{TM} Standard Plant

Containment Purge Ventilation System

ITAAC Scope:

- Basic configuration
- Removal of particulate matter
- Containment isolation
- Displays and controls in main control room
- Valve loss of motive power test

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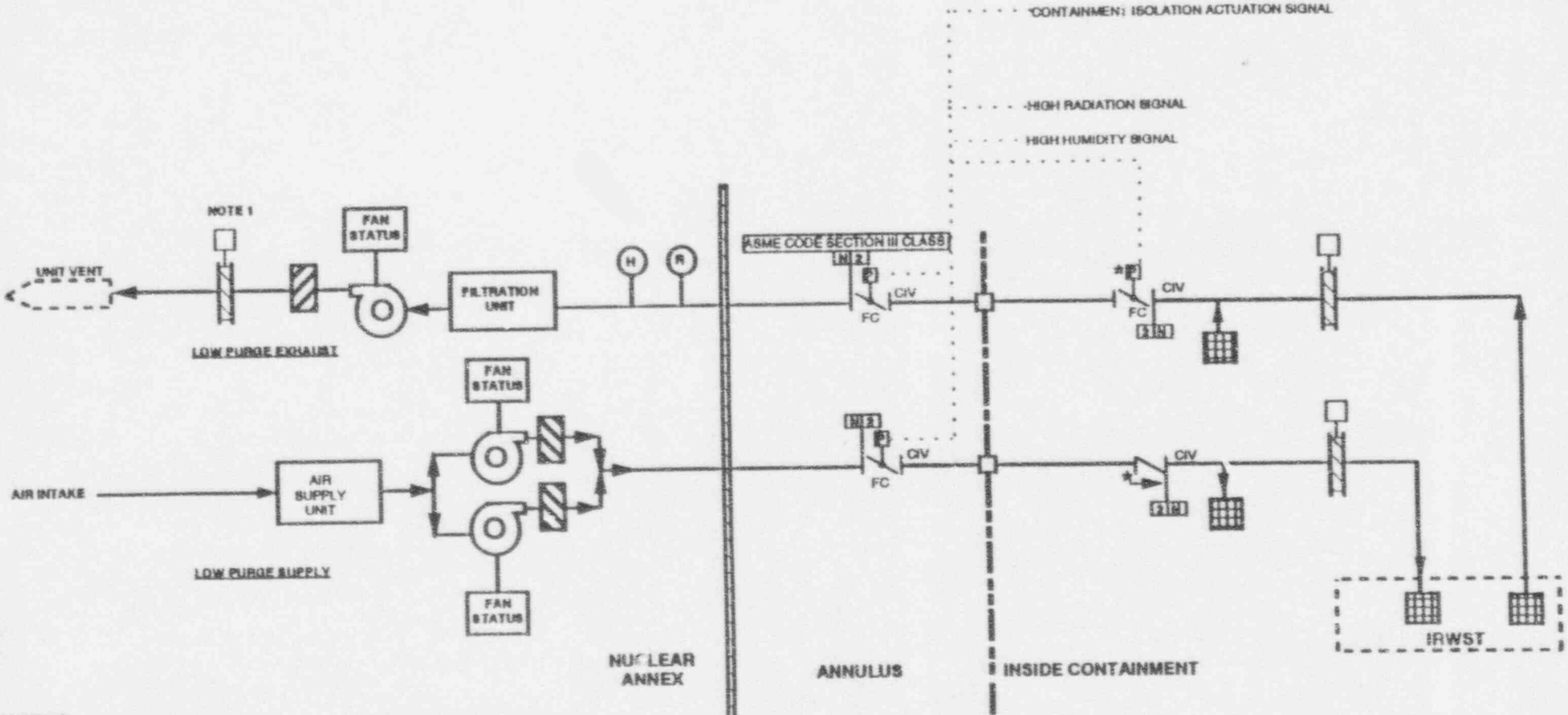
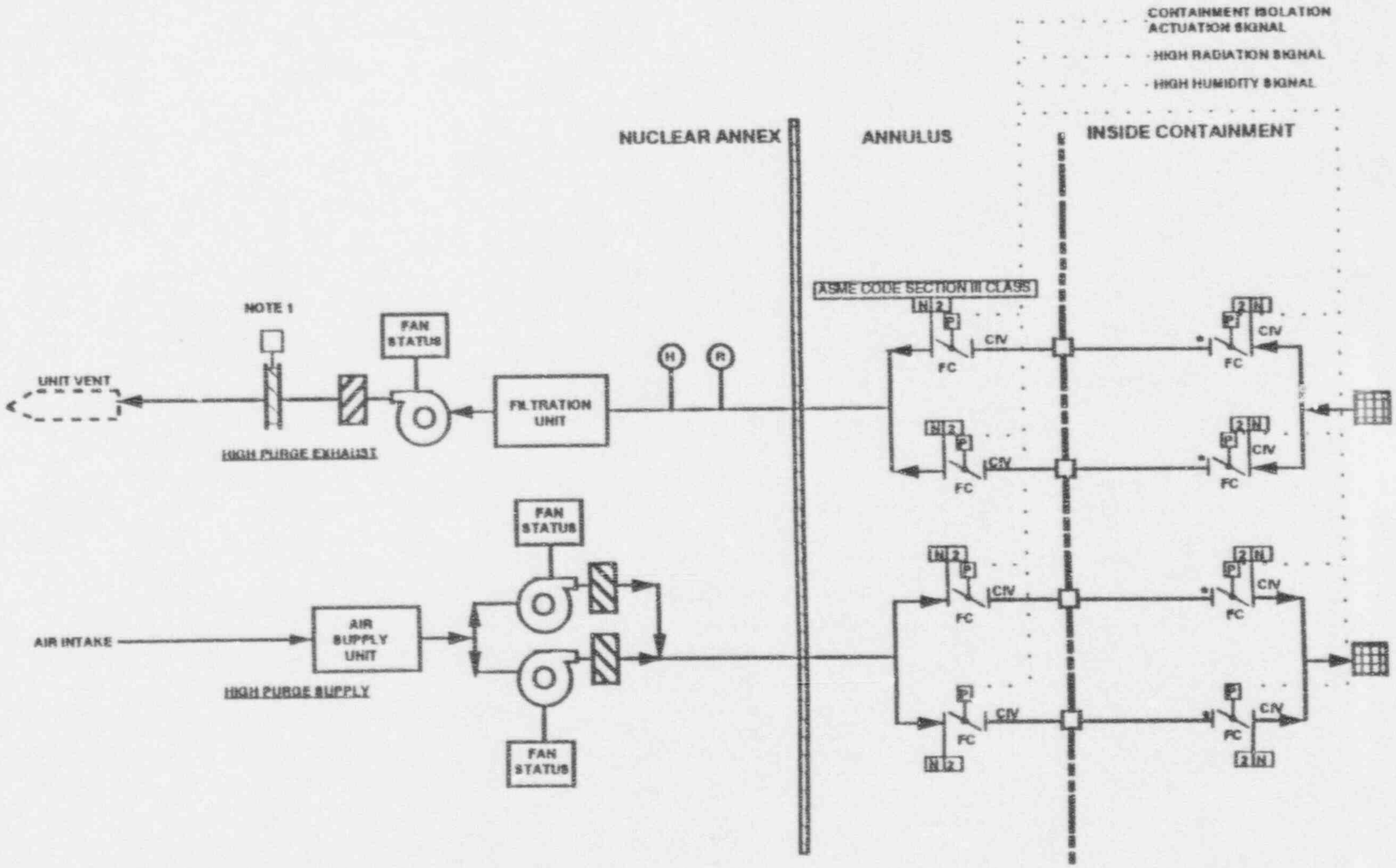


NOTES:

1. THIS DAMPER IS MANUALLY CLOSED DURING A TORNADO WARNING.
2. * EQUIPMENT FOR WHICH PARAGRAPH NUMBER (3) OF THE "VERIFICATIONS FOR BASIC CONFIGURATION FOR SYSTEMS" OF THE GENERAL PROVISIONS (SECTION 1.2) APPLIES.
3. THE SAFETY-RELATED ELECTRICAL EQUIPMENT IS CLASS 1E.

FIGURE 2.7.21-1
CONTAINMENT PURGE VENTILATION SYSTEM (LOW PURGE)



NOTES:

1. THIS DAMPER IS MANUALLY CLOSED DURING A TORNADO WARNING.
2. * EQUIPMENT FOR WHICH PARAGRAPH NUMBER (3) OF THE " VERIFICATION FOR BASIC CONFIGURATION FOR SYSTEMS" OF THE GENERAL PROVISIONS (SECTION 1.2) APPLIES.
3. THE SAFETY-RELATED ELECTRICAL EQUIPMENT IS CLASS 1E.

FIGURE 2.7.21-2
CONTAINMENT PURGE VENTILATION SYSTEM (HIGH PURGE)

System 80+™ Standard Plant

Containment Cooling and Ventilation System

Design Bases:

- Maintain containment temperature less than 110°F during normal operation
- Maintain cooling to control element drive mechanisms
- Maintain temperature of concrete surrounding reactor and pressurizer within acceptable limits
- Clean up containment air to reduce airborne radioactivity

System 80+™ Standard Plant

Containment Cooling and Ventilation System

Design Summary:

- Containment recirculation cooling system consists of four large cooling units, each with cooling coils supplied from normal chilled water system and recirculation fan
- Redundant pressurizer compartment fan provides pressurizer compartment cooling
- Redundant reactor compartment cooling fans provide reactor compartment cooling
- Two 100% capacity CEDM cooling units each with cooling coils supplied from the normal chilled water system and fan providing continuous air flow across the drive mechanism
- Two filtration units consisting of prefilter, absolute (HEPA) filter, carbon adsorber, post filter (HEPA), fan, ducting, and dampers circulate containment atmosphere for cleanup

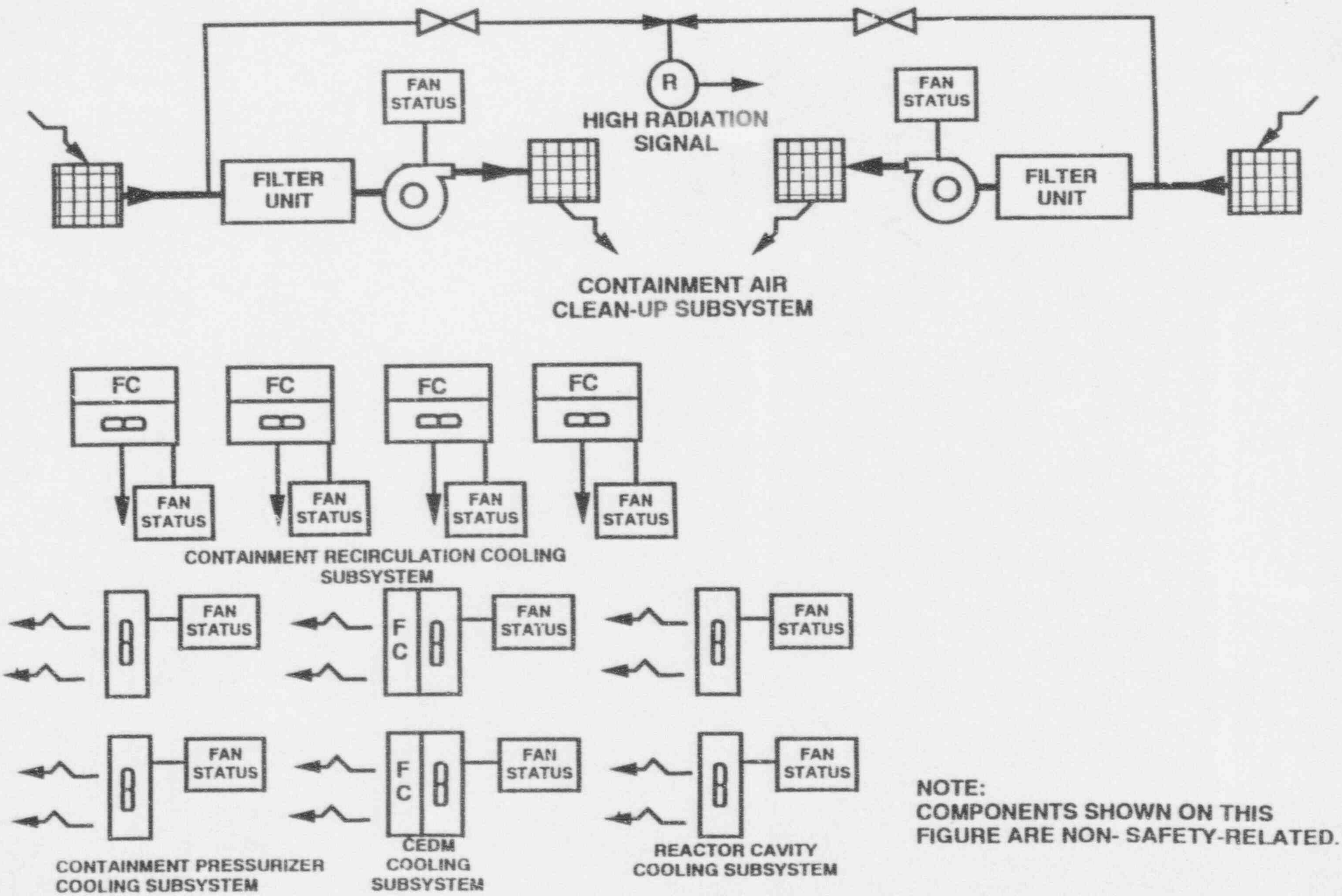
System 80+™ Standard Plant

Containment Cooling and Ventilation System

ITAAC Scope:

- Basic configuration
- Displays and controls located in main control room

[illegible]



NOTE:
COMPONENTS SHOWN ON THIS FIGURE ARE NON- SAFETY-RELATED.

FIGURE 2.7.22-1
CONTAINMENT COOLING AND VENTILATION SYSTEM

12-31-93

System 80+™ Standard Plant

Turbine Building Ventilation System

Design Bases:

- Maintain suitable environment for operation of equipment and personnel (40°F to 110°F based on 5% exceedance outside air temperatures)

System 80+™ Standard Plant

Turbine Building Ventilation System

Design Summary:

- Outside air drawn into turbine building through louvers and exhausted by roof mounted fans
- Recirculation fans provided where required to provide mixing

System 80+™ Standard Plant

Turbine Building Ventilation System

ITAAC Scope:

- Basic configuration

System 80+™ Standard Plant

Nuclear Annex Ventilation System

Design Bases:

- Maintain mechanical equipment rooms less than 100°F
- Maintain negative pressure for airborne contamination control

---

System 80+™ Standard Plant

Nuclear Annex Ventilation System

Design Summary:

- Area cooling maintained by recirculating coolers of the essential chilled water and normal chilled water systems
- Ventilation supply air also provides cooling through cooling coils located in the air handling units with cooling water supplied from the normal chilled water system
- Separate non-safety systems provided for each division such that there is no duct penetration through the divisional wall

System 80+™ Standard Plant

Nuclear Annex Ventilation System

Design Summary (continued):

- Supply subsystem consists of one 100% capacity supply unit and two 100% capacity supply fans and associated dampers and ductwork per division
- Exhaust subsystem consists of one 100% capacity particulate filtration exhaust unit and two 100% capacity exhaust fans for Division I and two 50% capacity particulate filtration exhaust units and two exhaust fans per exhaust unit for Division II
- During normal operation filters are normally bypassed and are automatically aligned on high radiation signal

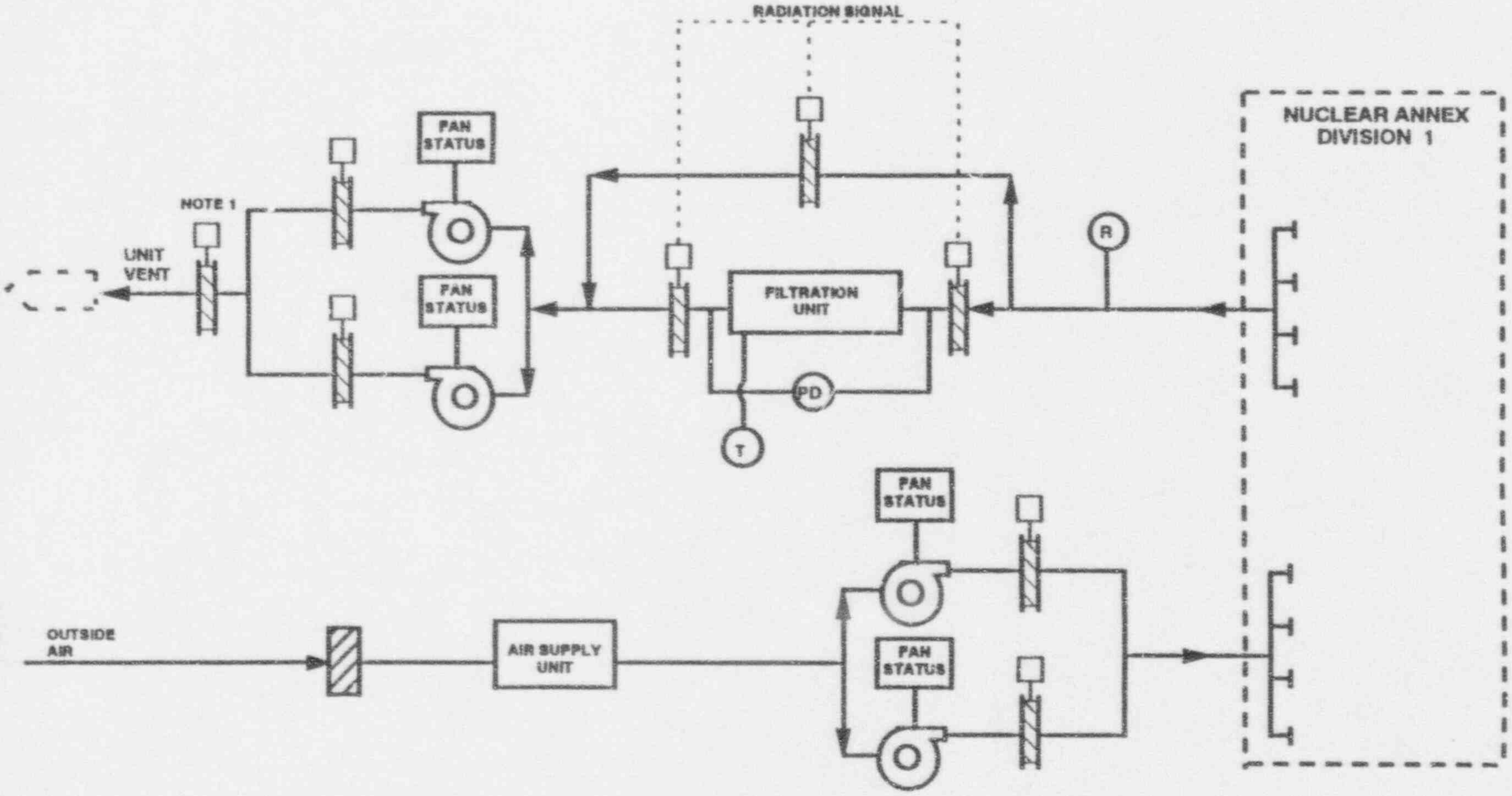
---

System 80+™ Standard Plant

Nuclear Annex Ventilation System

ITAAC Scope:

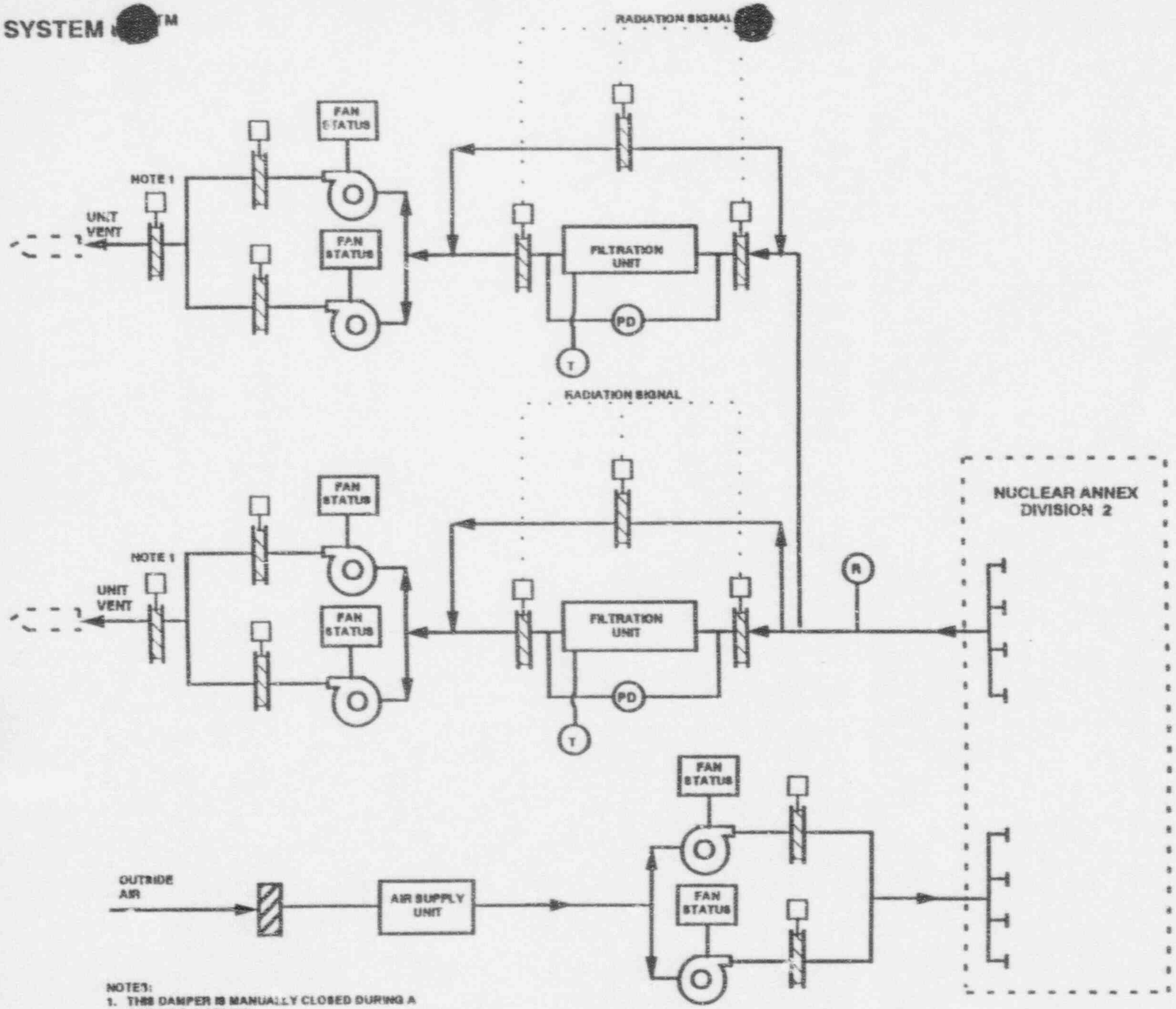
- Basic configuration
- Maintenance of negative pressure
- Divisional separation
- Displays and controls located in main control room
- Alignment to filtered mode



NOTE:
1. THIS DAMPER IS MANUALLY CLOSED DURING A TORNADO WARNING.

FIGURE 2.7.23-1
NUCLEAR ANNEX VENTILATION SYSTEM
(DIVISION 1)

12-31-93



NOTES:
1. THIS DAMPER IS MANUALLY CLOSED DURING A TORNADO WARNING

FIGURE 2.7.23-2
NUCLEAR ANNEX VENTILATION SYSTEM
(DIVISION 2)

System 80+™ Standard Plant

Component Cooling Water Heat Exchanger Structure Ventilation System

Design Bases:

- Maintain suitable environment for operation, maintenance, and testing for both equipment and personnel

---

System 80+™ Standard Plant

Component Cooling Water Heat Exchanger Structure Ventilation System

Design Summary:

- Non-safety system
- System provided for each division with no interconnections between divisions
- Each system consists of one exhaust fan with associated dampers and ductwork
- Electric resistance heaters maintain temperaure above 40°F

System 80+™ Standard Plant

Component Cooling Water Heat Exchanger Structure Ventilation System

ITAAC Scope:

- Basic configuration

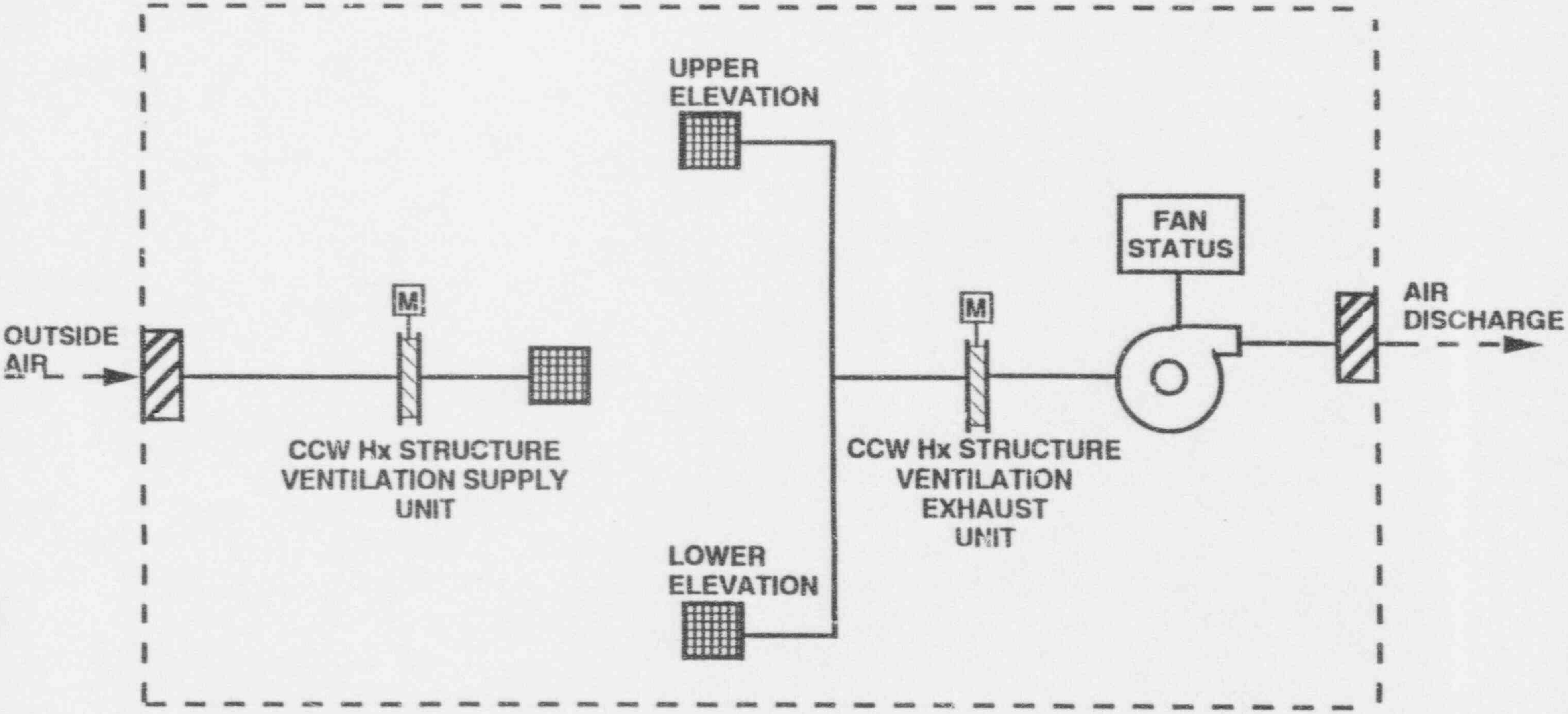


FIGURE 2.7.31-1
CCW HEAT EXCHANGER STRUCTURE VENTILATION SYSTEM
(ONE OF TWO SYSTEMS)

ABB Combustion Engineering

System 80+™ Standard Plant
Section 9.5.1 - Fire Protection System

Thomas D. Crom
Duke Engineering & Services, Inc.

ACRS ABB-CE Standard Plant Designs Subcommittee
April 5 & 6, 1994

System 80+™ Standard Plant

Fire Protection

Goals:

- Prevent radioactive release
- Prevent core melt
- Prevent personnel injury
- Maintain unit availability
- Protect capital investment

System 80+™ Standard Plant

Fire Protection

Design Bases Objectives:

- Prevent the possibility of a fire affecting redundant divisions of equipment required for cold shutdown; prevent fire-induced LOCA; and prevent interaction with other systems which could lead to a fire-induced LOCA
- Provide adequate access and egress routes for personnel protection
- Provide sufficient compartmentalization to preclude damage to redundant equipment
- Provide fixed systems for prompt fire detection and suppression
- Provide manual fire fighting for early suppression

System 80+™ Standard Plant

Fire Protection

Design Bases Objectives (continued):

- Provide smoke removal capability for manual fire fighting and to prevent migration of smoke beyond the fire area of origin
- Comply with NUREG-0800, BTP CMEB 9.5-1 and SECY 90-16

System 80+™ Standard Plant

Fire Protection

Criteria/Guidance used:

- Standard Review Plan, Section 9.5.1, Fire Protection Program
- Generic Letter 86-10
- SECY 90-16
  - Augments existing criteria and guidance for next generation of facilities
- NFPA
  - Systems design, installation, inspection, and testing

System 80+™ Standard Plant

Fire Protection

Safe shutdown following a fire:

- Cold shutdown can be accomplished using one of the two safety related divisions
- Cold shutdown can be accomplished from the control room or the remote shutdown panel
- Cold shutdown can be accomplished without making repairs
- No manual actions are required except for activation of transfer switches for transfer from control room to remote shutdown panel

System 80+™ Standard Plant

Fire Protection

Fire separation:

- Outside containment
  - Three hour fire rated barriers are provided to separate divisions and fire areas within a division
  - Control room separated from the remote shutdown room with three hour rated fire barriers; physically and electrically isolated
- Inside containment and annulus
  - Cables required for safe shutdown are mineral insulated and three hour rated
  - Redundant shutdown paths are separated by:
    - Reinforced concrete walls
    - Component such as steam generator or pressurizer
    - Spatial separation of at least 20 feet with no intervening combustibles

---

System 80+™ Standard Plant

Fire Protection

Fire separation (continued):

- Additional three hour fire rated barriers are provided for property protection
- The need for a cable spreading room has been eliminated due to fiber optics
- Four channel cable chases separated with three hour rated shafts
- All fire barriers have listed/approved fire doors or equivalent doors

System 80+™ Standard Plant

Fire Protection

Fire separation (continued):

- Spurious operation of valves inside containment protected by one or more of the following means:
  - Two valves provided in series with power from different electrical control channels
  - Power to valves is normally deenergized (e.g. MCC breaker is open)
  - Channelized motor control centers are located outside containment and are separated by three hour fire barriers
  - Breaker removal

System 80+™ Standard Plant

Fire Protection

Fire separation (continued):

- Additional separation provided:
  - Reactor Building subsphere divided into quadrants with three hour rated walls
  - Within a division safety injection pumps, shutdown cooling pump, containment spray pump, and Class 1E 4160V switchgears along with associated cabling are separated by a three hour rated walls
  - Cables from diesel generator room to the Class 1E 4160V switchgears within a division are separated
  - Permanent non-safety X and Y switchgear and alternate AC combustion turbine are located in different buildings from the Class 1E 4160V switchgear and diesel generators
  - Permanent non-safety switchgear cables X and Y are separated by the divisional wall within the Nuclear Annex and are not routed through the diesel generator rooms

System 80+™ Standard Plant

Fire Protection

Smoke control:

- Ventilation systems designed in accordance with NFPA 90A, "Air Conditioning and Ventilation Systems" and NFPA 92B, "Guide for Smoke Management Systems in Malls, Atria, and Large Areas"
- Separate ventilation systems for each division of the Nuclear Annex; thus, no duct penetrations through the divisional wall (except at control room intake and fuel pool area exhaust)
- Control room and remote shutdown room have separate HVAC intakes

System 80+™ Standard Plant

Fire Protection

Smoke control (continued):

- Stairs between control room and remote shutdown room pressurized
- Smoke purge fans prevent migration from one channel to the other within a division of control complex
- Smoke purge for containment, subsphere, fuel pool area, Nuclear Annex, and diesel generator rooms accomplished with 100% supply and exhaust ventilation systems

System 80+™ Standard Plant

Fire Protection

Suppression Systems:

- No gaseous systems used
- Water based pre-action sprinklers
  - Water damage due to pipe rupture or leakage is minimized
  - Protects areas of regulatory concern
  - Protects areas where fire would cause substantial damage
  - Enhances life safety features of the facility
  - Need determined by the Fire Hazards Analysis
- Standpipe systems with fire hoses
  - Secondary protection for sprinkled areas
  - Primary protection for unsprinkled areas
  - Adjustable spray nozzles listed for use on energized electrical equipment

---

System 80+™ Standard Plant

Fire Protection

Fire Protection Water Supply:

- Treated fresh water
  - No biological fouling
  - No Microbiologically Induced Corrosion
  - Reduced maintenance and testing
- Source
  - Wells
  - Municipal system
- Redundant water supply tanks
  - Two 300,000 gallon tanks
- Redundant fire pumps
  - One electric pump
  - One diesel pump

System 80+™ Standard Plant

Fire Protection

Fire protection water supply (continued):

- Jockey pump maintains system pressure
- Dedicated fire protection water distribution system
- Safety related standpipe system is seismically qualified
    - Assures sufficient water to minimum two inside hoses for two hours following a seismic event
    - Separate seismically qualified water supply and pump (18,000 gallon tank and 150 GPM pump)
    - Seismically qualified piping
    - Seismically qualified check valves at connection with non-seismic portions

---

System 80+™ Standard Plant

Fire Protection

Fire detection and alarm system:

- Fixed detection and alarm systems provide prompt notification of fire
- Detectors are specifically selected for each location based on potential fire hazard, need for timely actuation, ambient conditions, ventilation, and ceiling height, as determined in the Fire Hazards Analysis
- Manual pull stations are located as determined by the Fire Hazards Analysis
- Batteries supply backup power for the detection and alarm system
- Alarms in control room and locally in the vicinity of the activated device

System 80+™ Standard Plant

Fire Protection

Systems interaction:

- Fire hose and standpipe systems located in the Reactor Building and Nuclear Annex are Seismic Category I
- Automatic pre-action sprinkler systems are utilized in the Nuclear Annex, Reactor Building, and Alternate AC-Combustion Turbine
- Sprinkler system piping is seismically restrained to avoid interaction with safety related systems and equipment
- Divisional separation prevents spraying and flooding of redundant safety related equipment
- Potential discharge of fixed fire suppression systems and fire hoses are considered in sizing of floor drains
- Safety related equipment elevated to avoid damage

System 80+™ Standard Plant

Fire Hazards Assessment

- A fire hazards assessment was performed
- The COL applicant shall utilize the fire hazards assessment to complete the fire hazards analysis

System 80+^{TM} Standard Plant

Fire Hazards Assessment Content

General:

- Fire Area Description
  - Name of area and location
  - Construction features
  - Occupancy
  - Importance to plant operation
  - Location of redundant systems/equipment
  - High energy equipment/voltages
  - Heat sensitive equipment
  - HVAC
  - Acceptable level of risk
- Operator actions
- Maintenance activities

[illegible]

System 80+^{TM} Standard Plant

Fire Hazards Assessment Content

General (continued):

- Other Activities
- Radiological/Toxic Material
- Potential ignition source
- Curbs, drains, equipment pedestals
- Summary of combustible material

[illegible]

System 80+™ Standard Plant

Fire Hazards Assessment Content

Fire Protection Features:

- Fixed automatic suppression systems
- Manual fire suppression systems
    - Hose stations
    - Fire extinguisher
    - Fire suppression system valves
    - Detection
    - Alarm/pull station
    - Fire barriers/insulating material
    - Method of communication to control room
    - Personnel egress/fire brigade access
    - Potential effects of fixed automatic suppression system

---

System 80+™ Standard Plant

Fire Hazards Assessment Content

Fire Protection Features (continued):

- Manual fire suppression systems (continued)
    - Potential effects of fire brigade activities
    - Radiological consequences of fire
    - Smoke control methods
    - Summary of fire protection features
    - Consequences of fire
    - Compliance with Design Basis

System 80+^{TM} Standard Plant

Fire Protection

ITAAC Scope:

- Fire Protection System basic configuration
- Fire protection water supply tank capacity
- Fire pump separation
- Power supply for motor driven pump
- Fire pump capacity
- Fuel supply for diesel driven pump
- Standpipes in Nuclear Annex and Reactor Building are Seismic Category I

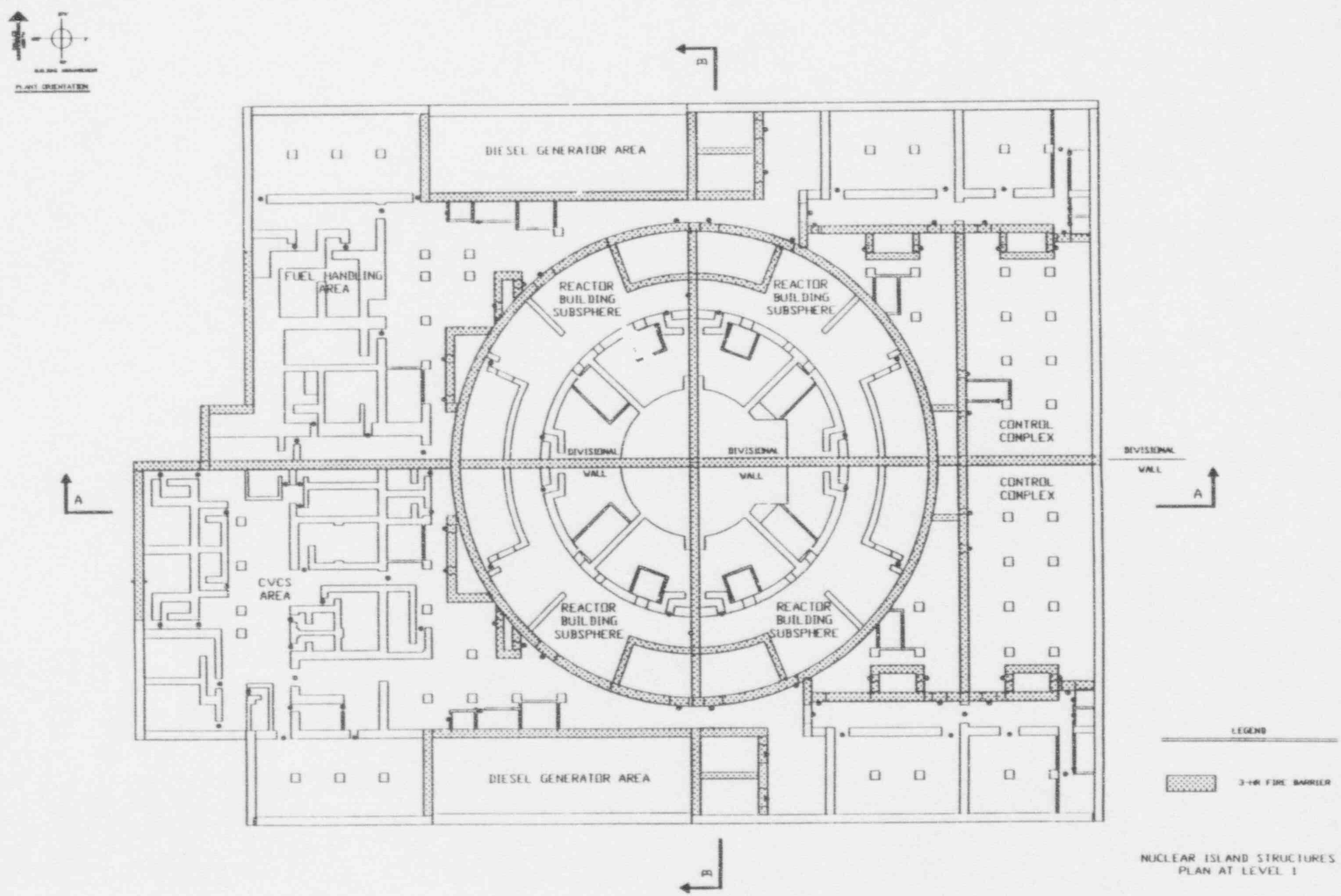
System 80+^{TM} Standard Plant

Fire Protection

ITAAC Scope (continued):

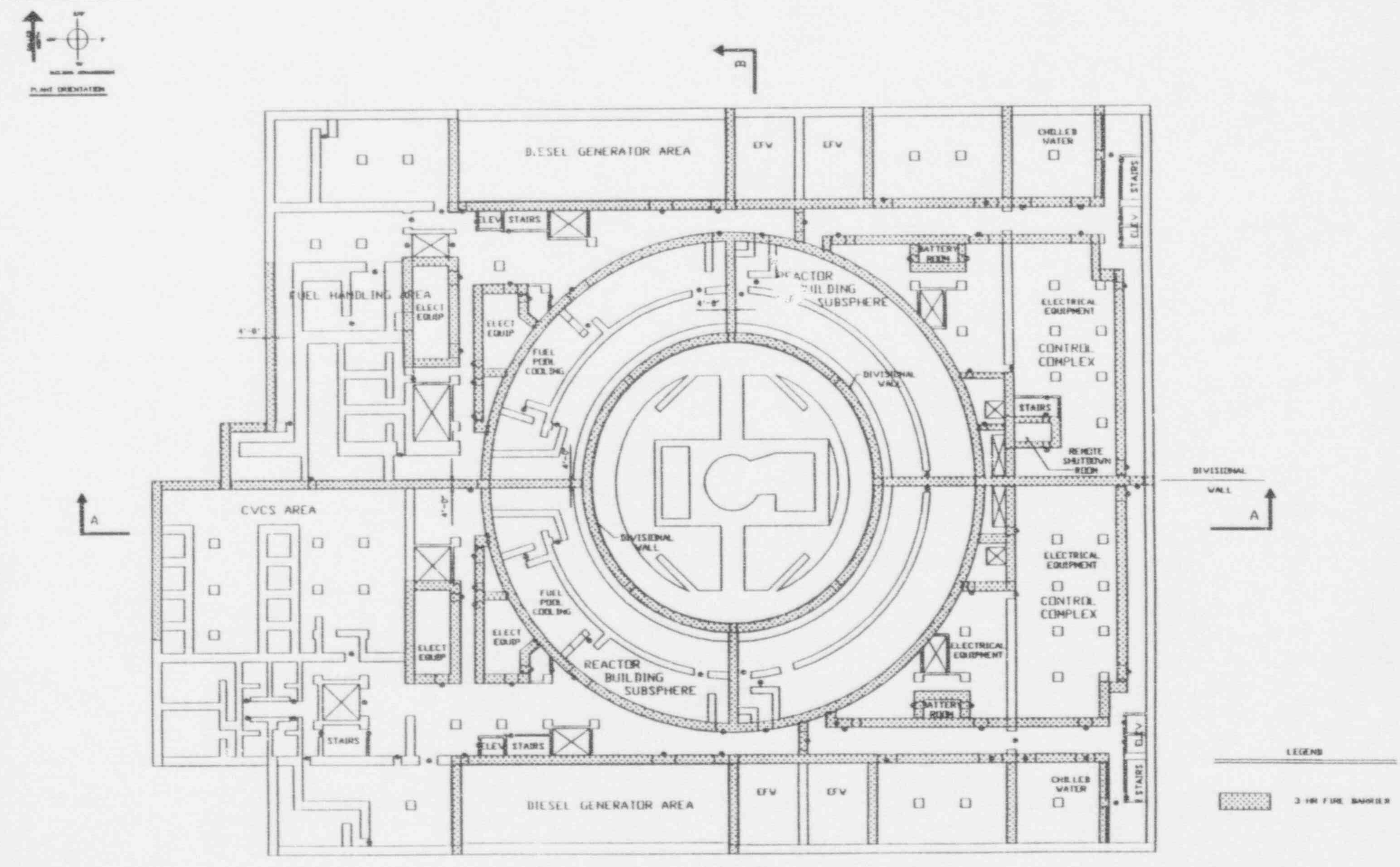
- Seismic Category I backup supply
- Power supply for detection and alarm system
- Fire Hazard Analysis
- Fire barriers covered in Nuclear Island Structures, Component Cooling Water Heat Exchanger Structure, and Diesel Fuel Storage Structure ITAACs
- Separation covered in individual system ITAACs

SYSTEM 80+ ™



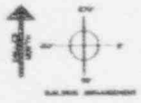
NUCLEAR ISLAND STRUCTURES
PLAN AT LEVEL 1

SYSTEM 80+ ™

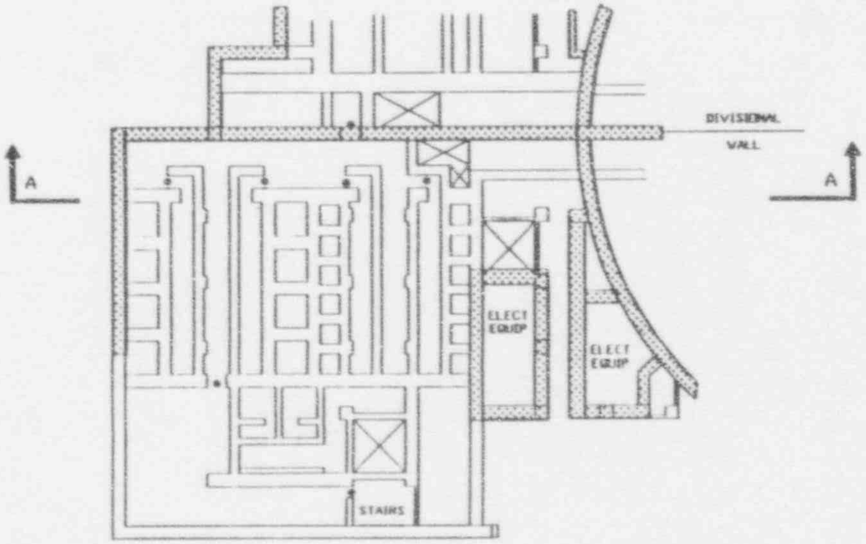


NUCLEAR ISLAND STRUCTURES
PLAN AT LEVEL 2

SYSTEM 80+ ™



PLANT ORIENTATION

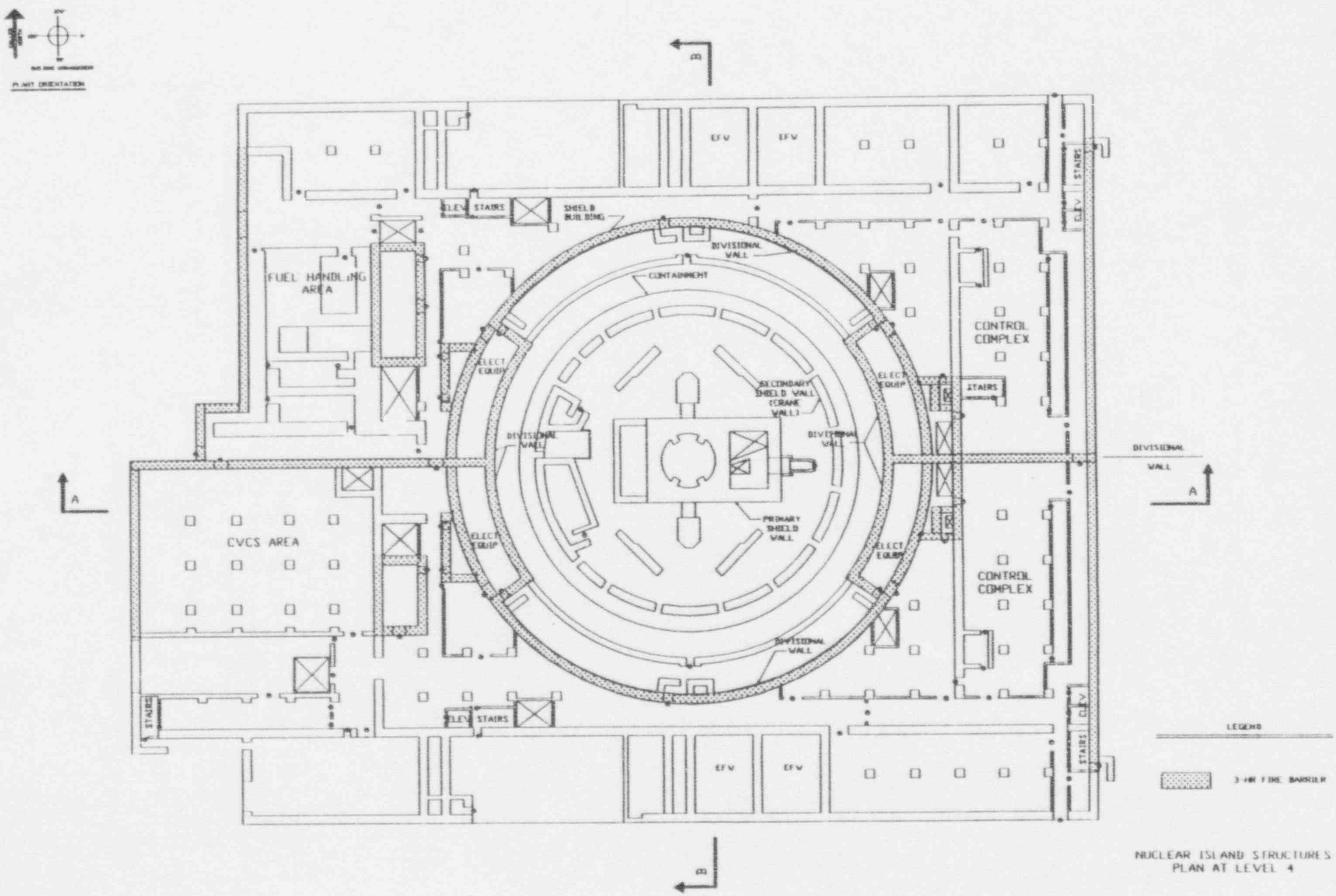


LEGEND

▨ 3-HR FIRE BARRIER

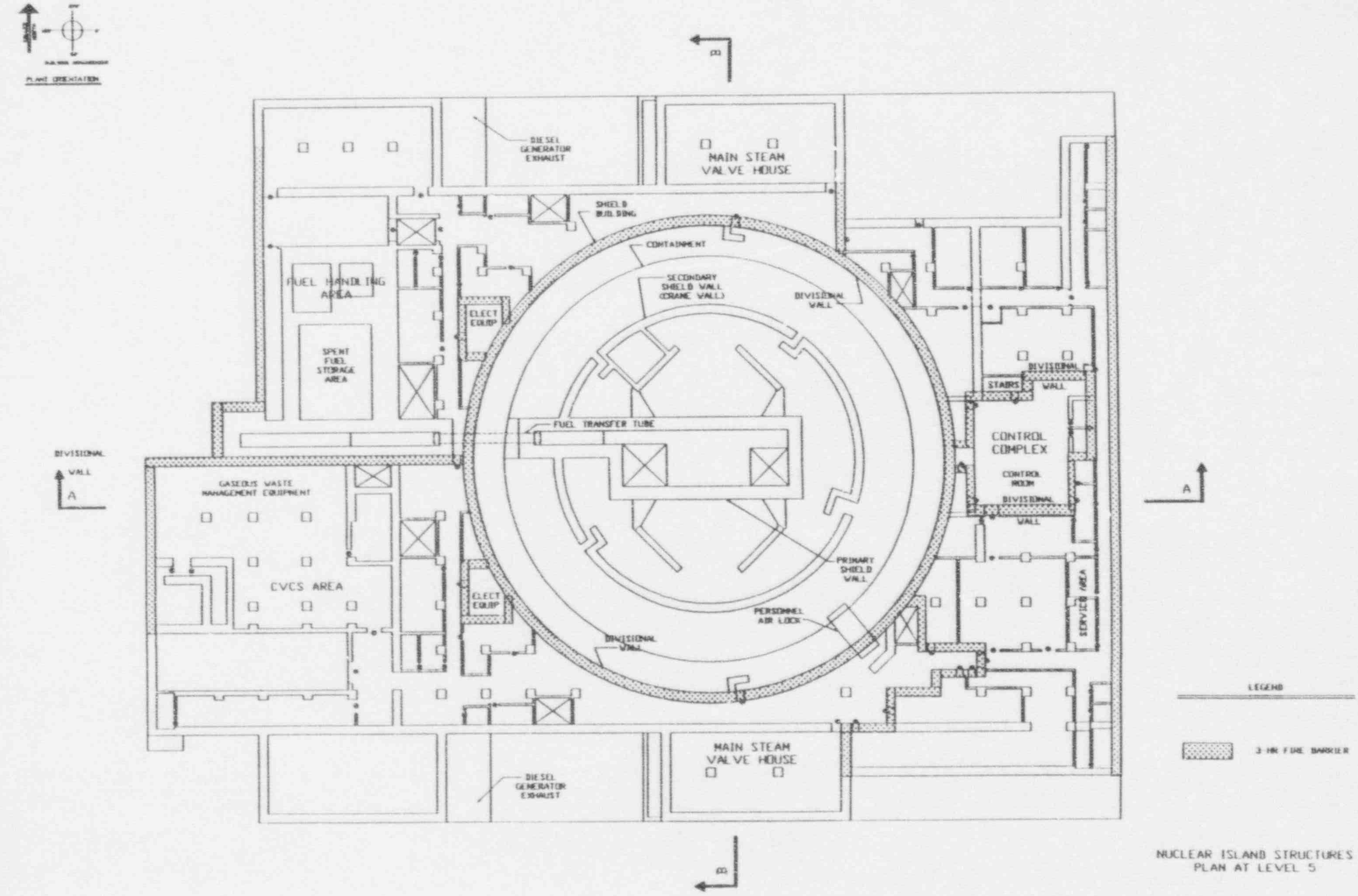
NUCLEAR ISLAND STRUCTURES
PLAN AT LEVEL 3

SYSTEM 80+™



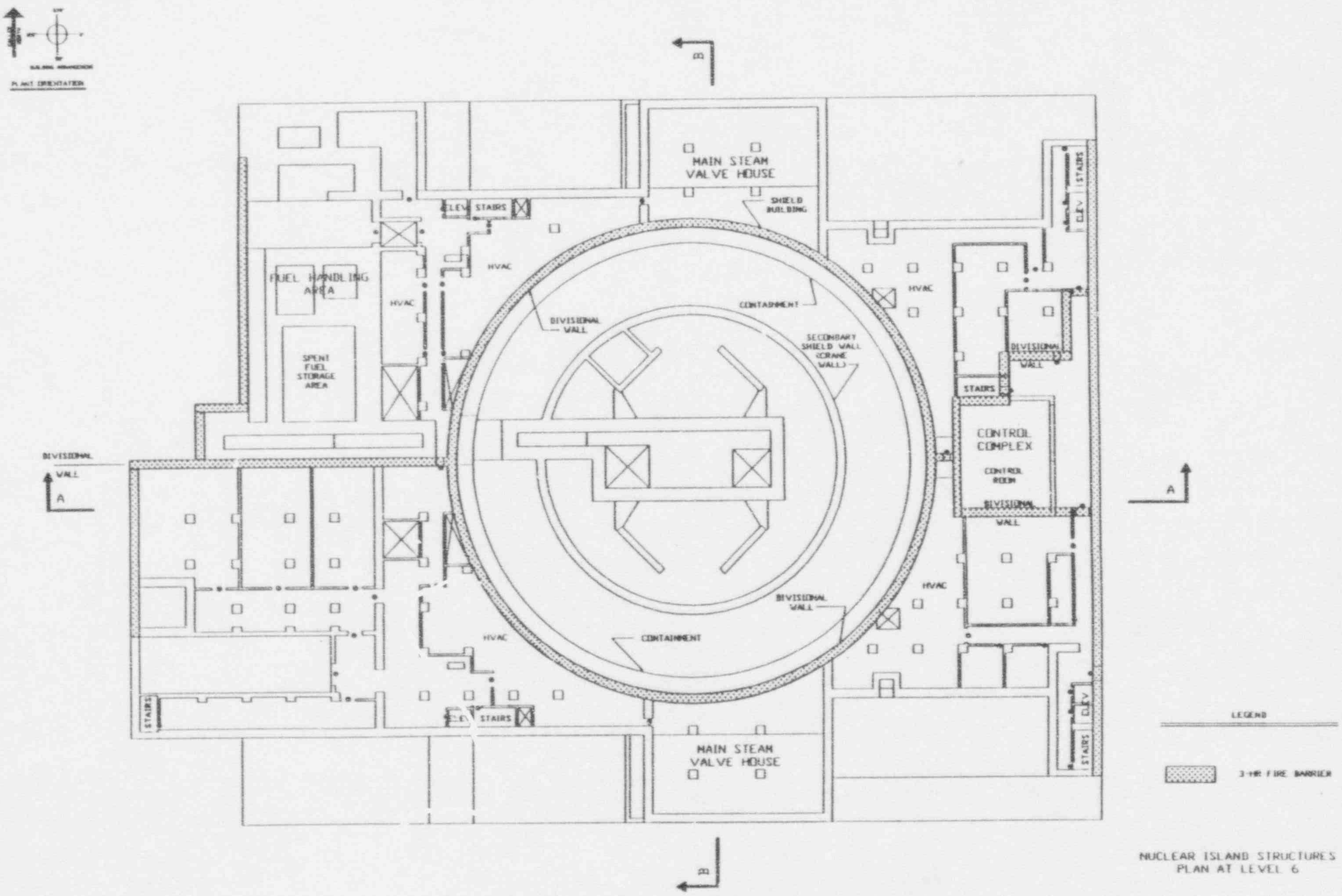
NUCLEAR ISLAND STRUCTURES
PLAN AT LEVEL 4

SYSTEM 80+ ™

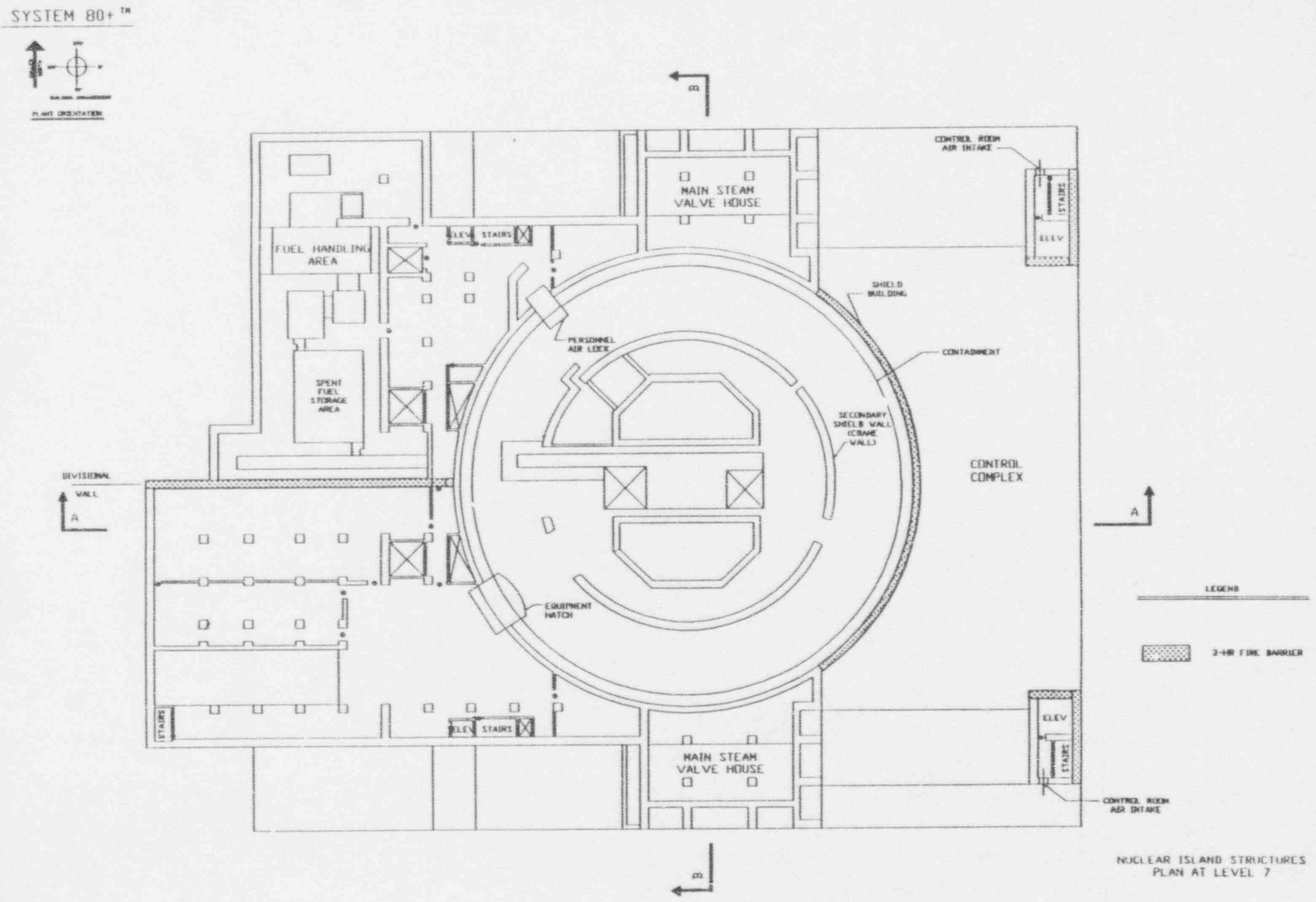


NUCLEAR ISLAND STRUCTURES
PLAN AT LEVEL 5

SYSTEM 80+™

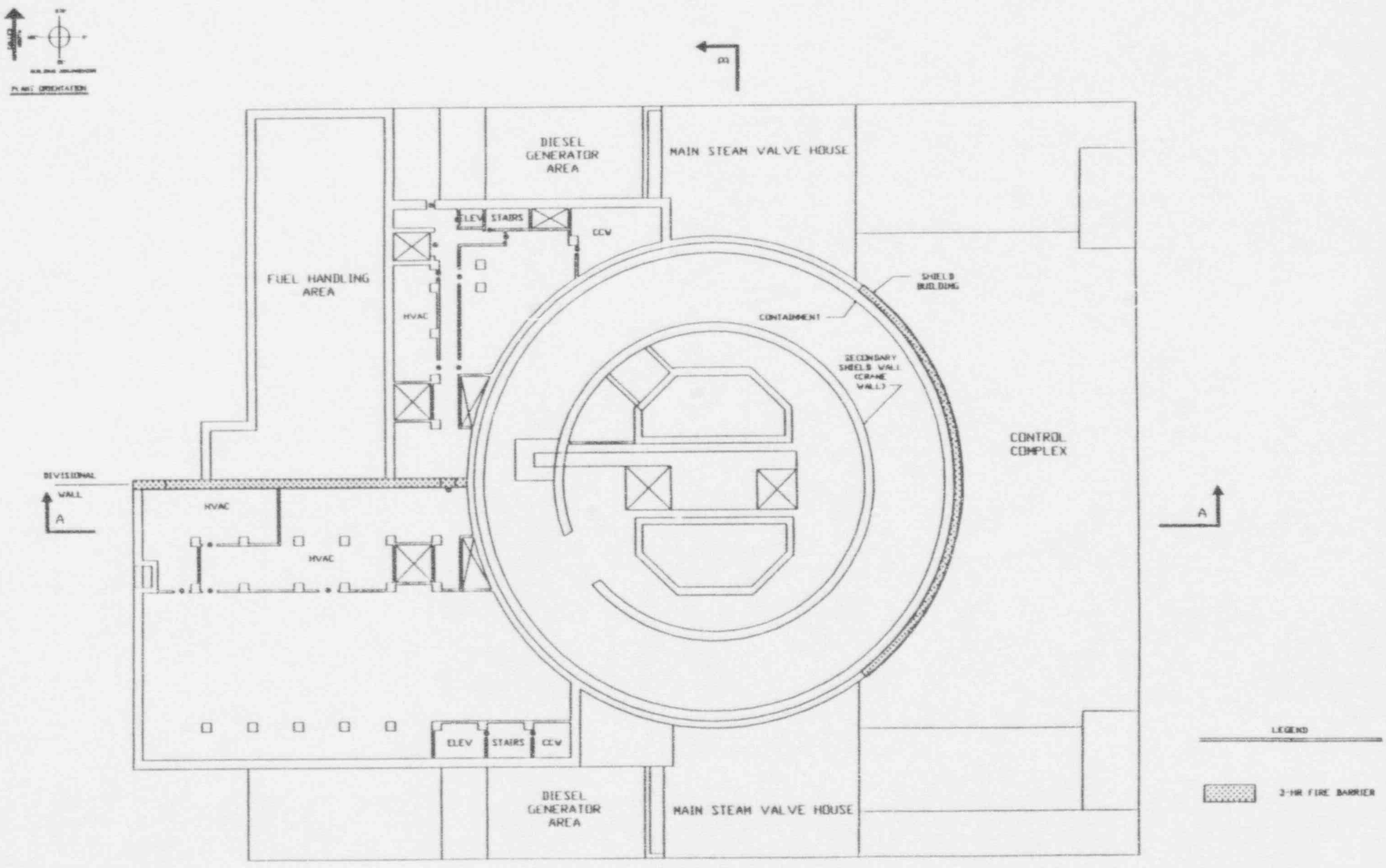


NUCLEAR ISLAND STRUCTURES
PLAN AT LEVEL 6



NUCLEAR ISLAND STRUCTURES
PLAN AT LEVEL 7

SYSTEM 80+™



NUCLEAR ISLAND STRUCTURES
PLAN AT LEVEL 8

ABB COMBUSTION ENGINEERING

System 80+™ Standard Plant

Chapter 5 Reactor Coolant System and Connected Systems

Special Analyses

J.P. Rezendes

ACRS ABB-CE Standard Plant Designs Subcommittee
April 5-6, 1994

System 80+™ Standard Plant
Chapter 5 Special Analyses

- Natural Circulation Cooldown
- ASME Valve Sizing
- Steam Generator Tube Rupture Containment Bypass Prevention

System 80+^{TM} Standard Plant Natural Circulation Cooldown

- Demonstrate That After The Loss of Offsite Power the NSSS Can Be Cooled and Depressurized From Full Power to SCS Entry Conditions Using Only Safety Grade Equipment

System 80+™ Standard Plant Natural Circulation Cooldown

- **Ground Rules**
  - Assume The Worst Single Failure (One Diesel Generator Fails to Start) Occurs At The Beginning Of The Transient
  - Analysis Performed Per "Design Requirements of Residual Heat Removal System," U.S. NRC Branch Technical Position RSB 5-1, Rev. 2, July 1981
  - Only Safety Grade Equipment Credited, Loss of One Diesel Generator Assumed
  - Plant Cooldown Using Manual Control of ADVs
  - RCS Inventory and Reactivity Control Using the SIS Pumps
  - RCS Pressure Reduction Using the Pressurizer Vent Of The RCGVS
  - Reactor Vessel Upper Head Void Reduction Using the RVUH Vent Of The RCGVS

ABB

System 80+^{TM} Standard Plant Natural Circulation Cooldown

- NCC Cooldown and Depressurization to SCS Entry Conditions Is Achieved Within 10 Hours Under The BTP RSB 5-1 Restrictions
- The Assumed Loss of One Diesel Generator (i.e., Worst Single Failure) Does Not Impose Any Significant Limitations or Restrictions On The NCC Process
- The Steam Void Formed In The RVUH Is Easily Controlled, Monitored and Eventually Collapsed During the NCC
- The Total EFW Usage During the NCC is 240,000 Gallons which is Less Than 35% Of The Total Minimum Available Capacity of 700,000 Gallons

ABB

System 80+™ Standard Plant
ASME Valve Sizing

- Overpressure Protection of the Primary and Secondary Systems Is Provided By The:
  - Primary Safety Valves
  - Secondary Safety Valves
  - Reactor Protection System
- The Reactor Protection System Contains Two Separate Safety Grade High Pressure Trips (i.e., Standard High Pressure Trip and CPC Auxiliary High Pressure Trip) to Mitigate Overpressure Transients
- The Maximum Primary and Secondary Pressure Must Be Kept Below 110% of Design During The Most Severe Abnormal Operational Transient in Conformance with the ASME Boiler and Pressure Vessel Code, Section III

ABB

System 80+™ Standard Plant
ASME Valve Sizing

- **Event Used to Verify Adequacy of Overpressure Protection is the Loss of Load With Delayed Reactor Trip**

- **Ground Rules:**
  - Analysis Performed Per USNRC SRP. Section 5.2.2, Overpressure Protection, Rev. 2, NUREG-0800, July 1981
  - No Credit For Any Control Systems That Mitigate High Pressure Conditions (e.g., Steam Bypass, Reactor Power Cutback System, Pressurizer Spray)
  - No Credit For The First High Pressure Safety Grade Trip (Second CPC High Pressure Trip is Credited)
  - Conservative Initial Conditions (e.g., 102% Power, Most Positive Moderator and Dopper Coefficient)
  - Primary and Secondary Safety Valve Flowrate is Based Upon The ASME Rated Capacity (Versus Actual Capacity)
  - Primary and Secondary Safety Valves Are Assumed to Open at Their Highest Possible Opening Pressure (Uncertainties Included)

ABB

System 80+™ Standard Plant ASME Valve Sizing

- Maximum Primary and Secondary Pressures Are Less Than 110% of Design Per ASME Code and SRP
- Primary and Secondary Safety Valves Pass Only Steam After Opening (Valves Not Qualified for Two-Phase Flow)
- Parametric Evaluation of Primary Safety Valve Area Versus Peak Primary Pressure Shows a Linear Function with a Modest Slope

ABB

System 80+ Standard Plant
SGTR Containment Bypass

- **Issue**
  - Capability of System 80+ Design to Minimize the Potential for Containment Bypass During SGTR Events

ABB

System 80+ Standard Plant
SGTR Containment Bypass

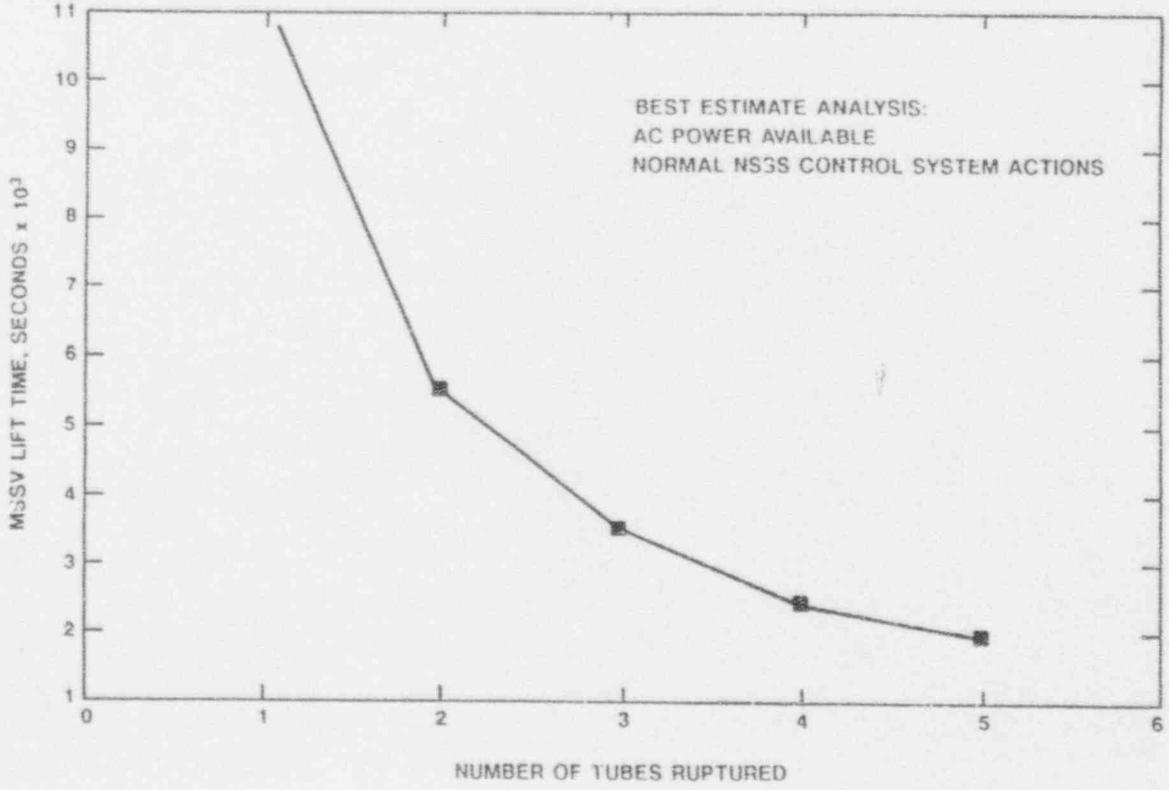
- **Current Design Features**
  - N-16 Monitors, One Per SG
  - CCW Design Permits Operation of Steam Bypass System After SIAS Generation
  - FWCS Terminates Main Feedwater to SG Following a Reactor Trip and Reduced RCS Temperature
  - RDS Actuated Manually When MSSVs Challenged
  - NUPLEX 80+ Control Room
  - Steam Bypass System Directs Secondary Flow From All Bypass Valves to the Condenser
  - Larger IRWST Volume as Source for Safety Injection
  - Larger SG Secondary Side Volume
  - Inconel 690 SG Tube Material with Reduced RCS Operating Temperatures

ABB

System 80+ Standard Plant
SGTR Containment Bypass

- Results

MSSV Opening Times for Current Design



ABB

System 80+ Standard Plant
SGTR Containment Bypass

- **Conclusions**
  - Current System 80+ Design Features:
    - Reduce the Risk of Incurring an SGTR
    - Improve Event Diagnosis and Mitigation, and
    - Accommodate Hypothetical Multiple Tube Ruptures Using Automatic Means
  - Reliance on Quick Manual Corrective Actions by Plant Operator is Significantly Reduced

ABB

ABB Combustion Engineering

System 80+™ Standard Plant

Chapter 6.2.1 - Containment Functional Design

J. P. Rezendes

ACRS ABB-CE Standard Plant Designs Subcommittee
April 5-6, 1994

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System 80+ TM Standard Plant

- **NRC Approved Computer Codes for Containment Analyses**
  - LOCA Blowdown Mass & Energy Release - CEFLASH-4A
  - LOCA Reflood and Post Reflood Mass & Energy Release - FLOOD-MOD2
  - Containment Pressure & Temperature Analysis - CONTRANS
  - MSLB Mass & Energy Release - SGNIII

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System 80+^{TM} Standard Plant

- **LOCA**
  - Hot Leg, Suction Leg, Discharge Leg Cases Analyzed with Maximum and Minimum SIS Flow
- **MSLB**
  - Cases with MSIV Failure and Containment Spray Failure Analyzed at Four Power Levels
- **Worst LOCA**
  - DEHLS 46.72 Psig
- **Worst MSLB**
  - 0% Power with Containment Spray Failure 48.11 Psig
- **Internal Design Pressure** 53 psig

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System 80+™ Standard Plant

Section 6.3 Performance Evaluation

J.P. Rezendes

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System 80+™ Standard Plant
Section 6.3 Performance Evaluation

- **Safety Analysis Ground Rules**
- **NRC Approved Codes**
- **Design Parameters Affecting Safety Analysis**
- **Safety Analysis Results**
  - Large Break LOCA
  - Small Break LOCA
- **Post LOCA Boron Dilution**

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System 80+^{TM} Standard Plant
Section 6.3 Performance Evaluation

- **Safety Analysis Ground Rules**
  - Use Existing NRC Approved Models
  - Use the Draft NUREG-1465 Source Term for Dose Considerations
  - Utilized the EPRI URD Atmospheric Dispersion Factors (X/Qs)
  - 18 Month Cycle Fuel Data (Initial And Reload Cores)
  - Accomodate A 10% Steam Generator Tube Plugging Margin
  - Core Power Upgraded to 3914 MWT

System 80+™ Standard Plant
Section 6.3 Performance Evaluation

- **NRC Approved Codes**
  - Large Break LOCA
    - CEFLASH-4A
    - COMPERC-II
    - STRIKIN-II
    - FATES3
    - PARCH
    - HCROSS
    - COMZIRC

  - Small Break LOCA
    - CEFLASH-4AS
    - COMPERC-II
    - STRIKIN-II
    - FATES3
    - PARCH

System 80+™ Standard Plant
Section 6.3 Performance Evaluation

DESIGN PARAMETERS AFFECTING SAFETY ANALYSIS

CORE POWER	3800 MWT	3914 MWT
NOMINAL T_{COLD}	558°F	556°F
NOMINAL T_{HOT}	615°F	615°F
SG SECONDARY FREE VOLUME	11330 FT^3	11278 FT^3
NUMBER OF FUEL RODS	54764	56876
CORE AVERAGE LINEAR HEAT RATE	5.42	5.38
UNCERTAINTY ON PSV OPENING	25 PSI	40 PSI
MAXIMUM MAIN FEEDWATER FLOW	140%	160%

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System 80+^{TM} Standard Plant
Section 6.3 Performance Evaluation

DESIGN PARAMETERS AFFECTING SAFETY ANALYSIS

LETDOWN LINE K (RCS TO LDHX OUTLET)	81	325
MAX RCP RATED HEAD	365 FT	376 FT
SURGE LINE LENGTH (NOMINAL)	87 FT	112 FT

System 80+™ Standard Plant
Section 6.3 Performance Evaluation

- **Safety Analysis Results: Large Break LOCA**
- **Various Break Sizes And Locations Were Looked at in the Primary Coolant Piping**
- **Limiting Large Break: Double Ended Guillotine Break in the Pump Discharge**
- **Standard Review Plan Acceptance Criteria**
  - 10 CFR 50.46 Criteria
    - Peak Cladding Temperature Shall Not Exceed 2200°F
    - Core Wide Oxidation Shall Not Exceed 1%
    - Local Cladding Oxidation Shall Not Exceed 17%
  - Radiological Consequences Meet 10 CFR 100 Guidelines

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System 80+™ Standard Plant
Section 6.3 Performance Evaluation

- Safety Analysis Results: Large Break LOCA

CORE POWER, MWT	PLHGR, KW/FT	PEAK CLAD TEMP, ° F	MAXIMUM CLAD OXIDATION, %	MAXIMUM CORE WIDE CLAD OXIDATION, %	2 HOUR THYROID, REM
3800	13.7	2147	7.5	<0.84	299
3914	13.7	2185	8.3	<0.84	172

- Higher Power and Revised Fuel Design Resulted in Higher Peak Clad Temperature and Local Oxidation

System 80+™ Standard Plant
Section 6.3 Performance Evaluation

- Safety Analysis Results: Large Break LOCA

- Lower Doses with Higher Containment Leak Rate (0.5% Versus 0.34% Vol/Day) and No Credit for Charcoal Filters in the Containment Annulus and Subsphere Ventilation Systems Result of Utilizing DRAFT NUREG-1465 Source Term

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System 80+^{TM} Standard Plant
Section 6.3 Performance Evaluation

- **Safety Analysis Results: Small Break LOCA**
- **Various Break Sizes and Locations Were Looked at in the RCS**
- **Limiting Small Break: 0.1 ft^2 Break in the DVI Line**
- **10 CFR 50.46 Acceptance Criteria:**
  - Peak Cladding Temperature Shall Not Exceed 2200°F
  - Core Wide Oxidation Shall Not Exceed 1%
  - Maximum Caldding Oxidation Shall Not Exceed 17%

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System 80+™ Standard Plant
Section 6.3 Performance Evaluation

- Safety Analysis Results: Small Break LOCA

CORE POWER, MWT	PLHGR, KW/FT	PEAK CLAD TEMPERATURE, °F	MAXIMUM CLAD OXIDATION, %	MAXIMUM CORE WIDE CLAD OXIDATION, %
3800	15.0	1164	0.025	<0.003
3914	15.0	1354	0.120	<0.016

- Higher Power Resulted in Higher Peak Clad Temperature and Local Oxidation

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System 80+™ Standard Plant
Post LOCA Boron Dilution

- **Small Break LOCA - Boron Dilution**
  - Issue:
  - Hypothesis that Condensed Steam May Collect in the RCS Loop Seals and Cause an Unacceptable Reactivity Change if Swept into the Core as an Unborated Slug.
  - Condensate Is Produced for Small Breaks in the Range of 1" to 3" Diameter. Larger Breaks (>3") Remove RCS Steam to the Containment and Very Small Breaks (<1") Do Not Void the RCS Piping

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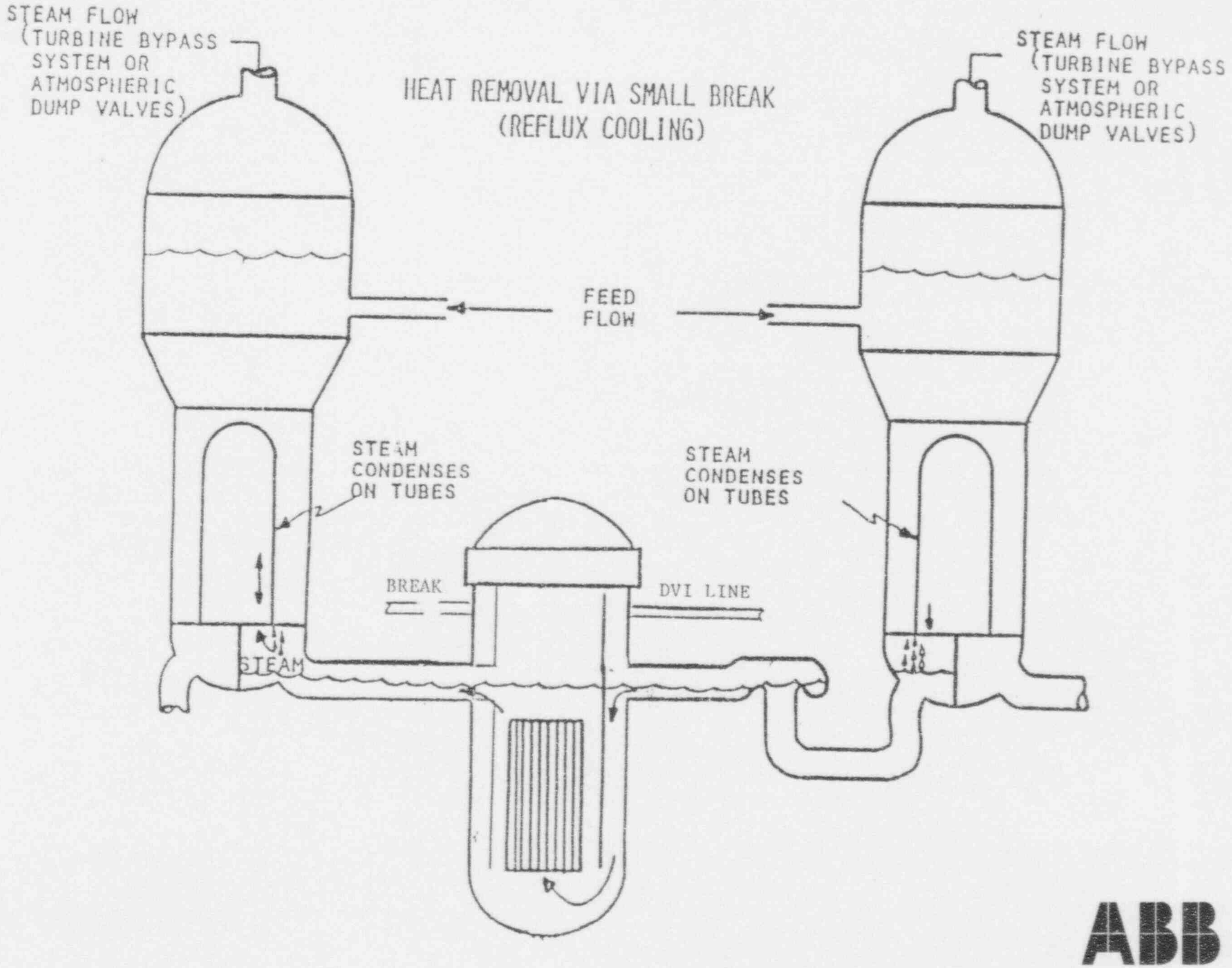
HEAT REMOVAL VIA SMALL BREAK
(REFLUX COOLING)



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System 80+™ Standard Plant
Post LOCA Boron Dilution

- **Small Break LOCA - Boron Dilution**
- **Resolution**
  - Demonstrated that Only a Small Volume (< 375 ft^3 Per Cold Leg) of Condensate Could Collect in the Loop Seals Due to the Assumption of Continued Cooldown Via the Steam Generators
  - Conservative Analysis Demonstrates Adequate Core Cooling is Provided Even if Pure Water is Assumed to be Inserted to the Core by Natural Circulation (RCPs are Stopped by Operators During a LOCA).
  - Revised Emergency Operating Guidelines to Minimize Likelihood of Premature RCP Restart.
  - Realistic Mixing Analyses Demonstrate Adequate Mixing of Unborated and Borated Water in the Reactor Vessel Which Precludes Criticality Even if RCPs are Restarted.

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Chapter 15 Accident Analyses

J.P. Rezendes

ACRS ABB-CE Standard Plant Designs Subcommittee
April 5-6, 1994

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System 80+™ Standard Plant Chapter 15 Accident Analyses

- Safety Analysis Ground Rules
- NRC Approved Codes
- Design Parameters Affecting Safety Analysis
- Analysis

System 80+™ Standard Plant
Chapter 15 Accident Analyses

- **Safety Analysis Ground Rules**
  - Use Existing NRC Approved Models
  - Use the Draft NUREG-1465 Source Term for Dose Considerations
  - Utilized the EPRI URD Atmospheric Dispersion Factors (X/Qs)
  - 18 Month Cycle Fuel Data (Initial and Reload Cores)
  - Accomodate A 10% Steam Generator Tube Plugging Margin
  - Loss of Offsite Power Considered As Part of Moderate Frequency Events
  - Zero Time Delay for Loss of Offsite Power Subsequent to Turbine Trip
  - Core Power Upgraded to 3914 MWT

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System 80+™ Standard Plant
Chapter 15 Accident Analyses

- **NRC Approved Codes**
  - CESEC III
  - TORC
  - CETOP-D
  - HERMITE
  - COAST
  - STRIKIN II

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System 80+™ Standard Plant
Chapter 15 Accident Analyses

DESIGN PARAMETERS AFFECTING SAFETY ANALYSIS

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System 80+^{TM} Standard Plant
Chapter 15 Accident Analyses

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System 80+™ Standard Plant
Chapter 15 Accident Analyses

- **Analysis**
  - Increase in Heat Removal By the Secondary System
  - Decrease in Heat Removal By the Secondary System
  - Decrease in Reactor Coolant Flow Rate
  - Reactivity and Power Distribution Anomalies
  - Increase in RCS Inventory
  - Decrease in RCS Inventory
  - Radioactive Release From a Subsystem or Component

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System 80+™ Standard Plant
Chapter 15 Accident Analyses

- **Analysis: Increase in Heat Removal By The Secondary System**
  - Events: Moderate Frequency

    - Decrease in Feedwater Temperature
    - Increase in Feedwater Flow
    - Increased Main Steam Flow
    - Inadvertent Opening of a Steam Generator Relief or Safety Valve
    - Above Events with Loss of Offsite Power

    - Limiting Moderate Frequency Event: Inadvertent Opening of a Steam Generator Relief or Safety Valve with a Loss of Offsite Power

  - Limiting Infrequent Event: Inadvertent Opening of a Steam Generator Relief or Safety Valve with a Loss of Offsite Power and a Single Failure

  - Limiting Accident: Steam System Piping Failures Inside and Outside Containment

System 80+™ Standard Plant
Chapter 15 Accident Analyses

- **Analysis: Increase in Heat Removal By The Secondary System**
  - Acceptance Criteria

    - Moderate Frequency
      Pressure < 110% of Design
      DNBR ≥ 1.24

    - Infrequent:
      Pressure < 110% of Design
      Offsite Dose ≤ 10% of CFR 100

    - Accident:
      Offsite Dose ≤ 10 CFR 100 with Fuel Failure or PIS
      Offsite Dose ≤ 10% of 10 CFR 100 with GIS

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System 80+™ Standard Plant
Chapter 15 Accident Analyses

- **Analysis: Increase In Heat Removal By The Secondary System**
- **Inadvertent Opening of a Steam Generator Atmospheric Dump Valve (IOSGADV) with a Loss of Offsite Power**
  - Major Assumption: MTC = -3.5×10^{-4} delta-rho/°F
  - Single Failure: Loss of Feedwater Control System Reactor Trip Override
  - Results

EVENT	DNBR
IOSGADV + LOOP	1.30
IOSGADV + LOOP + SF	1.29

System 80+™ Standard Plant
Chapter 15 Accident Analyses

- **Analysis: Increase in Heat Removal By The Secondary System**
- **Steam System Piping Failures: Steam Line Break Outside Containment During Full Power Operation With Loss of Offsite Power Concurrent With Turbine Trip**
  - Major Assumption: MTC = -3.5 x 10-4 delta-rho/oF
  - Single Failure: No Single Failure Makes Event More Adverse
  - Minimum DNBR = 1.25: Assumed 0.5% Fuel Failure
  - Two Hour Thyroid Dose at EAB = 70 REM

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System 80+™ Standard Plant
Chapter 15 Accident Analyses

- **Analysis: Decrease in Heat Removal By The Secondary System**

  - Events: Moderate Frequency

    - Loss of External Load
    - Turbine Trip
    - Loss of Condenser Vacuum
    - Main Steam Isolation Valve Closure
    - Loss of Non-Emergency AC Power to the Station Auxiliaries
    - Loss of Normal Feedwater Flow
    - Above Events with Loss of Offsite Power

    - Limiting Event: Loss of Condenser Vacuum

  - Limiting Infrequent Event: None-No Worse Than Loss of Condenser Vacuum By Itself

  - Limiting Accident: Feedwater System Pipe Breaks

System 80+™ Standard Plant
Chapter 15 Accident Analyses

- **Analysis: Decrease in Heat Removal By The Secondary System**

  - Acceptance Criteria

    - Moderate Frequency:
      Pressure < 110% of Design
      DNBR $\geq$ 1.24

    - Infrequent:
      Pressure < 110% of Design
      Offsite Dose $\leq$ 10% of 10 CFR 100

    - Accident:
      Pressure < 120% of Design With Loss of Offsite Power
      Pressure < 110% of Design With No Loss of Offsite Power
      Offsite Dose $\leq$10% of 10 CFR 100

System 80+^{TM} Standard Plant
Chapter 15 Accident Analyses

- **Analysis: Decrease in Heat Removal By The Secondary System**
- **Loss of Condenser Vacuum**
  - Major Assumption: MTC = 0.0
  - Single Failure: No Single Failure Makes Event More Adverse
  - Minimum DNBR = 1.26: No Fuel Failure
  - Peak RCS Pressure = 2726 Psia

System 80+™ Standard Plant
Chapter 15 Accident Analyses

- **Analysis: Decrease in Heat Removal By The Secondary System**
- **Feedwater System Pipe Break With and Without Loss of Offsite Power**
  - Limiting Break for Peak Pressure: 0.6 ft^2
  - Major Assumptions
    - MTC = 0.0
    - Steam Generator Low Level Trip Credited for Case With Offsite Power Available

System 80+™ Standard Plant
Chapter 15 Accident Analyses

- **Safety Analysis Results: Decrease in Heat Removal By The Secondary System**
- **Feedwater System Pipe Breaks (Continued)**
  - Single Failure: Failure of Emergency Feedwater Pump
  - Peak RCS Pressure With Loss of Offsite Power = 2793 psia
  - Peak RCS Pressure With No Loss of Offsite Power = 2676 psia
  - Minimum DNBR (Loss of Offsite Power) = 1.17: 0.22% Fuel Failure
  - Two Hour Thyroid Dose at EAB = 19.5 REM (PIS)

System 80+™ Standard Plant
Chapter 15 Accident Analyses

- **Analysis: Decrease in Reactor Coolant Flow Rate**
  - Limiting Moderate Frequency Event: Total Loss of Reactor Coolant Flow
  - Events: Accidents
    - Single Reactor Coolant Pump Rotor Seizure With Loss of Offsite Power and a Stuck Open Atmospheric Dump Valve
    - Single Reactor Coolant Pump Shaft Break With Loss of Offsite Power and a Stuck Open Atmospheric Dump Valve
  - Limiting Accident: Single Reactor Coolant Pump Rotor Seizure With Loss of Offsite Power and a Stuck Open Atmospheric Dump Valve

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System 80+™ Standard Plant
Chapter 15 Accident Analyses

- **Analysis: Decrease in Reactor Coolant Flow Rate**
  - Acceptance Criteria

    - Moderate Frequency:
      Pressure < 110% of Design
      DNBR ≥ 1.24

    - Accident:
      Pressure Below Acceptable Design Limits (< 110% of Design)
      Offsite Dose $\leq$ 10% of 10 CFR 100

System 80+^{TM} Standard Plant
Chapter 15 Accident Analyses

- **Analysis: Decrease in Reactor Coolant Flow Rate**
- **Total Loss of Reactor Coolant Flow**
  - Major Assumption: MTC = -0.1×10^{-4} delta-rho/oF
  - Single Failure: No Single Failure Makes Event More Adverse
  - Minimum DNBR = 1.27: No Fuel Failure
  - Peak RCS Pressure: 2665 psia

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System 80+™ Standard Plant
Chapter 15 Accident Analyses

- **Analysis: Decrease in Reactor Coolant Flow Rate**
- **Single Reactor Coolant Pump Rotor Seizure With Loss of Offsite Power and a Stuck Open Atmospheric Dump Valve**
  - Single Failure: One Atmospheric Dump Valve Fails to Close
  - Minimum DNBR = 1.09: 1.2% Fuel Failure
  - Two Hour Thyroid Dose at EAB = 3.18 REM

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System 80+™ Standard Plant
Chapter 15 Accident Analyses

- **Analysis: Reactivity and Power Distribution Anomalies**
  - Events: Moderate Frequency
    - Uncontrolled Control Element Assembly Withdrawal From Subcritical or Low Power Conditions
    - Uncontrolled Control Element Assembly Withdrawal at Power
    - Single Control Element Assembly Drop
    - Startup of an Inactive Reactor Coolant Pump
    - Inadvertent Deboration
    - Above Events with Loss of Offsite Power

    - Limiting Event: Uncontrolled Control Element Assembly Withdrawal at Power With Loss of Offsite Power

  - Limiting Infrequent Event: Inadvertent Loading of a Fuel Assembly into the Improper Position

  - Limiting Accident: Control Element Assembly (CEA) Ejection

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System 80+^{TM} Standard Plant
Chapter 15 Accident Analyses

- **Analysis: Reactivity and Power Distribution Anomalies**
  - Acceptance Criteria
    - Moderate Frequency: Rod Events
      DNBR ≥ 1.24

    - Moderate Frequency:
      Pressure < 110% of Design
      DNBR ≥ 1.24

    - Infrequent: Fuel Assembly Misload
      Offsite Dose ≤ 10% of 10 CFR 100

    - Accident:
      Radially Averaged Enthalpy ≤ 280 cal/gm
      RCS Pressure < Service Level C Limit
      Offsite Dose ≤ 25% of 10 CFR 100

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System 80+^{TM} Standard Plant
Chapter 15 Accident Analyses

- **Analysis: Reactivity and Power Distribution Anomalies**
- **Uncontrolled Control Element Assembly Withdrawal at Power with a Loss of Offsite Power**
  - Major Assumption: Reactivity Insertion Rate = 0.4×10^{-4} delta-rho/sec (30 inches/minute)
  - Minimum DNBR > 1.24
- **Inadvertent Loading of a Fuel Assembly Into The Improper Position**
  - Minimum DNBR > 1.24
  - Offsite Dose < 10% of 10 CFR 100

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System 80+™ Standard Plant
Chapter 15 Accident Analyses

- **Analysis: Reactivity and Power Distribution Anomalies**
- **Control Element Assembly Ejection**
  - Major Assumptions:
    - Minimum Delayed Neutron Fraction
    - CEA Ejection Time = 0.05 seconds
    - Ejected CEA Worth = 0.15% delta-rho
  - Peak RCS Pressure = 2742 psia
  - Radially Averaged Enthalpy $\leq$ 280 cal/gm
  - Fuel Failure = 6.8%

System 80+™ Standard Plant
Chapter 15 Accident Analyses

- **Analysis: Reactivity and Power Distribution Anomalies**
- **Control Element Assembly Ejection (Continued)**
  - Two Hour Thyroid Dose at EAB:
    - Via Containment = 69.8 REM
    - Via Secondary = 17 REM

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System 80+™ Standard Plant
Chapter 15 Accident Analyses

- **Analysis: Increase in RCS Inventory**
  - Events: Moderate Frequency
    - Inadvertent Operation of the ECCS
    - CVCS Malfunction-Pressurizer Level Control System Malfunction With Loss of Offsite Power
  - Limiting Event: CVCS Malfunction-Pressurizer Level Control System Malfunction with Loss of Offsite Power
  - Limiting Infrequent Event: CVCS Malfunction-Pressurizer Level Control System Malfunction with Loss of Offsite Power and a Single Failure

System 80+^{TM} Standard Plant
Chapter 15 Accident Analyses

- **Analysis: Increase in RCS Inventory**
  - Acceptance Criteria
    - Moderate Frequency:
      Pressure < 110% of Design
      DNBR ≥ 1.24
    - Infrequent:
      Pressure < 110% of Design
      Offsite Dose ≤ 10% of 10 CFR 100

System 80+^{TM} Standard Plant
Chapter 15 Accident Analyses

- **Analysis: Increase in RCS Inventory**
- **CVCS Malfunction-Pressurizer Level Control System Malfunction With Loss of Offsite Power and a Single Failure**
    - Major Assumption: Maximum Charging Flow to the RCS = 150 GPM
    - Single Failure (Peak Pressure Case): Failure of the Proportional Heaters to Turn Off
    - Peak RCS Pressure = 2682 psia
    - Minimum DNBR = 1.62: No Fuel Failure

System 80+^{TM} Standard Plant
Chapter 15 Accident Analyses

- **Analysis: Decrease in RCS Inventory**

  - Events: Accidents

    - Inadvertent Opening of a Pressurizer Safety/Relief Valve (Covered by Section 6.3)
    - Double-Ended Break of a Letdown Line Outside Containment
    - Steam Generator Tube Rupture
    - Steam Generator Tube Rupture with Loss of Offsite Power
    - Steam Generator Tube Rupture with Loss of Offsite Power and a Single Failure
    - Loss of Coolant Accident: Dose

  - Limiting Accidents:
    1) Steam Generator Tube Rupture with Loss of Offsite Power and a Single Failure
    2) Loss of Coolant Accident

  - Acceptance Criteria

    - Offsite Doses ≤ 10% of 10 CFR 100
    - Offsite Doses ≤ 10 CFR 100

System 80+™ Standard Plant
Chapter 15 Accident Analyses

- **Analysis: Decrease in RCS Inventory**
- **Steam Generator Tube Rupture with Loss of Offsite Power and a Single Failure**
  - Major Assumption: Operator Actions Consistent with the System 80+ Emergency Operating Guidelines (which were based on CEN-152)
  - Single Failure: Failure of an Atmospheric Dump Valve to Close
  - Offsite Doses:

LOCATION	GIS (REM)	PIS (REM)
2 HOUR THYROID (EAB)	62.4	93.1
8 HOUR THYROID (LPZ)	47.9	30.9

System 80+^{TM} Standard Plant
Chapter 15 Accident Analyses

- **Analysis: Decrease in RCS Inventory**
- **Loss of Coolant Accident: Dose**
  - Major Assumptions:
    - Draft NUREG-1465 Source Term
    - Containment Leak Rate = 0.5% vol/day
    - Annulus and ESF Charcoal Filters Not Credited
    - Portion of Containment Leakage that Bypasses the Annulus Building = 10%
  - Offsite Doses:

LOCATION	THYROID DOSE (REM)	WHOLE BODY DOSE (REM)
2 HOUR AT EAB	171.7	2.63
30 DAY AT LPZ	133.8	8.91

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System 80+™ Standard Plant
Chapter 15 Accident Analyses

- **Analysis: Radioactive Material Release From a Subsystem or Component**

  - Events:

    - Postulated Radioactive Releases Due to Liquid-Containing Tank Failures
    - Fuel Handling Accident
    - Spent Fuel Cask Drop Accidents

  - Acceptance Criteria

    - Liquid containing Tank Failures: 10 CFR 20
    - Fuel Handling Accident: Offsite Doses ≤ 25% of 10 CFR 100
    - Cask Drop: Drop Height ≤ 30 ft

System 80+™ Standard Plant
Chapter 15 Accident Analyses

- **Analysis: Radioactive Material Release From a Subsystem or Component**
- **Postulated Radioactive Releases Due to Liquid Containing Tank Failures**
  - Major Assumptions:
    - Limiting Tank Failure is Boric Acid Storage Tank (BAST)
    - The Concentration at the Nearest Potable Water Supply is Equal to the Maximum Permissible Per 10 CFR 20
    - Maximum Dilution Factor Computed in Lieu of Site Specific Parameters
      - Dilution Factor: Minimum Extent to which the Radioactive Liquid Released from the Failed BAST Will Be Diluted Prior to Reaching the Potable Water Supply
  - Maximum Dilution Factor: 2.55×10^{-6}

System 80+™ Standard Plant
Chapter 15 Accident Analyses

- **Analysis: Radioactive Material Release From a Subsystem or Component**
- **Fuel Handling Accident**
  - Major Assumption: All Fuel Rods in Dropped Assembly Fail
  - Two Hour Thyroid Dose at EAB = 53 REM

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ABB COMBUSTION ENGINEERING

System 80+™ Standard Plant
Chapter 6 & 15 - Source Term

James E. Metcalf
Stone & Webster Engineering Corporation

ACRS ABB-CE Standard Plant Designs Subcommittee
April 5 & 6, 1994

System 80+™ Standard Plant Impact of Revised ("Physically-Based") Licensing Design Basis (LDB) Source Term

Seven topics:

- Revised Source Term ("DBA LOCA" Release to Containment)
- Containment Transport and Deposition
- Airborne Iodine and IRWST pH
- Dose Consequences (PERC2 Code)
- Equipment Qualification for Radiation Exposure
- Chapter 15 Accidents Other Than DBA LOCA
- Protective Action Guide Comparative Dose Calculation

System 80+™ Standard Plant
Revised Source Term
("DBA LOCA" Release to Containment)

	TID-14844	NEW
TIMING:	PUFF AT T = 0	COOLANT RELEASE: 0 - 30 SEC
		GAP RELEASE: 30 SEC - 30.5 MIN
		FUEL RELEASE: 30.5 - 110.5
QUANTITY:	100% NOBLES	100% NOBLES
	50% IODINE	40% IODINE
	1% OTHER (CONT SUMP ONLY)	30% CESIUM
		<<1% - 15% OTHER (6 GROUPS)

System 80+™ Standard Plant

Revised Source Term

("DBA LOCA" Release to Containment)

	TID-14844		NEW	
FORM:	NOBLES:	GASEOUS	NOBLES:	GASEOUS
	IODINE:	95% GASEOUS	IODINE:	95% PARTICULATE
		(4% ORGANIC)		5% GASEOUS
		5% PARTICULATE		(0.25% ORGANIC)
	OTHER:	UNSPECIFIED	OTHER:	PARTICULATE

System 80+™ Standard Plant
Revised Source Term
("DBA LOCA" Release to Containment)

	TID-14844	NEW
SPRAY REMOVAL:	DOMINATED BY ELEMENTAL	DOMINATED BY PARTICULATE
	LAMBDA PER SRP 6.5.2	LAMBDA PER REALISTIC CALCULATION ("SWNAUA")
DOSE CALCULATION:	OLD 10CFR100 (E.G. "DRAGON")	NEW (E.G. "PERC2")

System 80+™ Standard Plant Containment Transport and Deposition

- Containment sprays are dominant mechanism.
- Described in EPRI Evolutionary Plant Source Term (S/T) Report.
- Two issues:
  - Removal coefficient (λ)
  - Mixing
- Volume flow x fall height/containment volume same for both EPRI Report and System 80+
- Differences From EPRI Report
  - Hygroscopicity (all condensation) neglected for System 80+ LDB
  - Spray droplet size larger for System 80+ (factor of three)
  - Input particle size

System 80+™ Standard Plant Containment Transport and Deposition

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Particle Size Definition Input to SWNAUA

Distribution used in EPRI Evolutionary Plant S/T Report:

$r_g = 0.21\ \mu m, \sigma = 1.7$

Percent Leaked @ ~ 100 min after start of fuel release (no hygro) = 0.00065% (containment leak rate 0.5% / day)

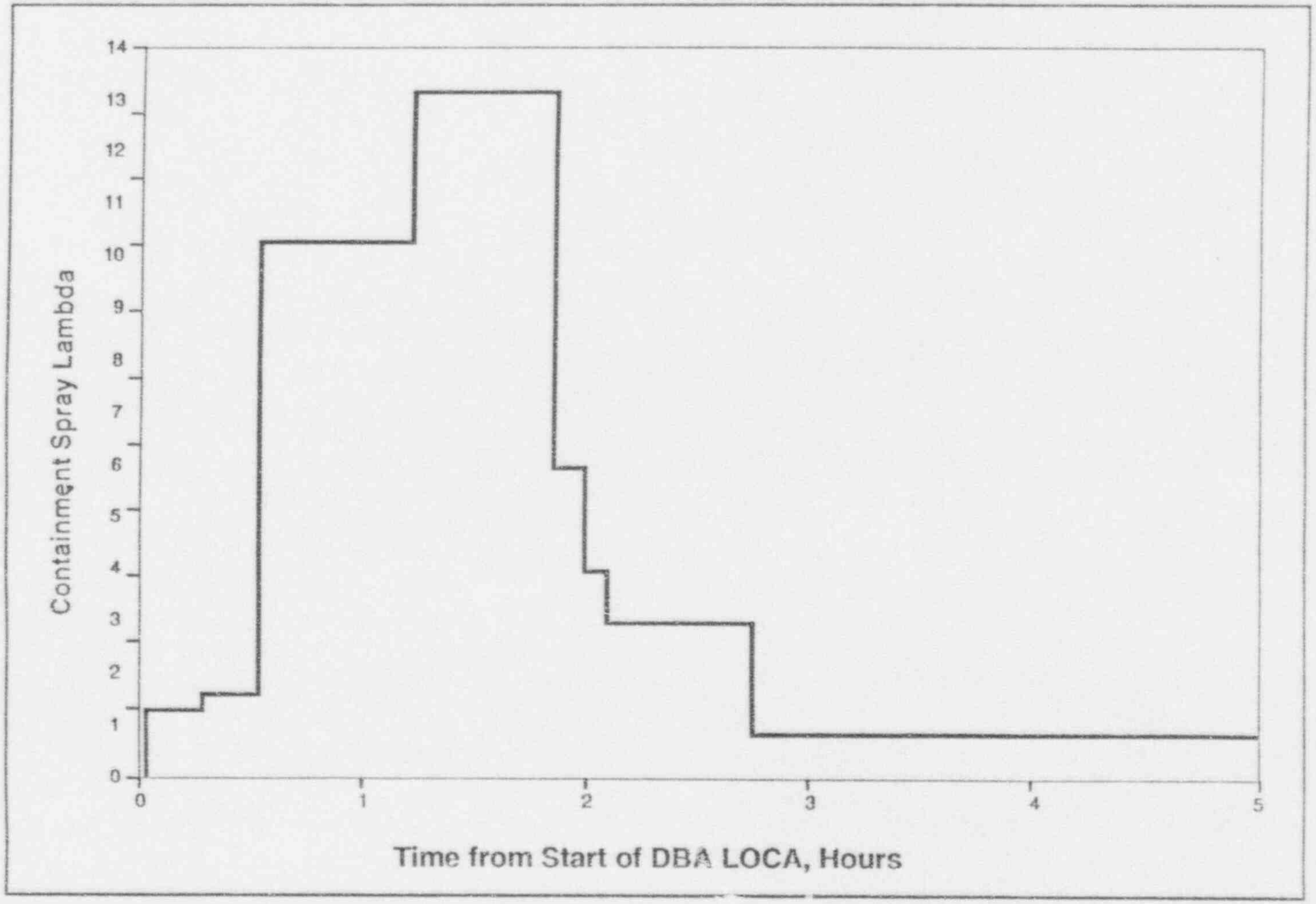
Distribution(s) used for System 80+ DBA LOCA (based on analysis of STEP-1 Experiment)

$r_g = 0.075\ \mu m, \sigma = 1.56$ (Gap Release)
$r_g = 0.40\ \mu m, \sigma = 1.46$ (Fuel Release)

Percent Leaked @ ~ 100 min after start of fuel release = 0.0018% (same containment leak rate)

System 80+™ Standard Plant
Containment Transport and Deposition

DBA LOCA Spray LAMBDA



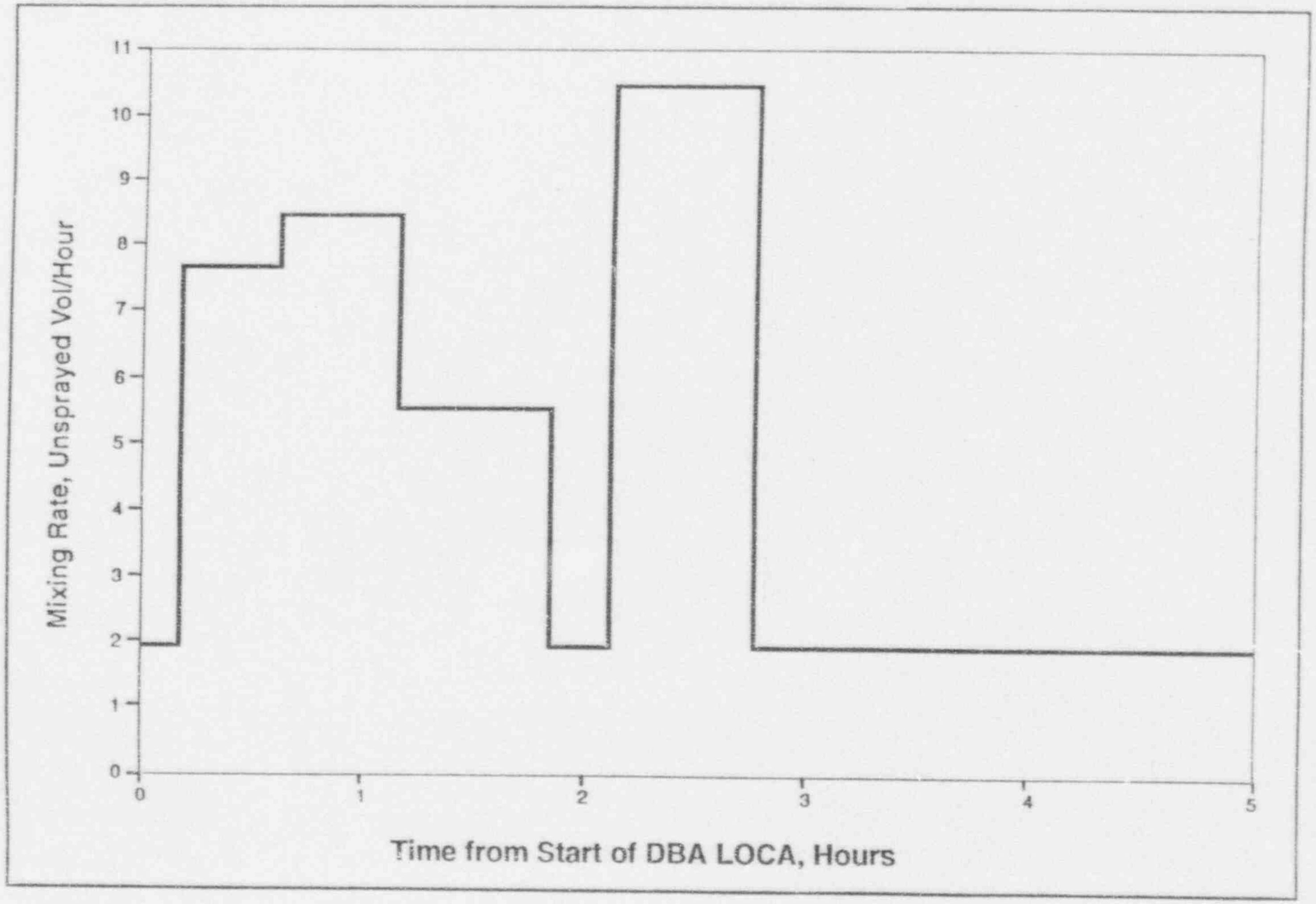
System 80+™ Standard Plant
Containment Transport and Deposition

Assumptions For Cooldown Mixing Analysis Described in EPRI Evolutionary Plant S/T Report:

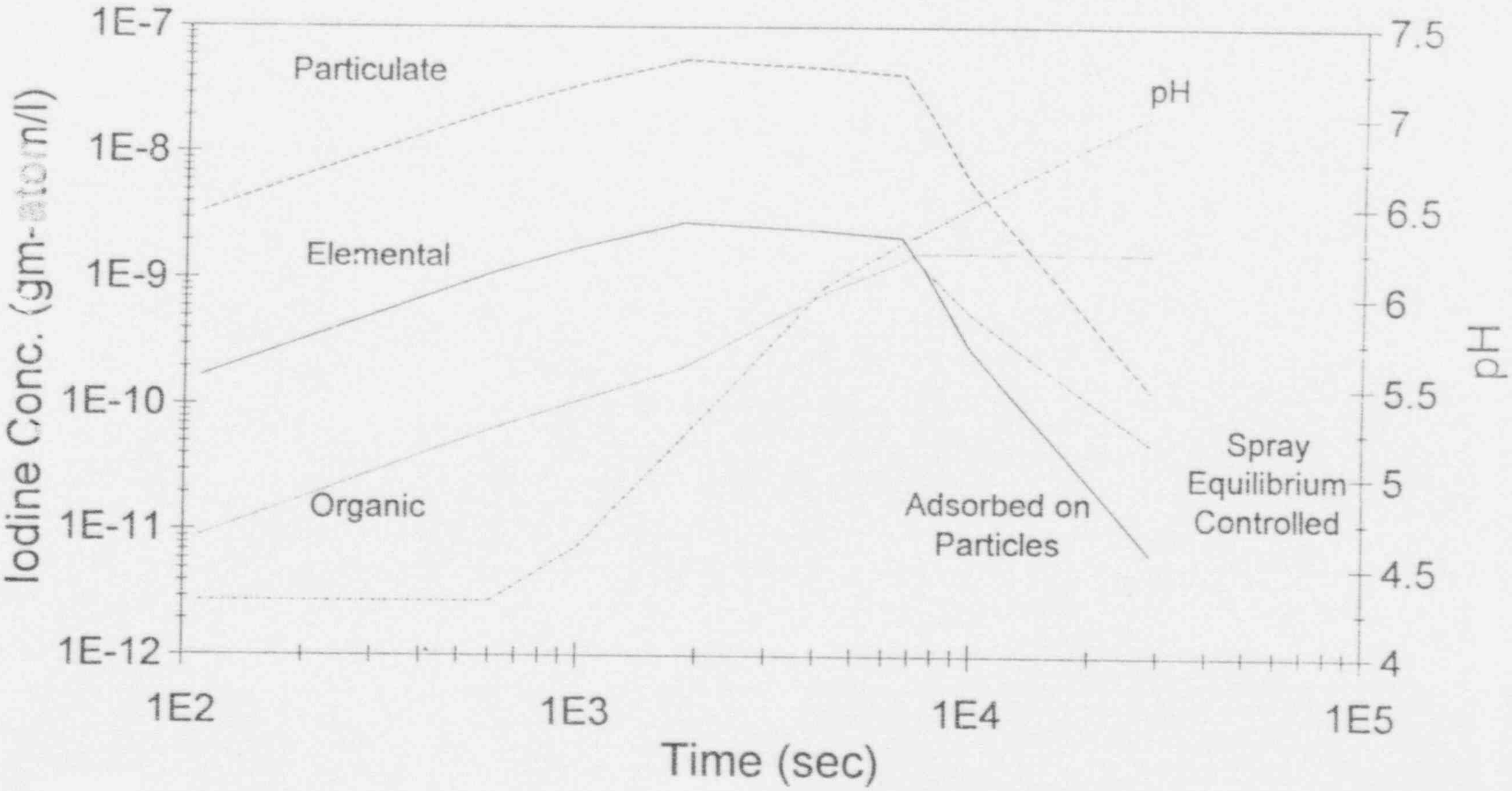
- Two-compartment, density-driven flow model.
- Containment atmosphere homogeneous prior to spray cooldown.
- Subsequent mass and energy release, radionuclide release, and containment leakage apportioned according to sprayed/unsprayed volume ratio (although radioactive "smoke" would actually rise).
- Containment atmosphere is a perfect gas (no credit for steam condensation/partial pressure of steam being lower in sprayed region).

System 80+™ Standard Plant Containment Transport and Deposition

DBA LOCA Containment Mixing Rate



System 80+™ Standard Plant
Airborne Iodine and IRWST pH



System 80+™ Standard Plant
Dose Consequences (PERC2 Code)

5 Region Model (Including Control Room)

Each region tracks inventory:

- Airborne
- On Walls
- On Filters (Recirculation, Effluent & Influent)
- Releases Via Effluent Pathway

12 chemical groups tracked.

Up to 4 isotopes comprise a decay chain - 150 decay chains.

System 80+™ Standard Plant
Dose Consequences (PERC2 Code)

Activity entering a region can be partitioned between walls and air space.

Removal LAMBDAs other than decay are user specified.

Daughter product fractional release from walls or filters - user specified.

Filter DFs - Time dependent and user specified, used to model filter modes of operation.

Separate (X/Q's) for each release point.

Integrated concentrations are tracked for each location.

System 80+ ^{TM} Standard Plant
Dose Consequences (PERC2 Code)

Dose Conversion Methodology and Results

- Dose conversion methodology identical to 10CFR100/TID-14844 (WB, thyroid & skin for Control Room)

- Results for 10CFR100/GDC-19 DBA:rem (limit):

	WB	THYROID	SKIN
2 hr EAB	2.6 (25)	172 (300)	- (-)
30 day LPZ	8.9 (25)	134 (300)	- (-)
30 day CR	3.5 (5)	24 (30)	21 (30)

System 80+™ Standard Plant
Equipment Qualification for Radiation Exposure

- New S/T release timing delayed.
- New S/T includes the release of large quantities of cesium.
- Airborne exposure same for TID-14844 and System 80+ LDB S/T.
- Recirculating sump water (IRWST) exposure greater for System 80+ LDB S/T than for TID-14844 (factor of two for integrated dose @ 100 days).
- Exposure duration important - two "default" exposures used:
  - 100 days for mitigation systems
  - 180 days for monitoring systems
- Two levels of qualification:
  - Level 1 for limited core damage → gap release only
  - Level 2 for "substantial meltdown of core" → new LDB source term
- Only one safety system in Level 1 (emergency FW); remainder in Level 2.

System 80+™ Standard Plant
Chapter 15 - Accidents Other Than DBA LOCA

APPROACH

- Identified accident scenarios that have radioactivity releases.
- Developed offsite and Control Room doses for these accidents.
- Added or removed engineered safety features based on resultant doses. (e.g., added automatic selection capability of less contaminated control room intake, downgraded the safety classification of charcoal filters in building exhausts.)

LIST OF ACCIDENTS ANALYZED:

1. Main Steam Line Break Outside Containment (MSLB)
2. Feed Water Line Break Inside Containment (FWLB)
3. Single Reactor Coolant Pump Rotor Seizure (LR)
4. Control Element Assembly Ejection (CEAE)
5. Letdown Line Break Outside Containment
6. Steam Generator Tube Rupture (SGTR)
7. Fuel Handling Accident (FHA)

System 80+ ^{TM} Standard Plant
Chapter 15 - Accidents Other Than DBA LOCA

GENERAL METHODOLOGY

- Transport mechanisms modelled are accident specific. Credit taken for holdup, decay, filtration as applicable.

- No credit taken for decay during plume transit.

- Offsite doses based on accident meteorology representative of an 80-90th percentile US commercial nuclear power plant site.

- Offsite submersion doses based on a semi-infinite cloud model, (RG 1.4 methodology), where if the concentration of the beta/gamma emitting isotope is X curies/m^3, and E is the average energy in Mev per disintegration, then:

  - Beta Dose rate = $0.23E_{beta}X$ Rad/sec

  - Gamma Dose rate = $0.25E_{gamma}X$ Rad/sec

System 80+™ Standard Plant
Chapter 15 - Accidents Other Than DBA LOCA

GENERAL METHODOLOGY (Cont'd)

- Control room gamma dose based on finite (CR equivalent volume) hemispheric cloud model.
- Inhalation Dose Conversion Factors based on International Committee on Radiation Protection Publication 2 (ICRP 2).
- No credit taken for operator action earlier than 30 mins post accident.
- Except as noted, accident dose analyses based on the guidance provided in appropriate sections of NUREG 0800.

System 80+™ Standard Plant
Chapter 15 - Accidents Other Than DBA LOCA

ENHANCEMENTS TO NUREG 0800

- For accidents that result in failed fuel, the gap activity and the chemical species of the iodines released from the gap are based on Draft NUREG 1465 instead of Safety Guide (SG) 25.

  ### Gap Activity

  Draft NUREG 1465 : 5% core NG, halogens, cesiums/rubidiums.
  SG 25 : 10% core NG, 30% Kr85, 10% iodines.

  ### Chemical Species of Gap Iodines

  Draft NUREG 1465 : 99.75% inorganic (i.e., 95% particulate, 4.75% inorganic gas), 0.25% organic.
  SG 25 : 99.75% inorganic, 0.25% organic.

System 80+™ Standard Plant
Chapter 15 - Accidents Other Than DBA LOCA

ENHANCEMENTS TO NUREG 0800 (Cont'd)

- Control Room Atmospheric Dispersion Factors based on Ramsdell Methodology (i.e., time-based dispersion model) instead of Murphy and Campe (i.e., straight line gaussian plume model).
- Particulate iodine released to containment is reduced prior to release by a gravitational settling coefficient of 0.15 hr^{-1} (per EPRI Evolutionary Plant Source Term Report).

System 80+™ Standard Plant
Chapter 15 - Accidents Other Than DBA LOCA

RESULTS

- Offsite gamma and thyroid doses are below the dose limits imposed by 10CFR100.11 as well as the more stringent dose limits provided in appropriate sections of NUREG 0800.

- Control Room beta, gamma and thyroid doses are below the dose limits imposed by 10CFR50, Appendix A, GDC 19 as well as SRP 6.4.

System 80+™ Standard Plant Protective Action Guide (PAG) Comparative Dose Calculation

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Goal: Meet Utility Requirement Document (URD) requirement to show that LDB S/T + vessel failure S/T + functioning containment yields dose < PAGs

Assumptions:

- Containment intact, leaking at L_A.
- Containment systems functioning - best estimate performance.
- LDB S/T + ex-vessel/late in-vessel (i.e., vessel failed).
- Median committed dose reported at site boundary, 24-hour exposure, independent of direction.

Results for System 80+:

- 0.3 rem CEDE vs 1 REM PAG
- 2.7 rem thyroid vs 5 REM PAG