ACRST-1829

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Agency: U.S. Nuclear Regulatory Commission
Advisory Committee On Reactor Safeguards

Title: Auxiliary And Secondary Systems

Docket No.

LOCATION: Bethesda, Maryland

DATE: Thursday, January 17, 1991 **PAGES:** 1 - 311

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PUBLIC NOTICE BY THE

UNITED STATES NUCLEAR REGULATORY COMMISSION'S

ADVISORY COMMITTEE ON REACTOR SAFEGUARDS

DATE: Thursday, January 17, 1991

The contents of this transcript of the proceedings of the United States Nuclear Regulatory Commission's Advisory Committee on Reactor Safeguards, (date) Thursday, January 17, 1991, as reported herein, are a record of the discussions recorded at the meeting held on the above date.

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UNITED STATES OF AMERICA

NUCLEAR REGULATORY COMMISSION

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ADVISORY COMMITTEE ON REACTOR SAFEGUARDS

AUXILIARY AND SECONDARY SYSTEMS

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

Thursday, January 17, 1991

The above-entitled proceedings commenced at 8:30 o'clock a.m., pursuant to notice, Ivan Catton, Subcommittee Chairman, presiding.

PRESENT FOR THE ACRS SUBCOMMITTEE:

Carlyle Michelson, Member
Charles J. Wylie, Member
J.G. Quintiere, ACRS Consultant
Thomas S. Rotella, Cognizant ACRS Staff Member

PARTICIPANTS:

R. Fraley	C. McCracken
P. Madden	A. Buslik
J. Murphy	D. Notley
R. Architzel	G. Kelly
C. Troutman	T. Storey
L. Connor	

PROCEEDINGS

[8:30 a.m.]

MR. CATTON: The meeting will now come to order. This is a meeting of the Auxiliary and Secondary Systems Subcommittee.

I am Ivan Catton, Subcommittee Chairman. The ACRS members in attendance are Carlyle Michelson and Charles Wylie. Also in attendance is ACRS Consultant, Jim Quintiere. The purpose of this meeting is to discuss fire protection and mitigation features in operating nuclear power plants. Tom Rotella is the Cognizant ACRS Staff member for this meeting.

The rules for participation in today's meeting have been announced as part of the notice of this meeting previously published in the Federal Register on December 28, 1990. A transcript of the meeting is being kept and will be made available as stated in the Federal Register Notice. It is requested that each speaker first identify himself or herself and speak with sufficient clarity and volume so that he or she can be readily heard.

We have received no written comments or requests to make oral statements from members of the public.

I have a few c ments that I would like to make myself. The purpose of today's Subcommittee meeting is to find out about fire at nuclear power stations. As you know, NUREG-1150 concludes that fire is an important contributor to risk, yet many believe that it is not. If it is important is there anything more that we should know, so that it can reduced in importance in new plants. Further, is there any reason for not wanting to know more about the behavior of fire.

I say this because there is no research effort in the area of fire. If the PRA's are correct, there ought to be. Future plants put fire concerns to risk by redundant systems being completely separated from one another. This means barriers must perform as expected. These barriers are given their ratings by the Underwriters Laboratory, and it seems to me that these are nuclear power stations so one has to ask the question, is this good enough for nuclear power stations. The British don't seem to think so.

What I am hoping is that I will be educated -- Carl here doesn't need to be educated -- today, and maybe we can address some of these questions with what we learn.

I have a note that was sent by J. Carroll, and he was very concerned. In the fire risk scoping study there is comment by Wisconsin Electric, and I will just read it. On page nine the study concludes that there has been a direct increase in overall fire risk because more event frequencies have been reported for nuclear power plants. The question is, has a real increase in the number of events occurred or is it simply that more complete reporting is now being performed.

In addition, a more detailed analysis of the data should be performed to determine if any of the events are really a threat to plant safety. Jay's concern is that a spark somewhere gets reported as a fire and goes into the database, and this becomes the initiator for the PRA.

Their comment is again, it is questionable whether the limited fire experience at nuclear plants is sufficient to draw conclusions. Hopefully, some of these things can be addressed today and the reason for the numbers being so high, and a justification for lowering them.

Conrad, it's yours.

MR. MCCRACKEN: My name is Conrad McCracken. I didn't hear you say anything that I didn't we were here today to address.

MR. CATTON: That's wonderful.

MR. MCCRACKEN: Which surprises me, because sometimes we are not quite in sync.

MR. CATTON: That's because Tom did a good job.

MR. MCCRACKEN: That could be. We had a lot of interface on this. I intend to address exactly the issues you raised. It is my intent in going through what we are going through with the whole day presentation to explain to you, we hope to your satisfaction, why NRR does not have a users need over in research to do additional research; why we think what exists today is adequate to ensure fire protection safety at nuclear power plants.

I am doing that primarily with Pat Madden, who will be our next speaker. I wanted you to hear directly from a fire protection engineer who has done a lot of work in the field and a lot of inspection, who can put perspective in some of the PRA results on what we actually see, what fires do, and the effects of fires, how they act on barriers and so on. The presentation is here to be sure that you understand the whole aspect of the fire protection program at nuclear power plants and what is going on.

My presentation will probably take about one-half an hour. I cut down on some of the things that I was going to say so that we can get into Brunswick fire in the personnel access hatch, which you had indicated you wanted to hear. That will be at the back of Pat's presentation. After you listen to the two of us then research, Art Buslik, who isn't here yet will be down and will present a fire PRA methodology and how they work, and he will focus on Brunswick and some of the issues associated with the fire PRA.

MR. CATTON: Sounds good to me.

[Slide.]

MR. MCCRACKEN: The areas that we are going to go through, fire protection in the nuclear industry for me is about six or seven slides, basically giving status of where we are and what we have done. I will talk a little bit about the issues of the fire risk scoping study which I have discussed here on a number of other occasions.

Then Pat Madden will go through our fire protection regulation guidelines and he is prepared to discuss those in any level of detail that you would like; overview of the fire protection requirements for nuclear power plants in selected countries that one of our contractor's SAIC had worked on and has a presentation prepared; fire isolation at nuclear power plant facilities that tells you what we think we can do as far as keeping fire where it belongs and preventing other problems in other areas of the plant; and the Brunswick personnel airlock fire.

Timing on it, looking at all the work we are trying to get through, is going to depend on you. In looking through the presentation based on past meetings, I can anticipate this could easily go until 8:00 or 9:00 o'clock at night, and we would still wouldn't answer all the questions or we could go earlier. It is purely the choice of the speed you would like to go at.

MR. CATTON: I guarantee you it will not go past 6:00 o'clock.

MR. MCCRACKEN: In that case, I will make sure that I call my wife and tell her to be down here for dinner.

MR. MICHELSON: Let me ask you, before you get too far into this -- you didn't ask the members if they had any comments. I will make my comments now.

MR. CA[illegible]ON: That's fine. I'm sorry.

MR. MICHELSON: The comment that I wanted to make was as we go through this various material, are you going to give some attention to the next generation plants?

MR. MCCRACKEN: Yes, sir.

MR. MICHELSON: Because, of course, that's the first place we might do something about some of the potential vulnerabilities.

MR. MCCRACKEN: I definitely intend to address those, and I will tell you where we think we have things ironed out and where we still think we have areas to work on.

[Slide.]

I believe the current fire protection programs are comprehensive, conservative, and they incorporate defense-in-depth with respect to ensuring safe shutdown capability. What I am saying there is a fire protection program has a whole lot of layers to it to prevent fires. If you look at the fire history it addresses the comments you had from Wisconsin Electric. A typical power plant has, on a average one significant fire -- and I won't define significant yet -- every two years. But they have a lot of small fires all the time. During any given year you will probably find five or ten depending on what stage, what construction, what they are working on. A lot of the fires that they have are little welding fires that occur and have a fire watch there that initiates and is put out.

You have to be very careful in looking at the fire database as to what you consider to be significant fires and what really could have had safety consequence in an operating plant. One will be an excellent example of that when Pat Madden gets into it is Brunswick, a fire they had in the personnel access hatch.

MR. MICHELSON: Excuse me. When trying to accumulate fire frequency data, I thought possible consequences had nothing to do with it. You accumulate the data on the basis of having experience of a certain level of fire, and you can define level however you wish, and having experienced an event of that level it goes into the database. It has nothing to do with what the potential consequences might have been; is that right?

MR. MCCRACKEN: I don't think so.

MR. MICHELSON: You mean -- I thought that's what fire frequency meant, the frequency with which to anticipate a particular type of event. Now you have to go back and look at where could that event occur within the plant, what would be the probability of having had one occur there that would get the plant in trouble and so forth. That's a different study. It has nothing to do with frequency.

MR. CATTON: It seems to me that's the kind of study that should have been made.

MR. MICHELSON: Yes.

MR. CATTON: If you are going to do it right.

MR. MICHELSON: But the database should contain only the probability of experiencing a fire of a certain size, magnitude or whatever you want to call it.

MR. CATTON: That's the other part of it. I don't think size and magnitude become part of the fire base fire frequency.

MR. MICHELSON: I think they exclude below a certain thresholds. Either it's on or off, I think.

MR. CATTON: Will there be somebody here who can explain to us how the fire frequency database is put together?

MR. MCCRACKEN: The fire frequency database, there isn't going to be anybody else here I don't think who has more than I do on it right now.

MR. CATTON: Okay.

MR. MCCRACKEN: The current fire frequency database that was used in the PRA's to date consisted of about 450 fires which were all the reportable fires that were in the LER's. That database has been updated by EPRI since then to include I think approximately a total of 600 fires through the end of 1988. What they are doing with that current database --and you will hear that as part of the five methodology which is supposed to be scheduled sometime later so I don't want to talk about that at all today -- as part of the five methodology they are going through that database with great care for exactly the issue you hear from the Wisconsin.

If it's a fire that occurred in a condition in a plant like construction where there wasn't any fuel loaded you could not have had safety consequences and it occurred because of an activity that would not be occurring in an operating nuclear power plant, then they are saying that doesn't count as far as something that I need to worry about in PRA. That's the type of methodology they are going through.

We haven't reviewed yet what they have done. We will review it and see if we agree with where they come out.

MR. MICHELSON: You have reviewed the Brunswick fire PRA.

MR. MCCRACKEN: The Brunswick fire PRA has been reviewed.

MR. MICHELSON: In the Brunswick fire PRA they seem to be looking first of all at the frequency and then at the location and then at the probability that it can cause core damage.

MR. MCCRACKEN: Yes.

MR. MICHELSON: In that order sort of.

MR. MCCRACKEN: Yes.

MR. MICHELSON: And, that's not quite what you just said I thought. Frequency is based only on how many times this is expected to occur, not even necessarily as to location although you can write a frequency for what the probability of a trash can fire is versus a cable tray fire. I don't think that's the way they have been doing it so far but they could. You could also have a certain threshold below which it cut off.

I was going to ask, in the case of the LER reporting, is there a lower threshold on fire? Is a trash can fire required to be reported?

MR. MCCRACKEN: No.

MR. MICHELSON: There is a lower threshold on it then. So, we aren't talking trash can fires even in the LER database, which I think is the lowest threshold that you go to in all of these fire frequencies. So, we are not talking about sparks.

MR. CATTON: Jim.

MR. QUINTIERE: Lower threshold is probably whether it's reported or not. On a national basis there is many fires that get into the statistics of NFPA but there is a wide variety of fires that never get reported to the fire department. So, those are really real fires that enter into frequencies as well.

MR. MICHELSON: They are using just --

MR. QUINTIERE: I am just making an analogy. I had a question though, Conrad. You mentioned the term significant fire; how would one define what a significant fire is?

MR. MCCRACKEN: By knowing how frequently it occurs, where it occurs, potential consequences if you have it. If it occurs out in the guard shack, the potential significance to safety is rather small even if you burn the guard shack down. If it occurs in the cable spreading room even if it's at a very low frequency, potential consequences are high.

The significance is dependent on the individual fire event.

MR. QUINTIERE: So, you would judge it on damage to the --

MR. CATTON: Damage potential.

MR. MCCRACKEN: Damage potential to affect your ability to safely shut down the reactor.

MR. WYLIE: That's the definition then?

MR. MICHELSON: Do you think that's the LER definition of what is reported?

MR. MCCRACKEN: The LER definition varies from plant to plant on what some of them report. If they report just according to the rules and regulations, 50.72 tells them if they have a safety system that is put out of service by fire they have to report. That, I think, would be a very small database. They report a lot more than that.

MR. MICHELSON: Are the guard shack fires reported in the LER database?

MR. MCCRACKEN: Not unless it was affecting security. If it potentially affected security, certainly it would get reported.

MR. MICHELSON: So, we are back to the meaning of the frequency number to begin with.

MR. MCCRACKEN: Right. That's an area where you have to look very closely. I promise you that's an area that we will look very closely when EPRI comes in with their modified or corrected database that they believe are all significant fires. That's where you have to be sure where you agree.

MR. WYLIE: Does EPRI have a definition of what a significant fire is?

MR. MCCRACKEN: I don't think they have ever given me one in a few words.

MR. WYLIE: Just judgment then.

MR. MCCRACKEN: I think when I look at their database when they are paring down from 600 to 350, I will know what they mean. Then I will see if we agree with them.

MR. WYLIE: It seems to be sort of loose goose as to what this definition is.

MR. MICHELSON: The problem is that a fire in one location would have no effect on safety. The identical fire in a different location would have a significant effect. The probability of getting that type of fire in any location is a certain number. We don't know that number from these kinds of databases. It's a higher number than just taking a significant event and using it only.

These kind of fires are occurring other places and could, under the same circumstances, occur in a vital area as well.

MR. CATTON: Except that the --

MR. MICHELSON: Go back and throw it all away to show how low the probability of fire is in a significant area. That's okay if you do the PRA the same way, but they are not. At least the Brunswick was not done that way.

MR. CATTON: It look like there is an inconsistency between the frequency data and how a PRA is executed.

MR. MCCRACKEN: The area that needs to be worked on closely is how you interpret the database and how that goes into frequency. If you have a frequency of fires for switch gear and there are no switch gears in the cable spreading room, then somebody can say any frequency of fire if I have one fire in a switch gear every two years, that doesn't apply to cable spreading rooms.

MR. MICHELSON: There are plants which do have switch gear in the cable spreading room.

MR. MCCRACKEN: Agree. If they have switch gear in the cable spreading rooms, then they have to use the frequency for the switch gears in the cable spreading room.

MR. CATTON: That's not a trivial problem to iron all of that out.

MR. MCCRACKEN: No, sir.

MR. CATTON: Is anybody spending the effort to get it done?

MR. MCCRACKEN: EPRI is spending the effort to get that database, and then we have to review it.

MR. CATTON: It might be that it takes more than just reviewing it. Is research involved in this?

MR. MCCRACKEN: Yes. Research will be the ones reviewing it.

MR. CATTON: So, when they get here they should be able to tell us what their basis is going to be.

MR. MCCRACKEN: I am not sure they have even started reviewing it, so I am not sure they can tell you that.

MR. CATTON: Well, they had better establish a base before they start reviewing it, or is this going to be on-the-job training.

MR. MICHELSON: That's right. It is just like in the codes. We had to develop our own codes before we knew how good other people's codes were.

MR. CATTON: Yes well, that's --

MR. MCCRACKEN: It isn't quite that bad, because we start off with the database.

MR. CATTON: You mean, it's not quite as bad as the codes.

MR. MCCRACKEN: No, it's not quite as bad as the codes.

MR. MICHELSON: That depends on what kind of experts research has on the staff to do this kind of work. It isn't a PRA expert necessarily alone that you are looking for, and it isn't certainly a fire protection expert alone that you are looking for either.

MR. MCCRACKEN: You are looking for a combination.

MR. MICHELSON: If they have the right talent they can do this ad hoc when the problem comes up. If they don't, they better be finding the right talent and getting them ready. Maybe they can tell us if that's what they are doing.

MR. CATTON: Carl, we should save that admonition for when research gets there, and don't forget the words you used.

MR. MCCRACKEN: Again, that's part of what is going on in the five methodology, and I don't think they are prepared to discuss that. That is not who is coming down here. The five methodology --

MR. CATTON: Are you saying five, f-i-v-e?

MR. MCCRACKEN: Five, f-i-v-e.

MR. WYLIE: Does the NRC have a definition of risk significant fire?

MR. MCCRACKEN: I don't have one sitting around on paper. To me, it is anything that has the potential or the impact to affect your capability to safety shut down. That's all of our fire protection.

MR. WYLIE: Is that understood?

MR. MCCRACKEN: Understood by me.

MR. WYLIE: That don't do me any good if you understand it and I don't.

MR. MICHELSON: A waste basket parked next to an inverter has a significant fire if the waste basket catches on fire. But we don't include waste basket fires no matter where they occur. It seems at least we don't.

MR. QUINTIERE: Just to maybe bring some

quantification to this. Some years back the British did a study just on statistics and developed and empirical relationship between the probability of fires in a certain kind of occupancy, commercial occupancy. This was based on fires reported to the fire department.

They determined the relationship to the probability or frequency of fires that became large loss fires. Typically the large loss fires resulted in flash over in a room with propagation to the adjoining space. So, they developed this empirical mathematical relationship that says given this frequency of fires in this industrial occupancy, this is the likelihood of large loss fires or fires involving more than one compartment.

If one took some of that frequency data away by expunging some of it and used that, you would get faulty results. I just bring that home to show the hazard in dealing with it in that fashion.

MR. MCCRACKEN: There is a hazard with dealing with it in that fashion but there's a hazard in dealing with it in the other fashion which is where you exclude no data. If you exclude no data, you may come up and conclude falsely that you need to make a lot of modifications to the power plants that are going to cost a whole lot of dollars that may be better spent elsewhere in improving safety. You need to know the real safety significance of what you are trying to do.

MR. QUINTIERE: Assuming that the statistical relationship between probability of large loss fire and probability of initial occurrence -- that is just on statistics -- what you are trying to do in a PRA I think is take the initial data of frequency and now construct the probability of the large loss fire by some mathematical approach.

If the mathematical approach is valid, you should get the same answer as to what occurs in the real world. But if you took some of this frequency data away it may not.

MR. MCCRACKEN: You can do that if you have the same fire protection criteria and the same type of level of safety to prevent spread of fires or to minimize fires from occurring. If you have a different level of safety in preventing and minimizing fires and preventing the spread of fires, then you can't use that same type of analogy. You have to use one that applies to the way nuclear power plants are constructed, operated, maintained in the area of fire safety. You can't use something for commercial buildings.

MR. CATTON: I don't think Jim was saying that. At least what I interpreted you to be saying was consistency. Your fire frequency data has to be consistent with its use. If it's not, your answers don't mean anything. I suspect that's where the problem lies.

MR. MCCRACKEN: But it also has to be associated with the ability to protect your safe shutdown capability.

MR. CATTON: I understand that. Whatever your criterion for collection of data is, you should use it consistent with that. If you don't, your answers don't mean much.

MR. MCCRACKEN: You are right. I agree, 100 percent.

MR. CATTON: If that's the reason the PRA's are giving large numbers, then somebody ought to be getting excited and going back and changing something. The PRA's say you ought to be spending more money.

MR. MCCRACKEN: That's what industry is doing right now in spending the amount of money they are spending in going through that database in great detail. They are trying to make sure that the fire database are fires that are something that could affect the potential to safely shut down a nuclear power plant.

MR. MICHELSON: If you are using the reporting as that basis which you are in part because I keep hearing the same numbers, that's already factored in. Those are only significant fires, if I understood what you said earlier correctly.

MR. MCCRACKEN: An example of that -- and I don't want to get into what Pat is going into later on -- we could discuss the Brunswick fire.

MR. MICHELSON: Let me get it clarified. Is the LER reporting system required to report fires that are not affecting safety-related equipment irrespective of magnitude, or is there thresholds, or how?

MR. MADDEN: My name is Patrick Madden. I am Senior Fire Protection Engineer with NRR. The criteria bounding the reporting of fires in either 10 CFR 50.72 or 50.73, to some degree it has a notation of monetary loss attached to it. Also, it has impact. Fires are only reported to have -- could have potential significant impact on the safe shutdown of a reactor like Conrad is saying.

You use an example of a garbage can next to a piece of switch gear for example. If there was a fire that did occur like that and the fire did cause damage to that switch gear, even though it may have been small in magnitude, that particular fire would have been reported.

MR. MICHELSON: But only if it had affected a safety-related piece of equipment.

MR. MADDEN: Not necessarily a safety-related piece of equipment.

MR. MICHELSON: I mean safe shutdown piece of equipment.

MR. MADDEN: As long as it would be in the power block. Your turbine building for example, we have fires in turbines. That is not definitely related to safe shutdown of a facility, but those fires are reported under 50.72 and 50.73.

MR. CATTON: If I just move that trash can one foot away from the switch gear and it doesn't impact it at all, then it becomes unreportable.

MR. MICHELSON: That's right.

MR. CATTON: Yet, that trash can fire certainly should be in the database.

MR. MADDEN: I am not disagreeing with you. There is a database out there that each individual facility does maintain. They are required to investigate every fire that they have on site, regardless if it is reported to the control room or not. The fire protection staff on-site do get the fires and they do have fire reports for every fire that has been either reported by a fire watch or seen by a fire watch.

If it is dealing with welding for example, they do a follow up report on those potential fires.

MR. MICHELSON: Let's deal though just with what is used in our studies and not what they may accumulate and not use.

MR. MADDEN: I am just saying there is a potential for getting, if you want additional data, plants do have that data.

MR. WYLIE: You say they are required to investigate each fire.

MR. MADDEN: By administrative control.

MR. MICHELSON: Yes.

MR. WYLIE: Let's say that you do have a fire over in the turbine building, and say it's associated with the oil purification system or something and it affects the cables that provide the off-site power for example. Now, they would then report that fire, right?

MR. MADDEN: Yes, sir.

MR. WYLIE: Where is that required in the regulations?

MR. MADDEN: In 50.72 and 50.73 reporting criteria.

MR. MCCRACKEN: Current rules and regulations are adequate to ensure implementation and monitoring plant-specific fire protection programs. There are a lot of rules and regulations in place in fire protection. There are a lot of tech specs in fire protection. There are a lot of requirements on periodic inspections and daily walk downs for fire safety at all these plants.

We are currently in a mode where we are supposed to be performing tri-annual audits of all the plants, whereas you go back in and see how they are doing all the things they had committed to in the past. You make sure they are maintaining their fire barriers; that they are maintaining their fire brigade; that they are doing all the things that they committed to in their FSAR and through their entire licensing process. That is the mode we are in, in all the operating plants right now.

[Slide.]

As a brief summary of where we are and how we got there, I wanted to go through a little bit about what occurred since Browns Ferry, and perhaps why we get some comments as we have from industry. We do get a lot of comments from industry. There are some people in industry that feel we went way overboard after Browns Ferry and we should just leave them alone in this area. We get that type of comment relatively frequently.

Prior to the 1975 Browns Ferry fire, all we required was compliance with the broad guidance in GDC 3, and it is very broad. That's like all the rest of the GDC or the majority of the GDC which there's a lot of latitude in how you meet it. It simply said you protect safe shutdown equipment and you do things like make sure that you don't get fire fighting equipment spraying or putting safety-related systems out of service.

We didn't try to narrow that down at all, and as a consequence when we got to the Browns Ferry fire we saw that they were basically worried about protecting their financial investment because the fire protection had been reviewed by their insurers. What the insurers were looking at was how do you prevent fires that are going to burn up large areas of the building. As the example that we had a little bit earlier where you have a fire under a switch gear it can be a very small fire, but if it affects safe shutdown that's what we are concerned about. There's not a big financial problem with that fire, it's a potential for safe shutdown.

So, we started focusing after Browns Ferry on how you maintain a safe shutdown capability safe and not worrying about what that was as far as financial damage. That was a totally different way of looking at nuclear power plants. In telling them to do that we had some licensees who really didn't want to go through it -- this was the Appendix R requirements -- they were objecting to the safe shutdown requirements that they had to implement, and the Commission by rule said that you had to have a safe shutdown capability which was III.G. You had to have emergency lighting, and you had to take care of the reactor coolant pump oil system to the volume of oil you had in the containment.

MR. MICHELSON: For clarification -- I don't have a copy of Part 50 in front of me at the moment -- somehow I recollect that Appendix R was to identify a certain class of plants in a certain time interval and how they shall be treated. Thereafter, you revert to 9.5.1. In 9.5.1, did it really incorporate Appendix R, or was Appendix R an explanation on how a certain class of plants were to be handled?

MR. MCCRACKEN: No. That's the very next slide.

MR. MICHELSON: Subsequent ones go back to 9.5.1 and that group in between Appendix R told you how to handle it.

MR. MADDEN: I will get into that later.

MR. MICHELSON: You will get into that, good, because I would like it clarified.

MR. MCCRACKEN: That was the next slide, which means you are not looking ahead. You normally look a little faster ahead at what we are doing.

MR. MICHELSON: You are going too fast for me. I'm just a little slow today.

[Slide.]

MR. MCCRACKEN: Plant license prior to January 1, 1979 have implemented Appendix R. That's what Appendix R applied to. Plant license after January 1, 1979 meet Branch Technical Position 9.5.1, which incorporates Appendix R.

MR. MICHELSON: That's the part that I am not at all sure is true, but I will take your word for it for the moment.

MR. MCCRACKEN: I promise you. We reviewed all the plants after 1979 to the Appendix R criteria plus additional criteria and did additional things with them that we could do because we were going through the licensing process.

The tech specs that we imposed on the plants after 1979 were a lot more rigorous than we had on the prior plants. There were a lot of things we did in 9.5.1 which was a step up from the pre-1979 plants. The only difference in these as a regulator is that because Appendix R is a rule, any time a licensee wanted to change something associated with the rule they had to go through the exemption process. They had to come in, process a formal exemption, go through a license amendment.

Plants that had to meet 9.5.1 that is not an exemption because 9.5.1 is not a rule, it's an SRP, they could simply do that by a normal review process, a normal exception and it wasn't an amendment. That was the difference in how they were treated. Only the legalistic way that you handle them, not the technical way we did fire protection. The technical way we did fire protection incorporated everything that was in Appendix R.

Additionally, Generic letter 88.20 -- which we have been down here four or five times on I believe -- ensures that a systematic vulnerability search will be conducted. I think that's very important. I think what the

PRA shows, whether you agree or disagree with the numbers, the bottom line numbers, is that there are vulrerabilities in power plants due to fire. The magnitude of that vulnerability may be arguable based on the database and based on a lot of other things. Forgetting the magnitude, vulnerabilities do exist relative to other things in power plants.

Therefore, if that relative vulnerability exists and you can identify it through a PRA methodology or the five methodology, that then gives you something to focus on to see if you need to make an improvement in that plant.

[Slide.]

Now, looking at where the rules and regulations are going. Looking at evolutionary plants, this is an issue we came before here and discussed, which is what we are going to do. Evolutionary plants are required to demonstrate safe shutdown without repair, assuming total loss of any fire area. That is the issue of the three hour barriers. They are all required and have agreed to have three hour barriers. We will have that between all safe shutdown equipment.

The ABWR has gone through a preliminary assessment using the five methodology which is in final draft form, and in their preliminary methodology review they have screened out all fire areas by going to step two.

MR. MICHELSON: At some point now or later you can point out to the Subcommittee if it's correct that the five methodology does not incorporate the SECY 90-016 requirements that they address to questions that were raised by the Sandia fire risk scoping study. Until five actually incorporates those concerns, the five methodology isn't necessarily applicable.

What GE did in the case of ABWR, they went room by room, tabulated everything in the room and said I will lose it and see if you got enough equipment elsewhere to handle it. It made no addressing anywhere to the questions about the effect of the fire within the room and what that equipment might do and so forth. Keep that in mind. Five does not include, to date at least, that kind of addressing. The Commission has already directed the staff to include it; is that correct?

MR. MCCRACKEN: The five methodology addresses three of the issues in fire scoping study.

MR. MICHELSON: It addresses some of them and not all of them. I was just wanting to make a correct clarification. They presently do not comply with SECY 90-016 in the case of fire.

MR. MCCRACKEN: I don't think I would make that statement. I haven't reviewed it, but --

MR. MICHELSON: You know the five methodology and you know how they are doing it. Do you agree that all you need to do is tabulate the equipment in the room and not consider system interaction from that equipment from within the room and that sort of thing, which is what SECY 90-016 told you to go back and do. It's one of the five concerns itemized in the Sandia risk scoping study. SECY 90-016 says you got to do address them.

MR. MCCRACKEN: There are six concerns identified in the Sandia fire risk scoping study. I do not agree that all of those issues need to be addressed by --

MR. MICHELSON: I am not asking if you agreed. I am asking, what is your understanding of what the Commission told you to do when they adopted SECY 90-016.

MR. MCCRACKEN: My understanding of the Commission is that they said I need to address the fire risk scoping study issues.

MR. MICHELSON: Right.

MR. MCCRACKEN: That means if I determine as a regulator that some of them are not necessary for industry to implement, they have been addressed.

MR. MICHELSON: When you decide one is an exception I would expect to see some documentation, an SER in which you went through some kind of ritual and concluded that it didn't need to be addressed. Have you prepared that type of ritual yet?

MR. MCCRACKEN: No. I am not sure that necessarily that I required to write an SER on a contract --

MR. MICHELSON: You certainly are going to have to document your decision when it is contrary to the intent, I think. I believe the intent of the Commission was that you do address these issues, and that means you have to either comply with them or show why compliance isn't needed. I think you do that in writing, and I don't think you do that off the top of your head.

MR. MCCRACKEN: I have to address it to the Commission. That's not necessarily a safety evaluation report.

MR. MICHELSON: Whatever.

MR. MCCRACKEN: That could be a SECY paper.

MR. CATTON: Is there one in preparation?

MR. MCCRACKEN: Not at this time there isn't, no. For the ABWR -- and I think the punch line I would like to get to on ABWR is basically ABWR, the evolutionary plants are simply the current designs that we have licensed today with a lot of improved fire protection. I have no hesitation in saying in the area of fire, what they have done for the evolutionary plants is a safety improvement. They are clearly better than the standards we have used today.

For passive plants, I think we have not yet made up our mind where we stand. The passive plants will be required to meet the same criteria as the evolutionary plants. They will be required to address heat control, smoke control, they will be required to have the three hour barriers. But the concern with the passive plants is that they have a lot fewer safety systems.

The requirement supply for the safety systems, and then because you now have a majority of systems that used to be safety systems that are not now safety systems, we simply don't know what they plan on doing. That's an area that we are starting to question them, what do you mean because you now have a much larger balance of plant which used to be safety systems, and what are your fire protection criteria back there, what are you really going to intend to do. Do you intend to do the same thing that you had done for the safety systems and you are just not calling it safety, or what is the status?

That is an area where we intend to focus resources, because we simply don't know what they intent is in that area for the passive reactors.

MR. QUINTIERE: Can I just go back and try to understand something that maybe Carl is getting at this. Can we go back to the first bullet item you have. It assumes that you totally lose to fire area.

MR. MCCRACKEN: Correct.

MR. QUINTIERE: How is an analysis carried out to see what impact that is likely to have on the rest of the facility; does it just say that you have lost that capability and if you have a redundant system someplace else then everything is fine?

MR. MCCRACKEN: It looks at the reliability of your redundant system.

MR. QUINTIERE: Or does it say --

MR. MCCRACKEN: For all normal losses you would have for the other redundant system.

MR. QUINTIERE: Does it also look at the consequences of fire and does it presume a fully involved fire in that fire area; is that what constitutes a loss of that space by fire? If it did do that, then what does it say about the products of combustion or interaction of fire with the rest of the facility around that shell? You can't just have a fire burning for three hours in a closed space. That is not valid. Something will have to happen, something will have to give.

MR. MCCRACKEN: They have to do a fire hazards analysis for every fire area in the plant.

MR. MICHELSON: Have you looked at their fire hazard analysis for ABWR?

MR. MCCRACKEN: No.

MR. MICHELSON: I would invite you strongly to look at it. I have taken a look at it. It's a very interesting document. I would think that General Electric would be a better one to paraphrase what is in there. I was extremely disappointed, because none of what you just talked about is in there. What they have done is, they have gone through each area, tabulated all the equipment in that area, determined that none of that equipment -- assumed it is total loss -- and determined that there was enough equipment left in other fire areas to produce safe shutdown.

It made no mention of the type of fire, system interaction, the ability of the barrier to retain the heat from getting into adjacent areas and causing equipment damage there, nothing like that is addressed. No reliability numbers or nothing. It is a pure tabulation. It gave you 100-some pages of tabulations but it was the same thing area by area; here's the equipment in the area and here is what I have left

MR. CATTON: The assumption basically is that there's an adiabatic boundary surrounding the fire zone, and that is it.

MR. MICHELSON: The water doesn't get out of the zone if you are addressing the fire with water.

MR. CATTON: Completely sealed.

MR. MICHELSON: The environment is completely sealed, completely. That is just unrealistic to believe.

We have enough experience to know barriers aren't that good. We have had plenty of water releases, we know where water goes when we get a little water on the floor, how it goes down through the floor. We know all these things, and all those are ignored in this study. Those are the things that the Commission says you got to go back and address. That's what SECY 90-016 is about.

MR. MCCRACKEN: SECY 90-016 said -- that's what we gave to the Commission. When they reviewed it, they said we need to address those issues. We said that we will address those issues. The way you just characterized fire barriers as you can't rely on them, I absolutely, categorically do not agree with it.

MR. MICHELSON: You remember, I didn't say you can't rely on it for fire propagation, I said you got to look at it from the viewpoint of water getting out of the barrier, warming up of rooms adjacent because heat ratings have nothing to do with temperature elevations and so forth. You have to address the environment around this box that you say you --

MR. MCCRACKEN: You have to address how nuclear power plants are constructed --

MR. CATTON: Could you define what a fire hazards analysis entails?

MR. MCCRACKEN: It is basically an analysis of the total fuel loading in a fire area, and its potential to cause fire and damage. That's the punch line. If you looked in this room a fire hazards analysis would look at all the wooden tables, the carpets, the chairs, everything in here.

MR. CATTON: Then what would it do, release that amount of energy --

MR. MCCRACKEN: The amount of energy capable of being released.

MR. CATTON: Do you take a look at what is on the other side of that wall and --

MR. MCCRACKEN: First you look at what is in there.

MR. CATTON: I understand that. GE does that very simply by saying okay, we lost everything in here and it's over.

MR. MCCRACKEN: Right. Then you look at -- in the fire hazards analysis you look at the other side of the wall if you have a significant fuel loading in here. If here is a cable spreading room where you have a lot of fuel, then you need to look at okay, that fuel loading what would I get to on the other side of this wall. If what is in here is simply a big empty room with a trash can and nothing that will burn, what is on the other side of the wall is irrelevant.

MR. CATTON: What you just defined is fuel loading per unit volume of some sort. Do you have a criterion like that for -- does GE have something like that?

MR. MCCRACKEN: I haven't reviewed what GE did. I said the preliminary basis on what they have told us. I haven't reviewed it.

MR. CATTON: When you look at it, do you use something like that?

MR. MCCRACKEN: Yes.

MR. CATTON: Somehow I need to get a measure.

MR. MCCRACKEN: We use fire hazards analysis, fuel loadings in many of our licensing decisions on how we handle power plants and what we agree is adequate in barrier protection. Very specific, fuel loadings in this fire area.

MR. CATTON: If I have a fuel loading in a room like this, there is some size of this room.

MR. MCCRACKEN: Correct.

MR. CATTON: The fuel loading for this room, that same amount of fuel in a smaller room or bigger room would have an entirely different impact.

MR. MCCRACKEN: Right.

MR. CATTON: Is that included in your --

MR. MCCRACKEN: Yes.

MR. CATTON: If you track through this kind of analysis you would see that?

MR. MCCRACKEN: Yes. Dave Notley would like to make a comment.

MR. CATTON: Okay.

MR. NOTLEY: I am David Notley, Fire Protection Engineering in NRR. Whatever fire protection review has been done of the ABWR, I have done.

MR. MICHELSON: You are acquainted with what they have done then?

MR. NOTLEY: I have looked through it. The caveat we gave in our safety evaluation was that the evaluation GE had done to date is so sketchy that there really is no way we can do a final evaluation.

MR. MICHELSON: We haven't seen your SER yet, but when we get it I guess that's what --

MR. CATTON: His conclusion is the same as ours.

MR. MICHELSON: Your conclusion is the same as mine. I thought the thing was --

MR. NOTLEY: We have promised them we will do this kind of review, and that there simply isn't enough in there to do anything right now.

MR. MICHELSON: We are together undoubtedly then. I thought maybe we were far apart on the view. Could I ask one other question. Do you include in the fire hazards a consideration of the ability to confine the environment to the area where the fire is? In other words, the ability to keep the water from getting away and keeping the heat and smoke from getting away? Or if it does get away in your analysis, will you trace it down to what its consequence might be.

MR. NOTLEY: I said that GE is going to have to address every one of those, Carl.

MR. MICHELSON: Okay. I think it's got to be done. I mean, I thought the directive from the Commission was rather clear in this regard.

MR. CATTON: And, it sounds like they are carrying out the directive.

MR. MICHELSON: Yes.

MR. NOTLEY: Ralph was just mentioning to me that our statement is that it will be done on a plant-specific basis whenever these plants come in.

MR. MICHELSON: You think you won't have to do this for standardization, for certification rather? I would be very surprised. I have never sensed that the Commission thought that all you need to do is say I am going to have a design for fire protection and that's all you need to assure us. Maybe I am all wrong, but SECY 90-016 certainly didn't give me that feeling at all.

SECY 90-016 dealt with what do you have to do to get certified, not what do you have to do to build a first plant.

MR. NOTLEY: There is a big part of me that wonders how you are going to be able to do this.

MR. MICHELSON: Let's not get into it.

MR. NOTLEY: We have seen some very specific designs. They have committed to it in principle, and we are going to look at that.

MR. MICHELSON: This is what 377 is all about. How much of this information do you need before you can certify a plant and not go back and look at it again?

MR. MCCRACKEN: Yes, and that's an issue that hasn't been resolved.

MR. MICHELSON: No, it hasn't been resolved yet. It hasn't been resolved yet, unless you are aware of something that I am not aware of. I haven't heard that the Commission has written their letter on 377 SRM.

MR. MCCRACKEN: It hasn't been resolved.

MR. MICHELSON: It has not, excuse me.

MR. MCCRACKEN: We are in a position where we have identified that as an issue that we have to have further information to finalize. We think adequate information can be provided but we don't have it. The Commission may tell us you can go through without it or not, but that's a choice they have to make.

MR. CATTON: Moving on.

MR. ARCHITZEL: This is Ralph Architzel, also with

Plant Systems Branch. I guess the only point that I would like to make to Conrad's point is, currently the way the draft SER is, we are deferring some of these issues. When ABWR comes in and has an issue like this and says they are going to do it, defer that to the plant owner and the --

MR. MICHELSON: Certification --

MR. WYLIE: I don't see how you can certify a plant on that basis.

MR. MICHELSON: You can't certify something on a promise only, or why do we go through any design. Just give me your promises and I will certify your promises, and then tell me the plant details. That's another approach.

MR. WYLIE: There is sufficient information available to do an analysis because GE and ABWR goes into great detail with their design.

MR. MICHELSON: In some areas, yes.

MR. WYLIE: Yes.

MR. MCCRACKEN: Some areas, but not all areas.

MR. WYLIE: If they don't and it is safety significant, they should.

MR. MICHELSON: That's right.

MR. MCCRACKEN: I think you and the Chairman agree.

MR. QUINTIERE: Let me just pick up on that point, whether there is sufficient information. There may be sufficient information about the details of what is in the spaces and the geometry of the facility. What you are also dealing with is if you assume that you have a fully involved fire in one of these three hour fire zones, then you need the computational ability to decide what the impact of that fire is on the surroundings.

The current technology in fire safety says that there are some computer models available that purport to do this. In Germany they have a long term study of conducting experimental fires in reactor facilities and testing the experimental data against a host of computer models, because they do not know the reliability of these computer models, their physics, their mathematics. It's sort of like a black box to some extent.

So, if one is going to proceed along those lines and make some hazard assessment, then you are going to have to get some comfort with computer models or develop some of your own or have some research sort of put into perspective what the accuracy of a certain class of models are. Otherwise, you won't be able to make these calculations. You may even need some experimental validation of this.

It's not a trivial problem. You can't just rest on the basis that if the equipment in the space is wiped out then you are assured that there is no other impact. I think that's a faulty premise.

MR. MCCRACKEN: Research is following what is going on in the German experience. To say I have a totally involved fire, which you have mentioned three or four times, there are very few areas in a nuclear power plant where you are going to have a totally involved fire in the context that you are discussing. The amount of fuel doesn't exist in the vast majority of spaces.

The spaces where it does exist have extra fire protection criteria like automatic suppression systems. They have a very well defined knowledge of what is or is not next to those fire areas, and what they need to do if that area is involved.

To assume you are getting that type of involvement, you have to assume that your detection system didn't work, your suppression system didn't work, and your fire brigade didn't work. You are making some very strong assumptions to get you to a point that you are going to assume that the fire is going to get you in trouble. In the nuclear industry with 1,500 plus years of experience now -- and I don't know how many three hour barriers but say there are 50 fire areas per plant and three barriers for each one of those, so you probably are talking 200 three hour barriers per plant -- I am not aware of any case where we have failed a three hour barrier due to a fire.

MR. MICHELSON: But we have failed plenty of them due to releasing water on the floor and the water coming on through. If we get a fire of modest extent in one area and we release a lot of water due to all the automatic fire protection, it may be the water that gets us into deep trouble.

MR. CATTON: Go and see that one inch crack under the door.

MR. MICHELSON: You have the experience to show that's the case.

MR. MCCRACKEN: There have been cases. A lot, I think, may be overstating it.

MR. MICHELSON: We didn't say a lot. There's enough.

MR. MCCRACKEN: There have been cases. The licensees have been informed of this very clearly, and they have done things to look for problem areas like that. It isn't an area that has been ignored.

MR. MICHELSON: The experience is recent and not old.

MR. MCCRACKEN: Pat Madden will go into that in a little more detail.

MR. MICHELSON: Okay.

MR. MCCRACKEN: I think we are getting into a lot more detail in the general discussion.

MR. MICHELSON: It's the details that are going to kill you in this case, I'm afraid.

MR. CATTON: You just want to get away.

MR. MCCRACKEN: I just want to sit down and let Pat talk. You have heard me often enough.

[Laughter.]

MR. CATTON: I think it's his turn.

[Slide.]

MR. MCCRACKEN: Fire risk scoping study issues. The analytical codes, which is one of the issues, they are adequate to search for vulnerabilities in current plants, and I don't think they are needed for future plants. That's why there is not a NRR user need request over at research. With the separation they have, with the improvements they have made in the design, I have no doubt for the future plants that we can have greater protection of fire safety than we have in the current plants. I think the current plants, once we go through the IPEEE process, will have identified vulnerabilities that exist and have been fixed if they are justified on a cost benefit basis.

MR. CATTON: One of the concerns that I have heard Carl express is th ' some equipment begins to go a little bit bananas if you just warm it up too much. The kinds of codes that you have now will not give you that information. When we asked GE about that, the feeling that I got was everything that room, if the fire starts in that room, somehow doesn't matter.

Does that mean that they ha'e some special measures that will immediately isolate everything in the room where the fire is electrically?

MR. MCCRACKEN: Pat will get into that in safe shutdown and how safe shutdown is handled.

MR. CATTON: If isolation of the fire area means everything including electrical, then that first statement you make up there I would agree with.

MR. MICHELSON: We pursued that with GE a little bit.

MR. CATTON: We never got to any really good conclusion.

MR. MICHELSON: No, because I think they were thinking off the top of their head while we were pursuing it.

MR. CATTON: It was the wrong people.

MR. MICHELSON: Yes.

MR. CATTON: You follow me. If it's complete isolation including all electrical instrumentation and everything, then you are right.

MR. MCCRACKEN: Now you are at another control panel, and --

MR. CATTON: This room just does not matter anymore.

MR. MCCRACKEN: Right.

MR. CATTON: If there are things in the room that do communicate to the outside world, then your codes are inadequate.

MR. MICHELSON: Because you remember now, we are going to go this solid state control throughout the plant, and we are going to put multi-plexus, perhaps as many as 100 of them scattered around the plant in potentially adverse environments. Certainly environments potentially are affected by fire.

Now, what happens when the multi-plex gets warm. They don't have to get hot, they don't have to burn, they just have to get warm.

MR. MCCRACKEN: I am glad you said that, because you got me off track earlier when I was on advanced plants.

MR. MICHELSON: Before we get to that, let me add one more thing. This cost benefit basis business I think is fine for present day plants. Unless you do your cost benefit analysis correctly, it's a whole different answer for future plants because the costs are much more modest compared with the benefits than they are for present day plants.

When people say they exclude these things on a cost benefit basis, I sincerely hope you don't mean for --

MR. CATTON: Carl, they can't be using PRA because a lot of us feel that PRA gives too big a numbers. If they use cost benefit they would do it.

MR. MICHELSON: Yes.

MR. MCCRACKEN: I was talking IPEEE, cost benefits on only current plants. That doesn't apply to future plants.

At any rate, the issue that I wanted to get back to -- you got me off track and forgot on the slide -- the other area that we are looking at specifically on the future plants is the effect of smoke on electronic equipment. There is a lot of it there and a lot more reliance where a small amount of smoke may have an effect.

Part of what they are looking at and part of what is going to be going on in that area -- you could write the name down, Scott Newberry. I have discussed this in detail with him, and he is making sure that as they go through this they are addressing that specific area.

MR. MICHELSON: How about the heat aspect and not just the smoke, both heat and smoke.

MR. MCCRACKEN: Temperature -- what can they handle. [Slide.]

Seismic fire interactions with another issue in the fire risk scoping study, and it also concluded that it can be handled by a procedurally directed walk down which is part of the IPEEE process.

MR. MICHELSON: How will that be done for future plants, the seismic fire interaction?

MR. MCCRACKEN: It will be done by whatever we find in the walk downs on this generation of plants, addressing through our normal question process to make sure they eliminate whatever is found as far as an issue.

MR. MICHELSON: Since IPEEE is kind of a long program taking literally years, it is not going to do much good on ABWR.

MR. MCCRACKEN: I guarantee you that IPEEE will be done before the first ABWR is ever operated.

MR. MICHELSON: No. That gets back to this question of certification, and keeping in mind the finality rules concerning certification. You can't go back and readdress these things later, not unless you keep them all open issues. Keep adding up the open issues and that's another whole problem.

MR. MCCRACKEN: Again, as people doing the review we can only identify areas where they haven't fulfilled everything that we need to complete our review. There are a lot of areas like that. That's why the whole issue of how much you need is there. You asked me the last time I was down here what my opinion was, and I said I agree with the Chairman. I would like to have a complete file FSAR, everything there. That would certainly make my job a lot easier.

I don't think I will get that, but it would make my job easier.

MR. MICHELSON: You will get everything that you need to make your safety determinations, whatever that is.

MR. MCCRACKEN: Right.

MR. MICHELSON: Of course, we just make sure that you made all the determinations needed to be made.

[Slide.]

MR. MCCRACKEN: Fire barrier qualification. Pat is going to go into this in some detail, so I will just make the statement. Then, if you have questions when he goes into it in detail how they are designed and how they are tested, fire loadings and fire plants, you can get that --

MR. CATTON: He will tell us why some of them have failed early and why they are concerned about over-pressurization.

MR. MCCRACKEN: You have to define what you mean by failed earlier what application; are they a nuclear power plant type three hour barrier or something else.

MR. CATTON: I don't know how, it's just -- wasn't it at Berkeley that they did the test and it failed early, and the Sandia people claimed that there was at least one case where it failed within 15 minutes?

MR. MICHELSON: It depends on how the test is done.

MR. CATTON: Somehow these things need to be addressed if you want to make that statement.

MR. MICHELSON: Is there a difference between a three hour door for a warehouse and a three hour door for the nuclear power plant? I didn't think there was any, but I thought I heard you say it depends on whether it's a nuclear plant or not. As far as doors, it doesn't depend on whether it's a nuclear power plant.

MR. CATTON: That's right, the use the same UL standard.

MR. MCCRACKEN: When you talk about a nuclear plant, again, you are talking abou. fire protection defense-in-depth. You are talking about the amount of fuel loading that you have, the type of detection, the type of suppression systems, the fire brigade. You have a lot more fire protection defense-in-depth than almost any other type of facility you can think of in a nuclear power plant.

MR. MICHELSON: But the barrier is not in depth. There is only one barrier between two trains potentially.

MR. MCCRACKEN: Right.

MR. MICHELSON: There is no requirement for more than one barrier.

MR. MCCRACKEN: If there is not sufficient fuel load to burn through or give you a three hour fire -- if you can only get a 15 minute fire --- that three hour barrier is a conservative over design, which is the case that we have in almost all cases.

MR. CATTON: That is part of your evaluation?

MR. MCCRACKEN: Yes.

MR. CATTON: You say because of the fuel loading which is --

MR. MCCRACKEN: Yes.

MR. CATTON: -- this is a 15 minute fire.

MR. MCCRACKEN: Absolutely, yes.

MR. CATTON: Okay, and that's in the fire hazards analysis.

MR. MCCRACKEN: Yes.

MR. CATTON: I am looking forward to seeing one.

MR. MICHELSON: Yes, a real one.

MR. CATTON: Yes.

MR. MCCRACKEN: Manual fire fighting effectiveness. Again, here the individual plants have to justify their assumptions. That means they have to go through their logs and records and demonstrate in fact if they have fires in critical areas how rapidly they can get there and suppress based on actual data of what they can accomplish.

[Slide.]

Control system interactions, which is another issue out of the fire risk scoping study, the regulations require independent shutdown capability. Again, Pat will talk about what that means in our review, how we review it and what independent means as far as electrical independence to achieve safe shutdown. The licensee will verify the information notices which talk about a couple of cases where somebody in fact wasn't as electrically independent as they should have been and how they were supposed to address that.

MR. MICHELSON: When you do your system interaction effect, are you going to include the effect of not alone the fire but also the water and the heat and smoke and all the other things as a part of the system interaction effect? It is the water running down through the crack in the floor that is getting into the opposite train equipment. Is that sort of thing going to be a part of your study?

MR. MCCRACKEN: I am not sure what you mean by study. If part of what --

MR. MICHELSON: You are trying to show that the equipment for safe shutdown is truly independent, that means environmentally independent as well. Or, it can be protected against the environment that might result, one or the other. Is that included so that you have reached the conclusion then that it is truly independent? If you haven't traced it, then you don't know whether independence exists or not.

MR. MCCRACKEN: We review to see that they have stated that they comply with the regulations. We occasionally do an audit review, where we go out and look at what is in the plant and verify in fact that it exists. If they say they have a drain that will take this amount of water which they address on automatic suppression systems and that amount of water is going to flow out of the system, we look and see in fact if that looks like it exists.

We do not go out and trace every electrical wire in the power plant to make sure that they did what they said what they did.

MR. MICHELSON: I am sure you don't. But I am only asking, do you really determine that these are independent? In other words, if the study shows that the drain system requires a three inch head on the drains in order to take the rate at which the suppression is occurring --

MR. CATTON: Pat, you are going to address this a little later, aren't you?

MR. MADDEN: Yes.

MR. MICHELSON: If you are, fine.

MR. MADDEN: If you have some questions when I get up there, I can probably do a little bit better job.

MR. MICHELSON: Sure.

MR. MADDEN: I will address them when I am up there.

MR. CATTON: You mean, Conrad, you are not keeping up to speed?

MR. MCCRACKEN: He's just saying that having been through this I will never be a fire protection reviewer.

[Laughter.]

[Slide.]

The last issue of the fire risk scoping study, the total equipment survival issue. Again, GDC 3 requires that fire fighting systems be designed to not impair safe systems. That is a very clear requirement in GDC 3. Generic issue 57 is looking at the issue of suppression systems and their effect. If there is something that comes out of generic issue 57 which indicates it needs to be fixed, that is purely a compliance issue. You go back and say you have to fix it to meet the GDC.

The smoke effects on operators trying to get in and achieve safe shutdown is part of what they should be doing in IPEEE and will verify that they are doing that. If you have smoke that would impair an operator's ability to take action to achieve safe shutdown in an area adjacent to a fire area, again, you can't assume operator action in a fire area. If there is any fire or smoke propagation in an area adjacent you have to verify that in fact the operator can do his job.

Soot effects on equipment, we consider again primarily a clean up issue after a fire, looking at the defense-in-depth issue.

MR. MICHELSON: On this question of not entering a fi area to mitigate a fire, do you consider that in order to mitigate the fire that the protecting the mitigators must open the doors and shoot the water into the room? They have to somehow get something into the room to mitigate it.

MR. MADDEN: No. What Conrad is saying is, I can't leave an operator go into a room that is involved in a fire for example, to change the position of a valve in order to achieve safe shutdown.

MR. MICHELSON: How about the fire fighters, they are allowed to enter the room?

MR. MADDEN: They are allowed to enter the room and do what they need to do.

MR. MICHELSON: When you look at their manual mitigating steps, do you analyze now what happens because they opened fire barrier doors? That is okay because the fire is on the other side of the room and they can make that judgment, but how about the heat and smoke going out through the door and into the next area.

Is that sort of thing included in --

MR. MADDEN: I am going to go through here and explain to you for every safe shutdown related area, fire brigades are required to have what they call fire fighting strategy. There are certain topics that they have to look at, and mitigation of smoke and approach has to be considered so that you are not involving both trains by opening the door for example.

MR. MICHELSON: Are they required to analyze the effect of their actions, such as opening up fire barrier doors in order to go in ar^d do the job?

MR. MADDEN: Not in that great of detail.

MR. MICHELSON: When you open a door water can get through a door anyway to some extent, but it can get through in a much greater extent in many cases when the door is open. Also, the heat and smoke can enter other areas. We are talking about temperatures of 120 degrees or 110 in a room, not temperatures of 700 required to ignite cable. We are not talking about fire propagation, we are talking about effect on equipment in adjacent rooms.

Is that included in people's studies when they decide what they can open and what they can do?

MR. MADDEN: That assessment, in my opinion, is not done. The assessment that primarily is done is coming up with a strategy that allows a fire brigade to attack a fire in such a manner that it may be 90 degrees or 180 degrees out of sync with wherever the redundant train may be. Let's say the redundant train is on the North side of the plant. Well, in the fire somewhere between that involving one train in another compartment which may be on the opposite side, we certainly would not want them to go thro gh that compartment and open the door; that now, you would have direct communication between one train and the other train.

MR. MICHELSON: Unfortunately, most of the plants out there now are not that well physically separated.

MR. MADDEN: That's right.

MR MICHELSON: In fact, people have had to go in and add walls and everything. When you walk through some of those plants and you look at the smallness of the cubicles that they form and the number of doors that you have to go -- the doors between the barriers and the opposite train is right on the other side of the door -- I just wonder if we have really appreciated what hazard we introduce when we open doors under those circumstances.

MR. MADDEN: Hopefully if the system responds the way it is supposed to or the program responds the way it is supposed to, we shouldn't be ever getting to the stage that you are discussing.

MR. MICHELSON: You mean you shouldn't have that big of a fire.

MR. MADDEN: Correct. I got some specific examples that we will get into as far as --

MR. MICHELSON: I worry a little though, because I see modest bundle of cable stuck in a compartment inside of an enormous room, and in five minutes you can't even seen in the room. That wasn't, to me, a very big fire at all.

MR. CATTON: Carl, Conrad has two more slides and then we have Pat up.

[Slide.]

MR. MCCRACKEN: I hope one more slide. In summary of where we are, the current rules and regulations are adequate. Therefore, efforts are not being extended to modify them. We don't intend to do anything to modify 9.5.1. We are leaving it where it is. We think the GDC is where it belongs. The additions that we have made for the evolutionary reactors, we believe are adequate. To improve those, we believe fire safety will be better in those. Clearly, it would be better based on a PRA analysis. We believe that, in conjunction with IPEEE taking care of the current generation plants and any vulnerabilities, we will do everything that we need as far as rules and regulations to ensure all the safety we would need.

We believe we need increased emphasis on inspection of operating reactors to ensure continued compliance. This is an area where you talked about yes, you may find a fire door that is open or something. The way you find it is, you walk around and inspect it, and it is open.

You cite them, and they have a violation and will stay closed for a long time after that.

We need to ensure that they maintain what we have. We believe that what is out there is good enough, and what the effort should be is to make sure they maintain it and not let that start to degrade because of focusing effort in the wrong area.

The review of the passive reactors I talked about, where we still don't know exactly where they are going or what they are trying to do. That is an area where we intend to put in quite a bit of effort to be sure they are going where we think they should be going.

MR. CATTON: The passive reactors will be interesting then, won't they, because in order for it to be passive you build a chimney to get rid of the decay heat.

MR. MCCRACKEN: Yes.

MR. CATTON: If you get a fire, that chimney that fire is going to aggravate everything. I don't think you have the tools to address that problem, if you are interested in the degree of aggravation.

MR. MCCRACKEN: Unless what you do is simply address it by having virtually no fire hazards there.

MR. CATTON: Either that, or you have forced them to design it in such a way that they can accommodate it.

MR. MCCRACKEN: Correct, one way or the other.

There are a lot of areas in the passive reactors. There are broad policy issues that need to be addressed, and we are getting there.

Again, from an NRR perspective, we have no user needs for research right now, we don't think for instance the modified COMPBRN 3 code. That code is adequate. It has been used in a lot of PRA's to date. It does what it needs to do as far as identifying vulnerabilities. It isn't perfect, but it needs to do what it needs to do. It will certainly do it in the timeframe that it needs to do it, which is over the next three to four years.

MR. MICHELSON: Do you think it will do it when we start worrying about temperatures well below ignition points but well above the capability of the equipment to withstand it? We are talking temperatures 200 fahrenheit, 300 fahrenheit. Do you think you can use COMPBRN for predicting temperature in the corner of a room during a fire, at those kind of levels?

MR. MCCRACKEN: No, I don't.

MR. MICHELSON: I don't think so either.

MR. MCCRACKEN: I don't think I need to do anything like that, because I simply need to in the advance reactors, have sufficient separation and electrical independence that I can isolate them.

MR. MICHELSON: And make sure also that even though the equipment is warming up in the fire area that it is not doing any -- performing any unwanted actions.

MR. MCCRACKEN: That I need to be able to isolate it within a reasonable time before it's doing something that I don't want it to do, yes.

MR. MICHELSON: Yes. The provision to isolate it, which might be the only good way out.

MR. MCCRACKEN: Right.

MR. MICHELSON: Have you discussed that in your SEP, the provisions to isolate this equipment, in the ABWR SER? I will look forward to reading it if you have.

MR. NOTLEY: That's one of the things that we said they had not sufficiently addressed.

MR. MICHELSON: They didn't give you enough detail to know what they intend to do. Have you asked them the question if they intend to isolate --

MR. NOTLEY: They have committed to it. They have committed to it, and we have noted their commitment.

MR. MICHELSON: Committed to what, the isolation?

MR. NOTLEY: Pardon me?

MR. MICHELSON: Committed to isolation of the equipment before it produces unwanted actions; is that what you mean, they committed?

MR. NOTLEY: Yes.

MR. MICHELSON: That will -- that is going to --

MR. NOTLEY: The technology --

MR. MICHELSON: Is that in an answer somewhere?

MR. NOTLEY: Pardon me?

MR. MICHELSON: Is that commitment in an answer?

MR. NOTLEY: I believe it was in an answer. It was either in the answer or stated in very general terms.

MR. MICHELSON: But it's your understanding they are going to take the approach of trying to electrically isolate the equipment before it produces unwanted actions.

MR. NOTLEY: Yes, and we have acknowledged that commitment.

MR. MICHELSON: Knowing when that has to occur because the equipment is in the corner of a room and it may only take 150 fahrenheit to cause this, you have to either have standard procedures that as soon as you get the fire alarm you kill all the power or you have to have some way of predicting how many minutes you have before you have to kill the power.

To do that, you have to have some calculational tool for this fire to tell me how quickly the corner of the room is heating up.

MR. NOTLEY: We mentioned earlier --

MR. MICHELSON: We don't have that tool, to my knowledge.

MR. NOTLEY: Carl, Ralph injected that we have said that a number of these things would be done on an individual plant basis, and you challenged that. GE has said that these things are beyond the scope of their design, and will have to be addressed by the purchaser.

MR. MICHELSON: We will have to wait first of all, for a Commission decision on 377. Depending on what that decision is, then we go back to see how much they have to provide if they want to get certified.

MR. CATTON: I can see this just huge blades sitting around the room that just sever everything.

MR. MICHELSON: I can too. But certainly if they want to use that as their approach, that's fine.

MR. QUINTIERE: I would like to come back to COMPBRN. My recollection of the Sandia report is that they had some issues with COMPBRN and that there were different versions of COMPBRN. Realizing that COMPBRN represents sort of a family of fire models that exist, and it speaks to the German research that says which is the most reliable fire model to use. One has to wonder where COMPBRN fits into this.

Also, my understanding is that COMPBRN is a single room model and it requires that there is a vent someplace. One can make some rational assessments of fire size relative to temperature, given fire development in a room with a vent. I mean, one can do this. Even if the model has some issues of reliability, one can put a factor of safety on that so that you truly are then conservative and can get at some of these issues that maybe Carl is raising about the temperature level in the room.

In order to do that though, one would have to if he were to use a model like COMPBRN, presume there is a vent. Also, you need to put in to your model the rate of burning of your initial fire. What I don't see is where one gets that data from. In other words, there are many different kinds of things that might burn in these facilities, recognizing that the fuel content might be low relative to the volume. But what I don't see is sort of like a catalogue of this is how an electrical cabinet would burn. This is how cables in a contained protected system would burn. This is how bare cables would burn.

Some sort of benchmark that would say these are sort of plausible fires, and given in this base if we have this fire, this is what the fire consequence is going to be. I don't see that information readily available, so I would see some difficulty in implementing such an analysis without that.

MR. MCCRACKEN: I agree. I think there are an enormous number of variables associated with trying to implement a model like that, which is exactly why I have not tried to issue a users need to anything in that area. I think the amount of variables are so great that the end product is never going to be anything that you are going to convince me as a licensure that I am going to accept.

If somebody runs a model like that in a control room and tells me that I ran it and I hit 127 degrees in this piece of equipment in the corner, if I took care of that by removing two clip boards over on this table and now it won't get that hot for another 30 seconds, I can guarantee what my response will be.

MR. MICHELSON: Does COMPBRN require a point vent or uniformly distributed vent?

MR. CATTON: COMPBRN basically says that you have a fuel source at some location if this table is the room, at some location in the room as a result of the fire source there's a plume, you have a hot layer at the top and the plume feeds it.

There are some simple things that bother me about COMPBRN.

MR. MICHELSON: You didn't say anything about a vent.

MR. CATTON: I wasn't aware that it required a vent.

MR. MICHELSON: I wasn't aware that it required a vent.

MR. CATTON: I think you are reading some physics into it. In order for that process to occur --

MR. MICHELSON: Clearly --

MR. CATTON: -- there should be a vent somewhere.

MR. MICHELSON: You have to get some oxygen in. What it is, is a uniform oxygen vent leaking out.

MR. CATTON: From the rest of the room, and the layer gradually drops.

MR. MICHELSON: Yes.

MR. CATTON: COMPBRN is only good if the room is big enough.

MR. MCCRACKEN: Absolutely.

MR. CATTON: If you shrink down the aspect ratio of the room, the whole character of the process changes. When you ask somebody what size room are you using COMPBRN on -- if you ask the people who are the practitioners of PRA -- they use it for everything. They don't distinguish between a room that is very wide and one that is very narrow. Yet, the phenomena is very different.

It is all simply implemented much like COMPBRN is. This is the kind of thing that I think is easily built into a tool that you could use with the PRA, yet is not. Research won't do it if you don't say it's needed. It seems to me those kind of simple things you do need, or else you don't need COMPBRN at all or don't need PRA at all. But you probably believe that.

[Laughter.]

MR. MCCRACKEN: Remember, what I am looking for are vulnerabilities that could affect the ability to achieve shutdown. The areas that I believe I have concern for that are areas where I have redundant trains in the same fire area. If it's a very small room, I don't need COMPBRN. I know what I need to protect it, I need an automatic suppression system--

MR. CATTON: But one of the questions Conrad is, we are not sure what small means. When this change in the process occurs I don't know, and I have asked several people who are in the business and they don't know either. Yet, they know that it happens and there is data that shows it, but nobody has tried to say if the width to height of the room is greater than, then COMPBRN is fine. Nobody has put down that number.

It seems to me that's a relatively easy thing to do if somebody would just do it.

MR. MCCRACKEN: I think based on some of the stuff that I saw -- I don't know who was using it the way you said, where they are just using it in all rooms. I know in some small rooms they said no, they didn't try it.

MR. CATTON: I am not absolutely sure of that, it is just that I talked to my colleague who developed COMPBRN. Based on his understanding of the physics of fire, I worry a lot.

MR. MCCRACKEN: Where are those issues? One of the reasons in IPEEE we stated that you have to have a fire protection engineer available is somebody who understands the physics of fire and what they do.

MR. CATTON: I worry about that a little bit too. From my observation, the fire protection people are people who know what the rules are and can implement them in contrast to somebody who understands the physics of fire.

MR. MCCRACKEN: That's a regulator, not a fire protection engineer.

MR. CATTON: Okay.

MR. MICHELSON: Could we go back just for a moment to the question I raised about position 9.5.1 in Appendix R. I went back and checked my memory on 50.48, fire protection, and the last item in the entire 50.48 says nuclear power plants licensed to ope ate after January 1, 1979 shall complete all fire protection modifications needed to satisfy criterion three of Appendix A to this part in accordance with the provisions of their licenses.

You do not go back to Appendix R. Appendix R was never written for these new plants, it was written for old plants only, if my understanding is correct.

MR. MCCRACKEN: That's exactly part of Pat Madden's presentation, and he will address it.

MR. MICHELSON: Your slide is then incorrect, because it says that plants licensed after January 1st have met BTP 9.5.1 which incorporates Appendix R, and it doesn't incorporate Appendix R, if I understand it correctly.

MR. MCCRACKEN: No. My slide is correct.

MR. MICHELSON: It says nothing in here about after January 1st.

MR. MADDEN: I will get to that when I get up there.

MR. MICHELSON: Okay.

MR. MCCRACKEN: That's all I had. I think Pat is ready to start. My half hour took a little bit longer than I thought.

MR. CATTON: No, you were scheduled here for an hour and one-half.

MR. MCCRACKEN: I told you initially I was going to go for a half hour so that you could listen to Brunswick.

MR. CATTON: You mean we have precluded hearing Brunswick?

MR. MCCRACKEN: No. Pat will talk fast.

MR. CATTON: By the schedule here we are ten minutes ahead, but I suspect we should take a break. Pat Madden is up here to answer all of the questions that were deferred by Mr. McCracken.

MR. MADDEN: Of course. Just to introduce myself, good morning, gentlemen. I will just introduce myself again. My name is Pat Madden. I am Senior Fire Protection Engineer with NRR. I work for Conrad McCracken.

[Slide.]

Basically what I am going to try to do is give you an overview of fire protection regulations in nuclear power facilities, and the guidelines that we use as reviewers when we are looking at a nuclear power plant and how we find the fire protection program is acceptable.

[Slide.]

If you go to 10 CFR Part 50, specifically part 50.34, that requires you to come -- when you go for license submit a plan that basically addresses minimum criteria or principal criteria on how to design your facility. In Appendix A to Part 50, this establishes those principal design requirements. Appendix A, general design criteria or GDC criterion three addresses fire protection.

[Slide.]

When you look at criterion three it states basically that the probability and effects of fire and explosion on structures, systems and components important to safety, those must be minimized. Criterion three also requires you the use of non-combustible and flame resistant materials, and establishes the basis for minimizing adverse effects through the incorporation of fire protection, suppression, and manual fire fighting systems for components important to safety.

That's the basis of the regulation, saying that fire protection and the incorporation of a fire protection program into a nuclear power plant is important.

[Slide.]

Criterion three is satisfied at nuclear power plants, basically by meeting the fire protection plan program requirements of 10 CFR 50.48.

MR. CATTON: Does Criterion three define what non-combustible and flame resistance means?

MR. MADDEN: No, it doesn't go into that level of detail. That's kind of a like a policy statement on the design philosophy of the facility.

MR. CATTON: Is there somewhere that you reference a basis --

MR. MADDEN: When I get into the staff guidelines we will talk a little bit about non-flammable components, fire resistive components, non-combustible materials that are used.

MR. MICHELSON: I would like to ask you a question on criterion three. The last sentence of criterion three reads fire fighting systems shall be designed to assure that their rupture or inadvertant actuation does not significantly impair the safety capability of these structures, systems, and components.

What do you think that statement means, keeping in mind the word capability and not function was used there.

MR. MADDEN: I think that if you have an inadvertent actuation of a sprinkler system that could potentially knock out both trains of shutdown systems or systems required to control the reactor, that definitely does not meet criterion three.

MR. MICHELSON: How about where you have a piece of safety-related equipment and the [illegible] actuation will cause that particular piece of equipment to malfunction; are you dealing in other words with the function performed by the equipment or capability of that equipment to perform its function? The word used here is safety capability and not safety function.

Capability means the -- to me it meant the ability of that particular piece of equipment to work.

MR. MCCRACKEN: Our interpretation of that is I think you are doing too much focusing on what the actual words says. When it was written it wasn't that. If it won't do what it is supposed to do to maintain the plant in shutdown, then it isn't doing its job. If a fire fighting system by inadvertent rupture of operation will prevent it from doing the job that it has to do, then that doesn't meet the GDC.

MR. CATTON: You should have written GDC 3.

MR. MICHELSON: It should have been written quite a bit differently if that's how you wish to interpret it. If the word safety function had been used there would have been no problem. The word safety capability of the equipment was used, and that means I thought that piece of equipment adverses the function that the particular system is performing or that there is indeed even a redundant piece of equipment.

MR. MCCRACKEN: We are in the process now of preparing an office letter which identifies what operable means, because we have been through this argument too many times.

MR. MICHELSON: How about capabilities, are you going to identify what capability means also, since that is the word used here and not operable?

MR. MCCRACKEN: It puts everything in terms of what operable means, whether you are talking about capability, function or anything else. It is basically getting down to what is operable and what does operable mean.

MR. MICHELSON: I have never pressed the point, but it appears to me that a literal reading of GDC 3 says that you have to protect the equipment against inadvertant actuation of the fire protection that is there for the equipment. That's the capability of those pieces of equipment, not the safety function performed by that particular piece of equipment.

MR. MCCRACKEN: That's not the way that we interpreted it, and if we ever got to that issue we would have to go to a GC. The only person who could interpret it is the guy in charge of OGC. If somebody wants to argue that point --our interpretation is functionality interpretation. If it puts a safety system out of service, then it isn't doing what it is supposed to do.

MR. MICHELSON: But determining if safety system means looking at all the redundant trains which might be one or more redundant trains.

MR. MCCRACKEN: Correct.

[Slide.]

MR. MADDEN: I am going to try to explain to you a little bit about this plant license prior to January 1, 1979 and those licensed after January 1, 1979. I am just talking about their operating license.

Plants licensed prior to January 1, 1979 were required that their fire protection programs incorporate the fire protection safe shutdown features required by Appendix R, Section III, G, J and O and L under Section III G 3. The plants also had to satisfy Appendix A requirements, Appendix A to Branch Technical position 9.5.1 which was issued

August, 1976.

[Slide.]

We have to focus that Appendix A came about to the branch technical position, came about in response to the Browns Ferry fire. They were based on NUREG 0050, and based on the recommendations coming out of the Browns Ferry fire. So, the fire protection program in Appendix A was developed from those recommendations, and the study evolved around the Browns Ferry fire.

Plants licensed after January 1, 1979, criterion three can be satisfied in accordance with the provisions of their license. I think that was quoted pretty closely to what is in 10 CFR 50.48. Under the provisions of their license we generally require them to implement a fire protection program that met NUREG 0800, Section 9.5.1, fire protection program. The contents of NUREG 0800 Section 9.5.1 basically contained the III G, J and O requirements of Appendix R.

MR. MICHELSON: But not by reference.

MR. MADDEN: But not by reference, yes, sir.

MR. MICHELSON: The point is that for new plants you don't even need to talk about Appendix R. It had nothing to do with it. You talk about 9.5.1 only.

MR. MADDEN: Yes, sir.

MR. MICHELSON: Okay.

MR. MADDEN: You have it. That is correct.

MR. MICHELSON: But you still find it --

MR. MADDEN: You see, that's --

MR. MICHELSON: I don't think they have gone back and understood what the regulation: say.

MR. MADDEN: Right. The problem is that you have people using criteria which is very similar in 9.5.1 by saying Appendix R, the criteria is basically close to being the same for separation.

MR. NOTLEY: Pat, can I interrupt here for just a moment?

MR. MADDEN: Sure.

MR. NOTLEY: There are references here to BTP 9.5.1. I think it's important that you remember that there are two different revisions to 9.5.1 that we are using. The 9.5.1 and the Appendix A to 9.5.1 that came out r after the Browns Ferry fire -- a year after the Browns Ferry fire -- was revised after Appendix R came out to include all of the Appendix R issues.

When you are talking about 9.5.1 applying to plants licensed after January 1, 1979, you are talking about that revision of 9.5.1.

MR. MICHELSON: Which is the July, 1981 revision?

MR. NOTLEY: Yes, sir.

MR. MADDEN: I guess the point I want to make pretty clear here is that the SRP -- I am going to call the standard review plan or Section 9.5.1 probably throughout the rest of my talk -- just the SRP. The fire protection program guidelines contained in the SRP when they are fully implemented, will produce a level of fire protection equivalent to the provisions specified by 50.48 in those facilities licensed prior to January 1, 1979.

Under the SRP criteria, the newer generation plants were required to do additional things in addition to just Appendix R, those three sections.

MR. CATTON: How does the 20 foot separation business float through these series of changes?

MR. MADDEN: We will get into that. The 20 foot criteria is still maintained -- the 20 foot separation criteria is still maintained almost verbatim in the standard review plan or SRP. I will explain that to you.

[Slide.]

The next slide is just a little note that says that the fire protection guidance to the NRC in its development was based on NUREG 0050, which is the recommendations related to the Browns Ferry fire. These fire protection design features -- example like fire door, detection systems, suppression systems -- are designed, installed, tested and maintained in accordance with the fire protection industry standards. We got into a question of what standards we use in the Commission. Generally we use fire protection industry standards developed and established by the National Fire Protection Association. As far as system design we use NFPA standards.

MR. MICHELSON: Are any of the NFPA standards unique to nuclear power plants, or are they all just general fire standards?

MR. MADDEN: They are all unique to general fire standards except NFPA 0802, which was written specifically for nuclear power facilities. The guidance in that --

MR. MICHELSON: What is its subject?

MR. MADDEN: Nuclear power plant fire protection. NFPA 0802, the guidance provided in that parallels -- it's 0803, Mr. Michelson -- parallels our requirements and generally does not exceed our requirements. Our guidelines are probably more comprehensive than what was developed.

MR. MICHELSON: You mean the standard review plan?

MR. MADDEN: The standard review plan, yes.

MR. NOTLEY: Also, when 0803 was developed, it was recognized that by the NFPA Committee that NRC preempted them in safety related areas. And, 0803 was promulgated specifically for balance of plant -- those areas of the plant that NRC does not address.

MR. MICHELSON: Does it address the safety-related portions or just the non-safety?

MR. NOTLEY: Non-safety related.

MR. MICHELSON: It doesn't deal with --

MR. NOTLEY: It does not deal with the kinds of reactors that we are interested in.

MR. CATTON: If you are using the NFPA standards, how does that fit with an article that was in Scientific American by Ammons some years ago, where he showed if you took a group of the Western Countries and ranked things according to their view of what particular materials flammability was they were all different, and you could do just as well with a random number generator?

What it really gets down to is that flammability is in the eyes of the beholder, and it depends on how you run your test. Have you looked into any of that?

MR. MADDEN: I am not disagreeing with you.

MR. CATTON: If that's the case, it seems to me that within the nuclear power arena we ought to take a look at those things.

MR. MADDEN: This is just my professional opinion without looking at it. The flammability of materials in a nuclear power facility are a lot less than in this office building for example. On that basis, the standards are generally generated to fit applications of life safety, and that is to basically control the fire until you actually get a fire department or fire brigade on the scene. They do the complete extinguishment and overhaul.

MR. MICHELSON: I have been in a nuclear power plant already where they use plywood on the walls. They say this is good plywood, it's fire resistant and meets NFPA --

MR. MADDEN: It sounds like we are talking about St. Lucie.

MR. MICHELSON: I'm not naming any plants, I am just saying that I have been there already. How does that stack up? Then I went through the list and some other material that the agency writes -- man, plywood of any sort wasn't allowed in the control room.

MR. MADDEN: I am going to have a little case of plywood here that you are going to probably -- when we talk about the Brunswick fire a little bit, there's a case --

MR. MICHELSON: Yes, but that was temporary plywood and not permanent plywood.

MR. CATTON: Are they different?

MR. MADDEN: The flammability characteristics --

MR. MICHELSON: This is good stuff.

MR. MADDEN: The flammability characteristics of the material that you are talking about has been documented to have a flame spread of 50 or less, which is allowed by the standard review plan.

MR. MICHELSON: That's in there.

MR. CATTON: It's the test that is important.

MR. MADDEN: Yes.

MR. QUINTIERE: I think that was the issue that Ammons raised in that Scientific American document, which basically said that each country has its own test and they don't agree with each other. Also, if you go back even in this country when foam plastics were introduced in many different applications, there was the Federal Trade Commission actually issued a consent decree complaint against the plastics companies and the testing organizations to say that they weren't appropriately labeling flammability by things like the Steiner tunnel test and other small tests.

In those cases these materials were getting ratings in the Steiner tunnel test of less than 25, which presumably would be a very good rating. Yet, in their application where performing in a very terrible and hazardous way, leading to a lot of death and injuries that was brought to the Federal Trade Commission.

What it says is that we don't fully have the test calibrated for all situations. One has to be a little concerned when you are dealing with a nuclear reactor and safety to try to go a little bit beyond. Some people have actually said that you should test this material in the context of its use. If it's going to be on a wall ASTM has developed a standard room corner test which now gives you a measure of flammability of this material.

Many of us in research are trying to work to a prediction of a room corner test based on some smaller scale tests. The flammability of materials is still and issue, and I think one has to be aware of that and not just rest on what has been done conventionally to assure that use of such materials is safe. It could be a very critical point.

MR. MADDEN: We are not saying the use of that material is 100 percent safe. We are saying that demonstrated by this ASTM 084, there is some level of assurance there that the material was not arbitrarily purchased and placed on a control room wall for example, in the case that we are talking about; that there was some judgmental factor there made in the material selection.

We indicated by our guidelines that that would be acceptable to the Commission. If they can demonstrate that the material has a flame spread of 50 or less, we find that to be an acceptable material to be used in that configuration in that facility.

MR. MICHELSON: Is that just a one-eighth inch thick plywood, that's all your SRP allows.

MR. MADDEN: One-eighth inch thick.

MR. MICHELSON: It was that one-eighth inch?

MR. MADDEN: Yes.

MR. CATTON: I guess I still sort of have the question as to what does an NFPA designation of flame resistance mean, and is it adequate for nuclear power stations?

MR. MADDEN: NFPA is primarily utilized for the construction of fire protection systems. We use NFPA 251 which is the same thing as ASTM E-119 for barrier qualification or penetration seal qualification. As far as flame spread, we just go by what is presently acceptable by industry as far as Class I flame spread, Class 2, whatever, those designations.

They have ranges of flame spreads, zero to 25 is like Class 1.

MR. CATTON: Would it be possible for us to have somebody from NFPA describe how they run their --

MR. MADDEN: NFPA is a consensus standards, similar to ASTM.

MR. CATTON: Where could we get a detailed explanation about the adequacy of the NFPA consensus for use in nuclear power stations?

MR. MICHELSON: Why don't we do that in April?

MR. CATTON: We have shifted from -- at least in my conversation with Conrad -- you have shifted from worrying about the fire to separation and isolation. If that's the case, then suddenly some of these become much more important. Have you, indeed, isolated it and is this stuff as fire resistance as you think under the application?

MR. MADDEN: Wait a minute. We never said that the material is fire resistant, we are talking about the plywood. Let's go on into the presentation a little bit, and give you a little bit of background of what the program is.

MR. CATTON: Okay.

MR. MADDEN: I have never made an indication that paneling facing on a non-combustible or concrete wall is fire resistant. All I am saying is that it is not a contributor to a major contributor -- would be considered a major contributor to severe fire propagation in that room.

MR. MICHELSON: It would be to occupancy though, wouldn't it, or would it?

MR. MADDEN: Yes.

MR. MICHELSON: It was quite a bit in that particular case I had in mind.

MR. MADDEN: It could cause some occupancy problem.

MR. MICHELSON: Then it becomes the safety issue then, whether you could adequately abandon -- on paper, yes, you can abandon the control room. How many people have ever done it and how do we know how well it would really work. That's where the uncertainties come in, and that's where the probability assessed start dropping.

MR. WYLIE: How would you ever kindle such a fire if you get plywood burning?

MR. MICHELSON: That's where --

MR. MCCRACKEN: That's where the issue comes in and the judgment comes in. You put in a grade of product and in this case if it's one-eighth inch thick on a wall you have to understand what it is going to take to ignite it and how are you going to make it burn, and what are the people doing who are sitting around there this whole time. Are they just watching it?

MR. MICHELSON: Logic tells me why do you put it in there to begin with?

MR. CATTON: Separate --

MR. MICHELSON: A different issue.

MR. CATTON: That's right. Somehow I have decided what it will do. I want to understand how that decision was made.

MR. MICHELSON: Is there no smoking in the --

MR. CATTON: Somebody says that it is fire resistant, and that must mean something.

MR. MADDEN: No, it's fire retardant.

MR. CATTON: Fire retardant. Somebody has made a statement about this material that supposedly has some meaning that allows you to use it on that wall. I just want to understand what that process is.

MR. MICHELSON: It's under the --

MR. MADDEN: In the standard review plan there's a definition of what we call non-combustible.

MR. MICHELSON: This is non-combustible.

MR. CATTON: When you say non-combustible, again, you are referring to Underwriters Laboratory or something or other.

MR. MADDEN: I am referring to ASTM.

MR. CATTON: Or, ASTM.

MR. MADDEN: Right.

MR. CATTON: I just can't help but reflect on that graph that Ammons presented. There were things in one country that were considered absolutely inflammable that another country would rate very high because instead of holding it in one position when they did their test they held it in a different position.

If these tests have that much degree of freedom, then I worry about the use of them as a standard for an application in a nuclear power station. I understand this gets beyond where you are at. You are going to make --

MR. MCCRACKEN: No, it doesn't. You are getting exactly where I think I wanted to start out, which is the next slide that he is getting to.

MR. CATTON: Oh, I am just setting it up.

MR. MCCRACKEN: You do a fire hazards analysis.

We look specifically at what is in the nuclear power plants and the fire hazards in that area. If you took a one-eighth inch sheet of plywood and stuck it in the middle of a room where you had total access of air flow on both sides and it was near an ignition source, you could easily predict that you are going to get that to burn.

Like you talked about a cable fire that you saw in a videotape one time I think in a while back where somebody took a whole bunch of cables, spilled a pint of acetone on the bottom of them, lit them on fire and low and behold because it was in a nice chimney with little louvers on it, it burned in a hurry and created a lot of smoke. I would have been willing to run that test for $100,000.00 and prove to you that yes, it will burn.

I am not sure that represented exactly what would go in a control room.

MR. MICHELSON: Do they allow waste baskets in the control room?

MR. MADDEN: Yes.

MR. MICHELSON: And, is there a law that says waste baskets will never be next to the wall? The answer is no, or you can't assure yourself that. You aren't even counting waste basket fires in your fire probability study.

MR. MCCRACKEN: I agree, and that's why we said all utilities had to have a fire protection engineer.

Realistically, whether you are a fire protection engineer or not you know if you put a one-eighth inch piece of plywood up on that wall and it's solid concrete behind it and you put an ignition source on the bottom and start burning it, you can probably get it to burn.

I have little doubt you can get it to burn.

MR. MADDEN: That's the question. Probably or not.

MR. MCCRACKEN: The question is, it will burn. I know that I can put enough heat to the bottom of it that it can burn. How fast is it going to propagate and how fast am I going to put it out, that's the whole issue at nuclear power plants. You put something into a code to a standard, you then have your defense-in-depth approach which is what do you do in addition to just making sure they meet some codes and standards which are different depending on how you apply them.

There's the whole fire protection program. There's a whole hierarchy of things that you do to protect nuclear power plants. It doesn't just include making sure that it meets some code or standard when they come in, it has a lot of other things in it. I think that's part of what Pat is going through. He will go through that in detail on fire barrier testing and give you an idea where that fits into the whole program.

MR. MICHELSON: I guess for the ABWR I can put in a paneled control room and it will meet the standard review plan, as long as the paneling is chosen with this fire rating; is that right?

MR. MCCRACKEN: Yes.

MR. MICHELSON: Even though common sense would tell you that you ought not to do it, the standard review plan allows you to do it. It's only for aesthetics.

MR. MCCRACKEN: You and I would probably agree that I don't think it's a smart idea to put it in there. Do I think that there is a safety hazard with putting it in, no.

MR. MICHELSON: That's where we disagree then.

MR. QUINTIERE: I think you can't base it on common sense, because common sense requires that you have some database or some intuition. Really what we are saying here is that test methods are not adequate by themselves. If that's the case, then one would want to ask the question if I require material of 50 let's say in a tunnel test and I put that material on the walls or ceiling of some part of my nuclear reactor, what kind of fire condition will cause that material to propagate and become large, and how fast.

People are doing research. I am involved in this myself, to try to make some prediction of that based on some other kind of maybe more engineering oriented test data, not like tunnel test data. I think it behooves one to say that if one is going to use the criteria like that and realize that maybe the test is not going to screen out everything, you would at least want to know what size ignition source or under what condition, whether it be a waste basket in the corner of that facility or what, would lead to a large fire and how fast.

Then that would determine whether people in that control room or whatever could respond. Without that information, I think we are just going to be talking past each other forever.

MR. MCCRACKEN: I am not sure what context you are talking about in the need for that information.

MR. QUINTIERE: If one assumes --

MR. MCCRACKEN: Do you think that there's any way that I can put enough of a fuel source at the bottom of a one-eighth inch plywood panel on the side of a wall to make that plywood panel --

MR. QUINTIERE: Yes. It has happened time and time again.

MR. MCCRACKEN: The three people standing there are never going to suppress it. They are going to ignore it.

MR. QUINTIERE: It's a question of how rapidly -- no, they wouldn't ignore it. It's a question of how rapidly that fire would propagate, how fast the room would fill up with smoke, and how much time they have to go and get their suppression equipment, and would that be adequate. All of those times are needed because you have a developing fi. you have a room in which smoke is now filling up, and there's a visibility question. All those things come into play in all these scenarios that we are talking about.

MR. MCCRACKEN: That's correct. The judgment has been made for every power plant that we have licensed that it can be handled based on what they have in place now. You are saying you want to call into question all the codes and standards and how they are currently built and applied?

MR. QUINTIERE: No, I am saying that there is certain conventional wisdom that has to be applied, and there is some issues that cannot be perfectly calculated. Where you have questions of what is adequate or where time is involved and where response is involved, then it would seem to me that you need to have some benchmarks so that would at least give you the common sense that allows you to project and say this is safe enough.

There is some quantification that is needed to say that if I am going to allow this material with this rating, what size fire will cause it to propagate, what would be its consequences in that area, and would there be enough time for a response.

MR. MCCRACKEN: And, I am saying that judgment has already been made. The plants have been licensed. They have been licensed to meet the criteria that exists. They have been reviewed extensively in this area. I see nothing that would tell me to go back and re-review all the plants all over again to see if they are going to meet this.

MR. MICHELSON: How about the future plants? You say it's okay to go ahead and continue this practice for instance.

MR. MCCRACKEN: Yes.

MR. WYLIE: Most issues -- fire issues are based on some standard that exists, and that standard was developed with some testing associated with it. This particular one that you are talking about, I don't know whether it is or not, whether any testing has been done with plywood on concrete wall.

MR. MADDEN: ASTM 84 which is the Steiner tunnel test, what they try to do is propagate a flame on a horizontal surface.

MR. MICHELSON: Is that with the concrete behind it?

MR. MADDEN: That's with a non-combustible material on the back of it. It's not a --

MR. MICHELSON: This is non-combustible material itself, isn't it?

MR. WYLIE: The concrete wall is a big heat sink, and it's going to take a lot of heat.

MR. MICHELSON: I am just trying to figure out how they do a test, whether it's really a simulation or something else. Apparently, it's a simulation.

MR. MADDEN: A simulation of trying to propagate a flame on a surface.

MR. NOTLEY: You have focused in though on a one-eighth inch thick piece of fire retardant --

MR. CATTON: That's not the same as --

MR. NOTLEY: -- plywood.

MR. WYLIE: Is it fire retardant?

MR. MICHELSON: It is non-combustible, Charlie.

MR. MADDEN: It is defined as non-combustible by the ASTM 084 standard.

MR. NOTLEY: Anyway, you have focused in on that and you have ignored I think -- I haven't heard it this morning, about all of the other combustibles that are in a control room at a nuclear power plant.

MR. WYLIE: Such as the carpet on the floor.

MR. NOTLEY: I am not even thinking of that, I am thinking of the large -- what do you call those things that drawings hang in?

MR. MADDEN: Hanging file.

MR. NOTLEY: The hanging files that are much more likely to burn and burn quickly. They are hanging loose. There is good air circulation around them. Here we are spending this kind of time on the wall surfacing. I don't think it's smart to put it in.

MR. MICHELSON: Why do you allow it? What is the benefit versus what is the cost? Clearly it's cheaper not to put it in. They painted the rest of the walls.

MR. WYLIE: What is the basis to prevent it?

MR. MICHELSON: It's not a matter of whether it's smart.

MR. WYLIE: If we do that, we throw out all the regulations.

MR. MICHELSON: No. That's common sense --

MR. MCCRACKEN: You regulate by common sense.

MR. CATTON: We have somebody here who wants to help us. It's Ajit Gwal, from the Defense Nuclear Facility Safety Board. You would like to contribute to our discussion?

MR. GWAL: I will say a few words. I was involved in the power plant design of that. The plywood board that we are talking about I am not familiar with that, but I think control room has typically these things there, you know. More than plywood, they have a lot of cables in there too.

The NRC design allows that when you have -- they assume that there's a fire in control room. Based on that what they have is, as a part of the fire protection design they go zone by zone. In this zone I have a fire. You assume that you lost everything there, you know.

Interesting things came up with water, smoke and all of that of what happened to that in these areas. Similarly in control room area you assume that there is a fire and the loss of control room. Then you have the remote shutdown panel. What control room operator do, suppose the fire is out of control. Then they have a disconnect switch out of the control room that disconnects all the electrical connections which are going through the control room and he goes to the remote shutdown panel and safely shuts down the plant.

It looks like to me a moot point.

MR. MICHELSON: You haven't correctly defined what provisions are made for going to the remote shutdown panel. Many plants, you must go to a large number of panels throughout the plant and make your disconnect. You don't walk up to a switch and pull it and that's it.

MR. GWAL: I understand, yes.

MR. MICHELSON: The concern is that you don't want to abandon the control room for any reason, although we have made provisions to do it anyway. You don't want such trivial reasons as a combustible material burning in the control room to force you out of the control room. You eliminate them insofar as possible.

MR. GWAL: The way NRC has allowed the plants is that if there is a fire which cannot be controlled in the control room, you evacuate that room. The design is such that outside the control room you have the disconnect switch panels which have not one or two but at least hundreds of signals there which are disconnected so that you don't have spurious operation.

They go out of the control room, they go to the remote shutdown panel. From there, they can fully safe shutdown the plant. That's why the assumption was that when there is a fire in control room you evacuate that -- you cannot control it, so you evacuate it.

MR. CATTON: Somehow we got off the track. What I am interested in is the adequacy of the sort of standard industry codes that you use. The reason that I am interested in it is because for my house there is a requirement for the doors. The fact that that standard is the same one that is used in the nuclear power station just doesn't cease to amaze me. I can go out a window. My house can burn down and my insurance will pay for it. It is an aggravation, but the consequences are relatively low.

Now you take that same standard and you bring it into a nuclear power station where the consequences may be high, and it seems to me there is an inconsistency.

MR. MADDEN: That's where you --

MR. CATTON: Then I compound that with the observation made by Ammons about how sensitive the conclusion is with respect to fire resistance, flammability or whatever other category you want to put to how the test was conducted. I am just a little concerned about that whole package.

MR. MADDEN: Let's --

MR. CATTON: What I have heard is what you do is, you supplement this standard that may not be what it should be by as Conrad says, common sense and a fire protection engineer. I would like to see that tightened up. I think that my own personal view is that because the consequence is much different the standards should be different.

MR. MADDEN: I am not disagreeing with anything that you are saying.

MR. CATTON: It could be that these standards are adequate, but I think they deserve to be looked at in light of the different consequences.

MR. MICHELSON: That is why we have been discussing the particular one-eighth inch plywood. It's a non-problem otherwise.

MR. CATTON: That's why --

MR. MICHELSON: It is an example of where we are not really looking at where we are putting the equipment.

MR. MCCRACKEN: I think we need to let Pat get on, because we are way behind schedule.

MR. CATTON: I do too, or we are not going to hear about Brunswick.

MR. MCCRACKEN: Let me focus on where we are. I really don't think we are having much disagreement. We know that some of the NFPA codes and standards are not perfect, we are well aware of that, which is why we focus on exactly where he was trying to go in the next slide which is all the other things that you do. You don't just rely on a code or a standard, you rely on a lot of other things to ensure yourself that you have protected the safe shutdown capabilities in nuclear power plants.

MR. CATTON: But in other areas the nuclear power plants -- there has been another standard developed that maybe is a little bit more meaningful. Why shouldn't this be done in the fire area as well?

MR. MCCRACKEN: I believe that the codes and standards we are using in the fire area right now are adequate in conjunction with all the other measures that we have taken at nuclear power plants. If you are talking about a standard on piping for a nuclear power plant you are relying on that pipe for everything. It has to do the whole thing. It either works or it doesn't work.

MR. CATTON: That's true.

MR. MCCRACKEN: So, there is a certain standard that you do for a nuclear power plant. In the area of fire protection we have used the industry standards. They provide us some level of assurance about the basic construction materials and things that are used. We then have other things that we use based on fire hazards analysis to tell us where we need to focus additional attention.

MR. CATTON: But your fire hazards analysis is going to take that standard at face value.

MR. WYLIE: Not necessarily.

MR. MCCRACKEN: No.

MR. CATTON: I mean, do you actually go out and do a test, your own test?

MR. WYLIE: They challenge it.

MR. MICHELSON: The three hour barrier is a good example.

MR. CATTON: I was going to get to that.

MR. MCCRACKEN: We don't assume a three hour barrier is three hours. Three hours is an irrelevant number. It doesn't mean anything. It needs to be a good enough barrier to prevent the fire from spreading to the other side. It doesn't make any difference whether it's three minutes or three days, it needs to do its job.

If based on the fire hazards in the area, that barrier is going to prevent fire from spreading across it. It is what it needs to be. How long it lasts, the three hours is simply an arbitrary number.

MR. CATTON: But you see, the three hour barrier is the basis for the PRA which is the basis of cost benefit.

MR. MICHELSON: Did they show they could mitigate in less than three hours?

MR. CATTON: If you have a three hour barrier, that three hours is stuck into the timing associated with the process.

MR. MCCRACKEN: The three hours is only stuck into the timing in association with its spreading.

MR. CATTON: That's right.

MR. MCCRACKEN: If you put in a 24 hour barrier that you had absolute assurances you couldn't spread a fire through it. That would give you a different number.

MR. CATTON: But the --

MR. MCCRACKEN: You evaluate every fire barrier based on the fire hazards in that area.

MR. CATTON: I think what --

MR. MICHELSON: I haven't seen that being done, but maybe you can point out where it is. I have read a fair number of fire hazard analysis and never found the evaluation of how long they think the barrier would last. They usually say we think the fire will last an hour and one-half and this is a three hour barrier and that's it. They have never analyzed whether the barrier would even last an hour and one-half for the particular event going on in the room.

I haven't found that in these analyses, but maybe you can tell me.

MR. CATTON: Hopefully we will put GE's feet to the fire.

MR. MICHELSON: We will ask the ABWR to show us such analyses, sure.

MR. MCCRACKEN: I think we need to let Pat get going on this.

MR. CATTON: I agree.

MR. MADDEN: We are going to focus in on the defense-in-depth approach used in the nuclear plant fire protection programs -- the use of the defense-in-depth. The first portion of that approach is preventing fires from starting. I will talk a little bit about administrative controls, and we rely heavily on licensees to implement administrative controls to prevent fires from starting.

The second is detecting those fires quickly, and suppressing and extinguish them quickly to limit damage. The third portion of the approach is actually designing a plant safety system regardless of what we have done in those first two approaches that, if everything goes awry a fire will not prevent safe shutdown of the plant.

[Slide.]

MR. QUINTIERE: Item three means that detection doesn't work, suppression doesn't work, and now you have a fire and that's a big fire.

MR. MADDEN: It means that you have a big fire, exactly. Suppression maybe does not control the fire. The detection system may be failed, and now we have a fire that is free burning within a compartment and nothing is basically being done about it except residual implications. You may have someone notice the fire for example and maybe the fire brigade may be taking activities to preclude its spread in that compartment.

We accomplish this defense-in-depth approach by requiring the nuclear power industry to implement a fire protection program. That fire protection program has to satisfy the guidelines presented in the standard review plan.

MR. MICHELSON: Let me ask on defense-in-depth. I agree with your three items here except I think there is a fourth situation. That is where you detected the fire all right and you started mitigating it all right. The fact is that you got it out, but in the meantime you put so much water on the floor and it got in several places that you haven't even thought of.

Your defense-in-depth ought to assure that you have thought of where all the mitigants will go and what consequences they ultimately have. That thought generally doesn't get factored in here. Even your item three it's not stated. You are talking about the effect of the fire, and I am saying the fire had a small effect but the mitigants had a big effect.

MR. MADDEN: There is some guidance in the standard review plan on drainage and on water control run off.

MR. MICHELSON: There is on that but not on the environmental confinement. That's why we found these drains don't work because the floors have open penetrations in them for non-safety related equipment.

MR. CATTON: Sometimes some electrical guy comes in and installs a box with some outlets in it that is two or three inches off the floor. That conduit is not protected, and the water could run right down through the conduit.

MR. MADDEN: These are all --

MR. CATTON: I walked into one of these things.

MR. MADDEN: I have also been in power facilities where all the equipment is up on pedestals and the pedestals by six inches high around penetration seals. In their plant design criteria all conduit ends are supposed to be sealed, so that water propagation in the conduit is not --

MR. MICHELSON: An event recently occurred at a plant wherein all those rules were in effect and all that was done, except all to them meant all safety-related equipment had to be on pedestals. Non-safety didn't. Non-safety didn't have to be sealed. As a result, water on the floor from washing the floor went into the non-safety equipment and ran right down to the conduit and got into the safety related equipment below.

You have to make sure all means all safety and non-safety equipment in order for that approach to work. They don't mean that. They mean all safety-related equipment is on pedestals.

MR. CATTON: But Carl, if the word isolation is taken literally then the non-safety equipment in this fire area, you have to somehow seal it off too.

MR. MICHELSON: All my point is, you have to look at more than the fire. You have to look at the effects of mitigating the fire and make sure you have environmentally confined those effects.

MR. WYLIE: The question is, do you look at that kind of thing?

MR. MADDEN: As far as water drainage?

MR. WYLIE: Yes.

MR. MADDEN: The licensees are requested to look at how --

MR. WYLIE: No, I mean does the staff review that?

MR. MADDEN: The staff basically reviews the approach that the licensee is going to take with regard to drainage. If they do a drainage analysis for each given area and they say that the water will end up in the reactor building sump for example, they will dictate to us exactly how the water will get down there. If they indicate to us that all conduits will be sealed and all penetration seals will be water tight from floor to floor, we pretty much accept what they indicate to us.

We allow enforcement to go out there and take a look at it to see if actually they have designed and installed waterproof penetration seals, for example.

MR. WYLIE: Do they do that?

MR. MADDEN: Yes, they do that.

MR. MICHELSON: Clearly, at least in this one case, they missed it. In fact, I can give you about 30 cases where they have missed it in this country in the last three years.

MR. MADDEN: I am not going --

MR. MICHELSON: They are all in the LER's, just read the LER's.

MR. MCCRACKEN: Which I think supports the fact that we should be out there inspecting the power plant --

MR. WYLIE: The intent is that it be covered, right?

MR. MICHELSON: That's not clear. Where is that clear in the regulations, that they must look at the environmental confinement of each of these rooms from the viewpoint of release of mitigants? I can't find those words anywhere.

MR. MADDEN: The only --

MR. MICHELSON: The closest I can find is the inadvertant actuation, where you do talk about the effect on something, function or capability, I don't know which.

MR. MADDEN: As I go through my presentation I will point out to you that there is some ventilation aspects of the standard review plan where we talk about some forms of smoke control. Permanent as they may be in your sense of the word, but we do address some form of smoke control. We also address drainage in the standard review plan.

MR. MICHELSON: The requirement that the drain capacity be of a certain amount, mainly equal to twice the mitigating rate or something like that, yes. But you make no mention of having a water tight floor. Maybe you do, and maybe you can point that out to me.

[Slide.]

MR. MADDEN: Going back to the presentation, I am just pointing out in this slide some of the specific NFPA codes that we look at or standards that we look at under the topic of one which I call preventing fires from starting. It's kind of classified in the defense-in-depth approach, vis-a-vis some of the standards that we utilize in that specific area. They are pretty self-explanatory, and I am not going to go into detail.

[Slide.]

Under the topic of detecting, suppressing and distinguishing fires quickly, rely on NFPA again for design and installation of for example detection systems which specifically use NFPA 72-D and 72-E.

Under fire suppression systems, depending if it's a gaseous system or water system or a foam system, we use whatever applicable standard regulating the design and application of those systems.

[Slide.]

We will go on. Fire suppression activities under defense-in-depth approach, we also -- suppression systems go on dealing with suction valves, underground pipe, outside protection, centrifugal fire pumps and even the fire tanks themselves, the water tanks themselves. We also invoke some minimal standards of the NFPA with regard to the fire brigade. We what them to use a structure organization which they can interface with an off-site agency if that becomes a part of the emergency. We also want them to have sufficient training program which will give their brigade members actual hands-on fire attack training, where they are actually put in the situations where they have full room involvement for example, and have to extinguish the fire.

The training is very similar to what a new recruit would go through on a municipal fire department.

MR. CATTON: At a nuclear power station is everybody required to undergo training for fire fighting?

MR. MADDEN: Some form of fire protection training is required by every employee at a nuclear power station.

MR. CATTON: I was just interested, because my son went to work as an engineer at a refinery and his first day on the job was a day of fire fighting. That was day one, before he could be assigned an office of whatever, he had to go through the fire fighting training.

MR. MADDEN: During day one orientation, depending on what type of person you are -- let's say you are just a maintenance type of person -- you will go through probably some type of training which regards if you see a fire what you are supposed to do as far as detecting the fire, in notification, who you are supposed to notify, as far as description, what you are supposed to give, where you are supposed to be.

At some future time they even give a hands-on extinguisher training. If it's within your capability or you think it's within your capability based on the training that you have received, they will go ahead -- first they want you to report the fire and then they want you to, if you possibly can, suppress that fire with an extinguisher. Yes, that is done at a nuclear power facility.

A series of standards that we use -- and I call this combustion propagation control -- it is primarily dealing with the installation of known devices which have passed some form of fire test similar to ASTM 119 or are listed by UL and FM as a fire resistive device in their directory, or as being approved by Factory Mutual for use in their industrial insured facilities.

We go ahead and use these standards primarily for the installation of these devices.

MR. CATTON: NFPA 80 is where I would define a fire barrier?

MR. MADDEN: No. NFPA 80 only regulates the installation and design of fire doors.

MR. CATTON: What is a fire door?

MR. MADDEN: Well, a fire door is a steel door primarily -- maybe one of these doors would be -- which has been subjected to a fire test either at Underwriters Laboratory or Factory Mutual. It defines in NFPA 80 the test that is done. It is very similar to ASTM E-119. We will talk about that later on in the presentation.

MR. CATTON: Okay.

MR. MADDEN: It must maintain its continuity for "x" temperature at "x" time in a furnace.

MR. CATTON: If I read NFPA 80 and ASTM E-119, I would understand how you decide whether it is one hour, two hour or whatever.

MR. MADDEN: Yes, sir.

MR. MICHELSON: In 80, I assume that's where they tell you so much of a gap is allowable under the door when you put it in?

MR. MADDEN: Yes.

MR. MICHELSON: How much of a gap is allowable, or is it a varying number in a three hour door?

MR. MADDEN: One-quarter inch.

MR. MICHELSON: I had heard numbers much bigger than that, but I never heard anybody tell me --

MR. MADDEN: It depends on if it has a --

MR. MICHELSON: -- Tell me that with authority.

MR. MADDEN: It depends if it has a sill on it, it depends on the --

MR. MICHELSON: Is the sill required?

MR. MADDEN: No.

MR. MICHELSON: If it doesn't have a sill on it, you are saying the gap might be smaller than if it does have a sill? I will read the book.

MR. CATTON: You are going to --

MR. MICHELSON: You are going to get us a copy of 80?

MR. MADDEN: I believe that I have sent a copy of NFPA 80 over to the staff -- over to the ACRS quite some time ago.

MR. CATTON: You probably have, and it's not your fault if I don't have it.

MR. MADDEN: I also just recently sent Mr. Michelson a copy of --

MR. MICHELSON: I think I have gotten a copy of some of that already.

MR. MADDEN: I sent you a copy of ASTM E-119 because you requested that.

MR. MICHELSON: I probably have it somewhere too.

MR. MADDEN: Now I know what the licensee feels like.

[Laughter.]

MR. QUINTIERE: Before you leave that, I have a question on that. Could we go back to the previous slide?

MR. MADDEN: Sure.

MR. CATTON: You did send a copy, August 21st.

MR. MICHELSON: I think I have seen it, but I didn't pay much attention to it.

MR. CATTON: We didn't get this E-119.

MR. MADDEN: Just a couple of weeks ago I sent it through over to Mr. Michelson.

MR. MICHELSON: I haven't gotten it yet, but it takes some time. I would have grabbed it, for sure.

MR. MADDEN: If you need another copy, let me know.

MR. QUINTIERE: What I am trying to reconcile is that there was a statement earlier that said evolutionary plants are required to demonstrate safe shutdown without repair, assuming total loss of any fire area and in parenthesis, three hour barriers.

I assume this is the philosophy that you are talking about here, if the detection and the suppression system fails then. These standards are essentially -- if they are in practice and implemented properly the are going to minimize the impact of a fire in one of these three hour spaces.

But what I see as lacking is looking at the consequences of such a fire in a space, given that suppression doesn't work. Or, even if suppression does come on and the fire is like a hidden fire, a fire in a cabinet or in a cable tray that is enclosed so that the water really doesn't get to the fire and the fire continues because it's shielded -- if I look at such a situation in a closed space with some door gaps underneath these doors -- presumably these are not sealed spaces -- then when I release heat in that space, assuming that everything stays closed, the pressure will rise and out of all these gaps, little vents, smoke will --

MR. MADDEN: Effect of cooling from the sprinklers --you made mention that the room was in a sprinkler room and you had a cabinet burning. The sprinkler is actuated around it, hey, something is going to -- water has to cool the atmosphere. Pressure is --

MR. QUINTIERE: What I am saying is that there are two possible scenarios. One is that the water comes on and you have a hidden fire so there's still some heat release. Given that, there is going to be some -- even if the water is evaporating now you have a mass source in this room. As a consequence, the pressure will go up and push products out so that products will go out.

If none of this works, in other words you are going to your last bullet -- protection doesn't work so well, suppression doesn't work and now you have the fire and these are supposed to contain it, these don't per se address what is going to happen to the products. I just wanted to sort of explore that scenario with you and say that given a fire in a space the pressure will rise, and even though the thing is still closed products will flow out.

Surely, the fire is going to be detected by somebody if the automatic detection didn't work. Someone is going to investigate that fire and likely open that door.

MR. MADDEN: Let's go to the stages.

MR. QUINTIERE: I just wanted to play out this scenario --

MR. MADDEN: I understand.

MR. QUINTIERE: Now you have a ventilation source.

MR. MADDEN: I understand the scenario that you are trying to --

MR. MICHELSON: I would like to hear the rest of the answer.

MR. QUINTIERE: Now you have a ventilation source and now you have more chance of having your fire become large, because ultimately the fire in that enclosure has to be controlled by the ventilation source if there's is enough fuel there.

If you, in your analysis can demonstrate that there's not enough fuel there to burn, then you put a limit on that fire. Then you say if that material burns at the rate of which those kinds of materials burn, you will get a temperature. You will get a smoke condition. You will be able to estimate some consequence to the surroundings. That may be minimal in many cases.

But given that, you now have something quantitative to rest on.

MR. MADDEN: Let's go further in the presentation. There is a section that I talk about isolation of -- fire area isolation. I went through an looked at about ten facilities and did some quick back of the envelope fuel load calculations and came up with some average combustibles per square foot figures or pound per square foot of combustible.

If you take the old ASTM standard time temperature curve and the correlation that was done by NBS, right or wrong, in 1976 that's about all we had. If you take those correlations you are going to find that our fire barriers, just looking at -- I call them apples to apples -- are so grossly conservatively designed, you are going to wonder why we derived the three hours.

MR. CATTON: Wait a minute. He is not talking about failure of the fire barrier.

MR. QUINTIERE: That's a heat stress to the barrier, and that analysis was based on how wood cribs burn so the fuel loads are sort of related back to wood. Given a certain amount of fuel in this room if we say it burns like wood cribs, then we can calculate how long it's going to burn and that can be related, if the time temperature curve is the same, to a heat failure to the structure or to one of these doors.

What we are really talking about is that there is going to be some propagation of hot gases either out of these cracks or eventually someone opening up a door, and that is going to be a factor that impacts the surrounding. It may be that in many cases because the fuel load is low and maybe things don't burn so well or at a high enough rate, that there is a non-hazard. But some other kind of calculation is needed. Those kind of estimates can be made or tests can be made to demonstrate the reliability of such calculations, and you all would have something more firm to hang your hat on.

MR. MADDEN: I'm not going to disagree with that, but at this time based on this, this is my personal look at quite a few nuclear power plants in this country in trying to assess the significant hazards compared to other industries in the nuclear power plants.

My professional opinion is that what we have here is probably adequate with regard to protecting safe shutdown capability of the facility. Knowing the training and the administrative controls that are associated with power plant operators and the dedication that those people have that is safe operation of those facilities, I believe that this defense-in-depth approach is adequate for current licensed power plants.

MR. MICHELSON: When doing a --

MR. CATTON: But it has to be better than the industry because the consequences -- some sort of an industry average across the country -- it has to be much better because the consequence is much higher.

MR. MADDEN: Right now, if I compared our industry to the petrochemical industry pound for pound we have more fire protection in the nuclear power plant than they have in an oil refinery.

MR. CATTON: Well, I'm not sure about that.

MR. MADDEN: I am.

MR. CATTON: I will know soon.

MR. MICHELSON: In doing a fire hazards analysis, do you require that first of all you have to show that you can wipe the equipment in a particular area and still safety shut down. In doing that analysis to make that determination, do you also require that they determine that the mitigating equipment within that its ability to operate and function is not affected by the fire in that area?

MR. MADDEN: It has to be in another fire area.

MR. MICHELSON: In other words, they do analysis to make sure that the power for the pumps that are providing the water does not route through the area where the fire is postulated?

MR. MADDEN: Absolutely.

MR. MICHELSON: Is that spelled out as a requirement somewhere, or is that just a given or a known or something or a lot of good sense?

MR. MADDEN: Like fire pumps you mean?

MR. MICHELSON: For whatever. In their detection has the same problem, automatic actuation, all these things must be independent of the fire they are trying to mitigate. Is that spelled out, and can you tell me where -- which provision to look at? That's a part of the fire hazards analysis they must look at these things.

MR. NOTLEY: That's spelled out very clearly in III C.

MR. MICHELSON: What's III G?

MR. NOTLEY: III G of Appendix R.

MR. MADDEN: Are we talking just primarily fire suppression --

MR. MICHELSON: Hopefully it's spelled out in 9.5.1, because for new plants Appendix R doesn't pertain.

MR. NOTLEY: As I said, 9.5.1 was revised after --

MR. MICHELSON: It should be in 9.5.1 is what I am saying. What part of 9.5.1 do I read.

MR. NOTLEY: I don't have the numbers.

MR. MADDEN: We will pass it in this presentation.

MR. MICHELSON: I was just trying to make sure that clearly it is logically required.

[Slide.]

MR. MADDEN: I am going to try to give you a major overview of the SRP and what is required by the standard review plan. Specifically, one of the major things that is required by the SRP is a utility -- their upper management has to be involved in a fire protection program. They have to devote resources and develop the program through administrative controls and manage that program.

First of all, fire protection program is established by the licensee. And then, we review the licensee's program to meet our guidelines. The program, it states the program policies regarding the level of fire protection for structure systems, components important to safety. It's a basic policy statement that the licensee management commits to the NRC that they will develop a program to protect safety-related portions of the plant.

The program also establishes the organizational responsibilities for the formulation, implementation and the ongoing assessment of the fire protection program. We tried to make the licensee kind of police their problems and correct their problems themselves. That is through a spinoff of the QA program.

The fire protection program also establishes and defines the procedures, equipment and personnel required for program implementation. We look at the licensee staff and make sure it is adequately manned in order to get an adequate level of fire protection at that facility.

The standard review plan requires a fire hazard analysis to be done. It is performed for each plant by the licensee. It demonstrates a plant's ability to perform required shutdown functions and minimize radioactive release in the event of a fire. The fire hazard analysis must consider transient combustibles and the consequences of a fire on the ability to safely shut down. It defines the measures taken for fire prevention, fire confinement, detection and suppression and safe shutdown capability and the availability of safe shutdown capability for each fire area.

Any deviations to the standard review plan are discussed specifically in the fire hazard analysis. If they are approved by the staff, they would be identified in a safety evaluation report.

MR. MICHELSON: I looked at III G. They address throughout -- and correct me if I am wrong -- they only address the safe shutdown equipment. If somewhere you have defined safe shutdown equipment to include the equipment required to mitigate the fire in that zone then I would agree. Has that been -- somewhere is that identified as safe shutdown equipment?

MR. MADDEN: We kind of misunderstood your question. Let me see if I can explain to you with regard to let's say suppression systems.

MR. MICHELSON: Right.

MR. MADDEN: Let's take the fire pumps for example. You could very well have the power cables for the -- I don't know why -- you could have them going through a fire area in the reactor building or auxiliary building that is impacted.

MR. MICHELSON: The why is very simple. Electrical boards are where the power comes from, and those are potential fire sources.

MR. MADDEN: It starts usually with the pumps out in the pump house somewhere and the power feed is independent of the reactor building generally speaking for a fire pump. But even if that did occur --

MR. MICHELSON: It has to --

MR. MADDEN: Even if that did occur the pump motor failed, we like to see a diesel fire pump as a backup. The diesel, based on loss of pressure in the system would start and power up and provide fire suppression --

MR. MICHELSON: Do you require diesel backup, or do you allow electrical backup?

MR. MADDEN: We allow backup if they have two independent and separated power sources.

MR. MICHELSON: Where is that spelled out?

MR. MADDEN: I think it's in that SRP.

MR. MICHELSON: I didn't find it in there, but I will read it again.

MR. MADDEN: Under the --

MR. CATTON: We have a logistics problem. It has been pointed out to me that the remaining viewgraphs for this part of your talk is still pretty thick, at least the copies are a quarter of an inch.

MR. MADDEN: Right.

MR. CATTON: I am very interested in fire area isolation, so I really wouldn't want it impacted. I have two colleagues here and a consultant who may have other ideas. We need to do something.

MR. MADDEN: What I would suggest is, we did put together a little comparison of our guidelines versus other country guidelines.

MR. CATTON: Yes.

MR. MADDEN: I would like to show you some excerpts out of those things and go through those slides.

MR. CATTON: Okay, good.

MR. MADDEN: The rest of the stuff in the package as far as the SRP overview, you can get an idea of what the program is all about.

MR. MCCRACKEN: Before we pass that, I would urge that each of you do go through the remainder of those viewgraphs. If you have a question give a call. A lot of this is the whole basis of saying we are satisfied, and there are things in here that I think you need to see and be aware of.

MR. CATTON: What would you suggest we do with respect to the time remaining for Pat? It looks to me like it's a little over an hour and one-half including this afternoon.

MR. MCCRACKEN: I am not sure what your schedule shows on starting with the --

MR. CATTON: The schedule shows Brunswick starting at 2:15.

MR. MCCRACKEN: That's the PRA part of it.

MR. CATTON: Right.

MR. MCCRACKEN: So, he has until 2:15.

MR. CATTON: Right, and he's got the fire isolation part of his talk.

MR. MCCRACKEN: I am not suggesting that he go through them, I am just saying that there is a lot of information and I am suggesting that to at least go through it and don't pass through it so that you understand. This gives you a real quick summary of what the SRP does, all the things that we review. I think based on past meetings and that, there are some areas that we review that the Committee really isn't aware that we actually review. I would like you to have gone through that and be aware of that.

MR. CATTON: Is that okay by the rest of you?

MR. MICHELSON: Just for clarification when I came across -- I have heard differing opinions from you people. Are you still allowing the 20 foot physical separation to separate trains?

MR. MADDEN: For which type of facilities, new ones?

MR. MICHELSON: New plants only.

MR. MADDEN: No.

MR. MCCRACKEN: Before you say new plants, evolutionary plants no. Passive plants, no. All advanced reactors, no. If you are talking about Watts Barr, if you are talking about --

MR. MICHELSON: No, I am -- that is a change from the SRP then?

MR. MCCRACKEN: That is a clear change from the SRP and that was one that we went to the Commission on in 90-016.

MR. MICHELSON: Okay.

MR. CATTON: Where is that viewgraph in our package?

MR. MADDEN: It should be a separate package given to you -- I didn't have these until late last night, so they didn't get factored into my package.

MR. MICHELSON: One further question on new plants while you are looking for that. Are you allowing one hour fire barriers for safe shutdown equipment in new plants?

MR. MADDEN: No.

MR. MCCRACKEN: No, three hours.

MR. MICHELSON: Three hours, okay.

MR. MCCRACKEN: In fact, that was an earlier Committee comment that we implemented. So, we do listen.

MR. MADDEN: It is kind of cumbersome. I asked a contractor, SAIC which Tom Storey and Lynn Conner are back there from SAIC which can give me some support as we go through this package. You had a request that we look at other facilities and their guidelines and compare them to our guidelines. We tried to do that. It was a little hard and cumbersome. We did do correlation between some specific items like safe shutdown capability. I will go through each one of those and we will just take them from there.

MR. CATTON: I guess our particular interest is the British, because of their --

MR. MADDEN: The British have a very unique set of guidelines, and I am not --

MR. CATTON: That's true.

MR. MADDEN: All I can say is that I think that you are reading a little bit more into the British guidelines than the British guidelines really are. We will go into it.

MR. MICHELSON: I think we were looking at Sizewell B specifically.

MR. MADDEN: Yes, I know.

MR. MICHELSON: And it's not hypothetical, it's real.

MR. CATTON: Something of the isolated regions --

MR. MADDEN: I know it's not hypothetical, but I will show you that the British kind of focus in on IAEA guidelines and leave a lot of flexibility up to how individual plants handle their fire problems to an individual plant basis. They don't really specifically have any proscriptive or detailed guidelines like the United States does other than IAEA.

[Slide.]

What we kind of captured -- some fire protection requirements from Canada and Japan, Germany, Japan, USSR and the UK -- I have a lot of good experience with the USSR and I don't think you all want to hear about that.

MR. CATTON: They have had some rather interesting fires.

MR. MADDEN: Yes, and they still have a very interesting fire protection program.

MR. CATTON: In fact, it's a brigade is nationwide and run by a General.

MR. MADDEN: The General will be over here in March, if you want to meet him.

MR. CATTON: I have met him.

[Slide.]

MR. MADDEN: This is an overview of the fire protection requirements for nuclear power plants in the selected countries that I talked about. Basically, our regulatory requirements as we stated before was GDC 3 for existing plants. It's Appendix R, of course, has to be implemented in G, J and O. This gives you a list of the various regulatory documents that we took a look at.

Some interesting things on here is that ours are mandatory IAEA. It depends on the country if they adopt them or not. Canada has some portions of the guidelines mandatory. Japan is specifically all guidelines. France, yes, but a lot of alternatives are permitted. USSR, yes, their guidelines are mandatory. UK, their unique qualifying statement is as far as reasonably practical.

MR. WYLIE: You didn't address Germany.

MR. MADDEN: Germany is kind of a whole -- I am not too well at speaking German here. Germany, we don't have too much information on.

MR. CATTON: I have a copy of some of this in English, if you want it, of the German one.

MR. MADDEN: Yes, if you could.

MR. MICHELSON: Their physical separation is quite hard. Could we get a copy of the IAEA guidelines? I don't recall seeing those either. Apparently, many countries use them.

MR. MADDEN: We can get you a copy of those.

MR. CATTON: I have KT 2101.1 for you here.

MR. MADDEN: I appreciate it.

MR. MICHELSON: In English?

MR. CATTON: In English.

MR. MADDEN: We do have a copy of all of those. The only one that hasn't been translated is the Japanese.

MR. CATTON: I will give it to Tom, and he will see that it is sent to the right people.

MR. MADDEN: We appreciate it.

[Slide.]

From this information most agreed in a direct, one to one correlation. We looked at the fire barriers. The U.S. requires three hours -- uniqueness, unless the fire hazard analysis can justify lowering the rating. IAEA requires a minimum one hour rating unless fire hazard analysis demonstrates a need for a greater rating. Canada, minimum one hour, determined by fire hazard analysis. Japanese, we couldn't obtain the information. Germany, their Class F 90 one and one-half hour fire rated bulk heads -- I am assuming that is very similar to -- I don't know if that's a pressure type door or whatever on there.

MR. CATTON: It depends how they do their test. It may even be better than the U.S. three hour.

MR. CATTON: USSR, one and one-half hour. I take this all into consideration. I was at the USSR and visited VVER 1000 design. The one and one-half hour door is nothing more than a piece of steel, about one-quarter of an inch thick with a spring closure on it and no latching mechanism. To say, the fire doors were not very well controlled. UK, no specific requirement. They refer to IAEA for guidance.

[Slide.]

Guidance requirements for suppression detection, the O stipulates where detection is required and the X stipulates where suppression is required. If you take a look at this thing, control room in the U.S. for example, we require detection, we require some form of suppression capability, but we give -- if they implement Appendix R in an order generation type of plant we would allow them to comply with III L. That would require an exemption from the automatic suppression required by our regulations in the control room.

MR. MICHELSON: Does X mean automatic or manual or what?

MR. MADDEN: Tom, can you help me out a little bit on that?

MR. MICHELSON: The suppression is required throughout the building, isn't it, at least with a hose.

MR. MADDEN: I think it's more -- Tom Storey from

SAIC will help me out on this.

MR. STOREY: Tom Storey. Generally, the X is automatic suppression. We are comparing different guidelines from different countries, so there's not necessarily a one to one correspondence. As far as the U.S. guidelines go on the X, we are talking about automatic suppression.

MR. MICHELSON: I didn't think you automatic --

MR. WYLIE: I didn't think so either.

MR. STOREY: In the United States the Appendix R III L would -- the control room would be an alternate shutdown area, so you would have remote shutdown outside the area. Appendix R which is carried over into the new BTP, states that even for alternate shutdown areas you should have automatic suppression within that area. However, --

MR. MICHELSON: I was asking about the control room.

MR. STOREY: Right. However, the control room for most cases in the United States, there has been allowances of continuous manned location, there is manual extinguishment capabilities that there has been exemptions granted for not having automatic suppression.

MR. MICHELSON: Did you come across any control rooms with automatic fire protection in the control room -- under the floor now --

MR. STOREY: There are three control rooms that I am aware of that have automatic suppression.

MR. MICHELSON: What kind?

MR. STOREY: Halon.

MR. MICHELSON: In the control room where the people are?

MR. STOREY: Right.

MR. MICHELSON: Halon in the whole room?

MR. STOREY: Right.

MR. MICHELSON: Which plants are they?

MR. STOREY: The Millstone III, Adam Neck -- the automatic suppression was put in those control rooms to address other safe shutdown concerns that don't exist in the remaining plants.

MR. MICHELSON: I knew they were in a floor of a number of plants but I never heard they were in the people occupied spaces.

MR. STOREY: Right. Those specific control rooms have automatic suppression. That's --

MR. MICHELSON: Is there a halon detector in there or something then, or do you think they can smell it fast enough before they are asphyxiated by it, or what?

MR. MADDEN: It's a low percentage, probably five percent.

MR. MICHELSON: You mean, they put some kind of --

yes, five percent. If it's uniformly distributed, five percent you might be all right.

MR. MADDEN: Right.

MR. STOREY: I think the point that you want to get out of this slide is that of all the countries that we looked at, the U.S. is the most prescriptive about requiring suppression and detection throughout the facility, where the other countries allow you based on analysis to not have detection and suppression.

MR. MICHELSON: But to have good analysis which, in the case of Sizewell B, they have done what appears to be a very good analysis of the situation and ended up with a whole lot of detection.

MR. WYLIE: In the case of Germany you have generally four rigid separated trains.

MR. MICHELSON: Yes.

MR. WYLIE: So, you don't need a lot of --

MR. MICHELSON: They still have detection in those compartments.

MR. WYLIE: Yes

MR. MICHELSON: Whether or not they may have suggested they don't think detection is needed, it only suggests that they do their fire analysis first and then adjust detection accordingly, isn't that right?

MR. STOREY: That's correct, although analysis is required in the United States as well.

MR. CATTON: But it's not done to the same degree. It's a much lesser --

MR. STOREY: There is some fairly detailed fire hazards analysis out there.

MR. MICHELSON: Some. Which is the most detailed?

MR. STOREY: I don't know.

MR. MICHELSON: In other words, if I were to read only one and I would like to get a good education on what a state of the art one looks like, which state of the art one would I look at?

MR. CATTON: You are in the business, you should be able to tell us.

MR. MICHELSON: You should be able to tell me that one immediately.

MR. STOREY: There's a number of analyses out there.

MR. CATTON: We know that.

MR. STOREY: To pick up a particular plant --

MR. MICHELSON: A state of the art. What do you consider -- you spend a lot of time and lot of money looking at this. What do you consider now to be a state of the art analysis. You can name me three if you like or four, but which ones are the state of the art?

MR. STOREY: If you looked at a new plant --

MR. MICHELSON: State of the art suggests that it's probably the newer.

MR. STOREY: However, fire hazard analysis for a newer plant would not necessarily address many deviations or lack of separation issues. So, Vogtle or Sharon Harris or a plant like that would most closely represent the new BTP. That might be plants that you want to look at.

MR. CATTON: Vogtle.

MR. STOREY: Sharon Harris.

MR. MICHELSON: Sharon Harris I would like to look at, because that's the one that has that two train water chilled system for the whole plant, both trains in the same room and so forth. I would like to read their analysis of that one. Why don't we put that one on our next Subcommittee meeting, to look as an example.

MR. CATTON: Okay.

MR. MICHELSON: The Sharon Harris. You consider they did it state of the art?

MR. STOREY: Yes, that would certainly be one that is most current. Of course, the newer plants are not running into too many of the problems as far as identifying cables and so forth, so it's much more logically laid out. The older plants might be harder to find your way through the analysis. Although, the same level of analysis is required for all plants.

MR. CATTON: My interest is what they do, once they gather the information. To me, the gathering of the information is not analysis. What do they do with it, or do they address the kinds of questions that Jim has been raising about the area surrounding the area where the fire is; smoke peeping under the doors, arguing why the three hour barrier will survive for three hours?

MR. STOREY: I think if you look at the fire hazards analysis you will find that they do address those kind of issues.

MR. CATTON: Good.

MR. MICHELSON: That's a good one to look at.

[Slide.]

MR. MADDEN: Why don't we move onto the next slide, which is protection of safe shutdown capability. You know basically what our Appendix R criteria is, and now we only compared Appendix R criteria or even the standard review plan criteria here. All of this criteria that is presently on this slide is not going to be allowed in the advanced reactor design except for complete, three hour barrier separation.

MR. MICHELSON: For present day plants where you have allowed the 20 foot separation -- apparently there is quite a number of them listed -- what do you require concerning the water wall that you have to put up, the sprinkling system. Does it have to be mounted on the ceiling, or can it be mounted ten feet below the ceiling, or have you ever asked that question?

MR. MADDEN: It depends on the congestion of the area. If you have two trains, 20 foot separation -- there is not supposed to be intervening combustibles. That space is supposed to be basically void of everything in there except you could run HVAC duct or maybe some conduit in there through it, providing it has no combustibility whatsoever.

Depending on looking at the NFPA Code 13 again, there is an obstruction section in there. So, if the area was heavily obstructed there would be a two-tiered system. There would be a tier at the ceiling sprinklers, and then below the obstruction you would have another tier or sprinklers.

MR. MICHELSON: If it was unobstructed, where would it be?

MR. MADDEN: It depends on the relationship of where the trains are in the room, but if you had a fire in the room generally speaking, your highest heater -- where you want your sprinklers to react would be at the ceiling given the faster response time.

MR. MICHELSON: No requirement for that?

MR. MADDEN: NFPA 13 is the standard that --

MR. MICHELSON: Well, does it require that they be at the ceiling?

MR. MADDEN: Yes, there is definite --

MR. MICHELSON: I ventured into a plant on one occasion in which these sprinkler were far removed from the ceiling for various arguments, but the concern was the hot gases from one train went across the ceiling and weren't even cooled by the water wall which I thought part of the purpose of the water wall was not alone to mitigate -- to assure the fire didn't propagate across, but also to cool the gases so that you didn't --

MR. MADDEN: We specifically don't use --

MR. CATTON: How could that happen, because the fire was not underneath the sprinklers?

MR. MICHELSON: The fire is on one side and the other train is on the other side, and the sprinkler were down from the ceiling in the middle, and the heat went across the ceiling and was warming up the other side.

MR. CATTON: How could that be considered satisfactory?

MR. MADDEN: I can't answer the question without knowing the specifics of the plant and what the space --

MR. MICHELSON: We will find out for you.

MR. CATTON: We ought to tell them --

MR. MADDEN: If you have the specific plant, we will be glad to -- it sounds like an enforcement issue there.

MR. MICHELSON: I wasn't sure whether it was even an requirement by NFPA to have them on the ceiling. I have never taken the time to look up that requirement. You are assuring me that the requirement is that they be on the ceiling, and if there are obstructions there would be another set down below the obstructions as well.

MR. MADDEN: Yes, sir.

MR. MICHELSON: If I understood you correctly. Thank you.

MR. WYLIE: In the case of Germany, those notes there I assume pertain to the normal plant design. In addition to that, they have four separate bunker decay heat removal systems and shutdown capability with their own diesels.

MR. MICHELSON: The one that I went to was in Spain, and I don't know if that reflected other countries or not. It had regular submarine type steel doors, lugs and so forth. It tended to be water tight, of course, as well as --

MR. MADDEN: Probably in Spain the overruling consideration there was flood protection, and that's probably why that door was there.

MR. MICHELSON: Yes, I wouldn't want to claim that it was for fire that they did that. Clearly, it was for water.

MR. MADDEN: There is some more uniqueness about this slide, like IAEA they look at two different approaches, the fire containment approach and what they call fire influence approach. There is one that gives flexibility to whoever the engineer or country is that is implementing these guidelines a their guidelines.

MR. CATTON: The U.S. approach really is A, isn't it, fire containment approach?

MR. MADDEN: Yes.

MR. STOREY: Yes, that's correct.

MR. CATTON: Do you allow anybody to take the B approach?

MR. MADDEN: We allow to some degree in the old plant designs where a plant configuration were such that they could not meet the proscriptive requirements of Appendix R III G, they could come in for an exemption request and justify that request by I would say would be the B approach.

MR. QUINTIERE: Recognizing that some plant designs may locate sprinklers in some maybe ad hoc ways like what Carl was suggesting some distance down from the ceiling, would it not be useful or does anyone take into account in their design the activation time for such sprinklers and what kind of fires would be responsible for producing these activation times?

MR. MADDEN: With regard to sprinkler activation, just rule of thumb. It takes -- I am not going to say a significant fire -- but a fairly good fire to produce that heat to get the sprinklers to actuate Hopefully in the same compartment or space, if you follow our guidelines, you would have some form of fire detection capability, preferably smoke detection.

We would hope that with the type of system which we require a utility to implement which is a 72D Class A system, which I am not going to say is virtually failure proof -- but even if the circuit is in trouble or there's a problem with the circuit or the circuit card, that system could still detect the fire based on residual circuitry in that system.

Even if you had a fire, you would hopefully -- we have to go back and look at the response of the program and defense-in-depth approach -- you are going to get an alarm, you are going to get someone to respond --

MR. CATTON: That is not what the question was about. I think it's more about the location of the sensing device.

MR. MADDEN: The location of the sensing device in installation is looked at, yes. I mean, you try to place that thing in optimum placement, that you are going to get the best response to the fire in the compartment.

MR. CATTON: How do you decide what that is?

MR. MADDEN: It is basically primarily fixed on fixed combustibles in the room, generally looking at it.

MR. MICHELSON: This is detection now, not mitigation.

MR. MADDEN: Yes, detection.

MR. MICHELSON: Most of the detection that I have seen has been mounted correctly at the ceiling but the sprinklers have been located close to where the fixed combustibles were and not necessarily with having in mind the idea that heat goes across the ceiling and propagates to other areas. It was there to cool the fixed heat combustibles, not to cool that air that might move around in the room, particularly where the 20 foot separation was a consideration.

MR. MADDEN: If you have specific examples of that you could give them to me and I will look into them.

MR. MICHELSON: It was explained to me very carefully that it was important to locate those sprinklers close to the fixed combustibles to get proper spray patterns on the combustibles and so forth.

MR. CATTON: They --

MR. MICHELSON: They don't locate them up at the ceiling.

MR. CATTON: Do you bring them --

MR. MICHELSON: Bring them down to where the fixed combustibles are. A lot of times cable trays aren't at the ceiling, they are well removed from the ceiling.

MR. MADDEN: See, I don't know if that system is an open head system that is actuated by heat detectors. I don't know the principles of the design of this particular --

MR. MICHELSON: Well, I do in this particular case. It was a pre-admission system.

MR. CATTON: Do you understand what Carl is getting at?

MR. MADDEN: Yes.

MR. CATTON: It's a combination of doing something at a distance and the location of the sprinklers.

MR. MADDEN: I understand that.

MR. STOREY: One of the concerns with sprinklers that even though the combustibles may be at the floor since heat rises, if the sprinklers are closer to the ceiling they are likely to activate faster. If they are midway down at the midway elevation, that air temperature may not rise to the temperature to activate the sprinklers.

So, even though they may be physically farther away than the combustibles, they react faster if they are at the ceiling height.

MR. MICHELSON: My only interest was does NFPA tell you where you have to put them elevation --

MR. STOREY: Yes, NFPA 13. And licensee's, by NRC guidelines, have to comply with NFPA 13. If they do deviate for some reason, they have to justify that their design is adequate.

MR. MICHELSON: What does 13 require them to do?

MR. STOREY: Thirteen gives you spacing requirements, it gives you distances from ceilings, how to handle obstructions. It is basically an installation criteria for sprinkler systems.

MR. MICHELSON: What is, for instance, the distance from the ceiling that they allow?

MR. STOREY: No more than 18 inches.

MR. MADDEN: It's 18 inches.

MR. MICHELSON: Eighteen inches. When I see them mounted way down, I better make sure there's also a set up at 18 inches.

MR. STOREY: Or, they have some rationale why they did it that way.

MR. MICHELSON: I thought you already told me that 18 inches was the most I would ever see. From the ceiling they must be no more than 18 inches.

MR. STOREY: That's the guidance in NFPA.

However, they may have some rationale by analysis that there is some specific reason that they want to locate them where they did. They should know why they are there and have an analysis that demonstrates --

MR. MICHELSON: That it's okay.

MR. STOREY: If it's reviewed and found to be okay.

MR. MCCPACKEN: There should have been a deviation to 9.5.1 that should have been reviewed and approved by the staff.

MR. MICHELSON: That might very well have been, because they weren't 18 inches from the ceiling.

MR. NOTLEY: In addition to that, Carl, from what you are describing my guess is that there is a high probability that you are talking about a water spray system covered by NFPA 15 which is quite different. The water spray systems are open head systems that are actuated by fire detection system.

MR. MICHELSON: That would make a difference?

MR. NOTLEY: That sure would make a difference.

MR. MICHELSON: What do you require in this 20 foot interval where you want to provide this spray system, is that a water spray system allowed there?

MR. NOTLEY: As Pat said, without specific knowledge of which one you are talking about, I can't answer your question.

MR. MICHELSON: The one you described. You said it has to be 20 feet of non-combustible space. It can be a barrier between trains and it has to have automatic fire protection. I am asking only what kind of automatic did you proscribe?

MR. NOTLEY: It may be automatic sprinklers, it may be water spray. There may be a sealed tube system --

MR. MICHELSON: Water spray then, it doesn't have to be 18 inches from the ceiling, it can be something else.

MR. NOTLEY: It can be something else, yes.

MR. MICHELSON: There isn't -- NFPA then really doesn't -- depending on what system you put in, they could be way below the ceiling and still meet the requirements.

MR. STOREY: NFPA has standards for each type of system.

MR. MICHELSON: Okay.

MR. MCCRACKEN: If the detector is on the ceiling --

MR. MICHELSON: It is.

MR. MCCRACKEN: -- the sprinkler can be anywhere, if it's actuated by the detector.

MR. MICHELSON: Okay. Indeed, you can have large non-sprayed areas along the ceiling where the hot gases go from one train to the other.

MR. CATTON: Yes.

MR. MICHELSON: If that's true.

MR. CATTON: We have run into a logistics problem again. I don't know whether it is that we have too many topics or the educational process is taking more than we anticipated.

MR. NOTLEY: I was going to suggest a little earlier -- and this might be a good time to suggest it -- that you seem to have many questions on the whole standards process and what is included. Jim, I think you could probably be the focal point for putting together a presentation to ACRS on the entire -- everything that is included in these NFPA standards and perhaps get some of the historical backgrounds that we had in mind when we wrote the various things too.

MR. QUINTIERE: I think the historical background would be quite difficult, I think, because usually someone doesn't document that.

MR. NOTLEY: I am talking about the historical background on the various NRC fire protection documents.

MR. CATTON: Jim is not from NRC, he's from the Association of National Bureau of Standards.

MR. QUINTIERE: Formally.

MR. NOTLEY: Yes, formally, but you are also associated with NFPA and certainly have access to the various NFPA standards.

MR. QUINTIERE: Sure, in the same sense that it is in the public domain. I think what you are asking is impossible -- if I understand you correctly -- to try to bring some historical perspective into each of these standards that has been developed. There might have been some motivating factors for them that one could speak to as to why they were developed, but just the need for E-84 teletest -- one might not be able to justify why they did what they did.

That information usually is not necessarily available or would take an awful big effort to kind of push together.

MR. MADDEN: Shall we continue?

MR. CATTON: We are going to break for lunch at 12:[illegible]

MR. MICHELSON: Why don't we take a 45 minute lunch instead of a one hour lunch?

MR. CATTON: I was going to suggest a 30 minute, in order to start on time.

MR. MICHELSON: Thirty is better yet. Why don't we just have a 30 minute lunch.

[Slide.]

MR. MADDEN: Protection safe shutdown capability, Canada, they pretty much have a separation capability for their plant for safe shutdown capability. Their separation pretty well models the United States, except with some caveats there. Canada doesn't require suppression in areas containing redundant trains where combustible loadings warrant it. If they are low enough they say you don't have to have the suppression capability there.

Canada does require that within closed areas containing safe shutdown trains, at least one train be wrapped regardless of separation.

[Slide.]

Inadvertant suppression system activation. Just about everybody has something as far as the guideline there. UK has no specific requirement. It says refer to IAEA guidance. IAEA says normal spurious or inadvertant operation of fire extinguishing systems must not impair safety functions. Ours is normal or inadvertant operation of suppression systems should not affect the ability of a safety system to perform its intended function.

MR. MICHELSON: That's not GDC 3 though.

MR. MADDEN: That's standard review plan.

MR. MICHELSON: No. That's not standard review plan either. You start off the standard review plan with GDC 3 and requote it.

MR. MADDEN: That's back --

MR. MICHELSON: I know that back further there are interpretations. This is a staff interpretation.

MR. MADDEN: It's in the guidelines.

MR. STOREY: It's in the guidelines.

MR. MADDEN: USSR is pretty unique. Their fire suppression capability as far as extinguishing systems in their plant, they have a 15 minute water supply depending on the development of the system or the system, how it is designed in the room. They have a drain tank that is installed in the room that can drain 15 minutes of water from that suppression system. Once they have shot the 15 minutes of water there isn't anymore.

[Slide.]

Ventilation. U S. guidelines basically say separate smoke and heat vents should be provided for areas where the potential for heavy smoke -- where there is a potential for heavy smoke. Canada, smoke venting to the outside shall be provided for all indoor areas containing a high fire load.

MR. MICHELSON: Do we consider ventilation to be something that is required for safe shutdown?

MR. MADDEN: If it's a support function for a safe shutdown system --

MR. MICHELSON: No. Maybe I better rephrase my question.

MR. MADDEN: Yes.

MR. MICHELSON: The ventilation equipment that is ventilating the smoke from the zone or area where the fire is, is that ventilation equipment considered safe shutdown equipment? In other words, am I assured that the power for those fans is even provided for a fire in a given area?

MR. MADDEN: I can't 100 percent say that --

MR. STOREY: If it's demonstrated that a ventilation system is necessary to achieve safe shutdown either for smoke control or temperature control, that ventilation system has to be treated as a safe shutdown system and analyzed not only including the power for the fans but damper controls, air supplies.

MR. MICHELSON: I guess my real fundamental question, and it's just another corollary to the one raised earlier -- do we consider the mitigation of a fire and the ventilation of a fire to be safe shutdown functions, or if we do they are put in a safe shutdown set and we assure that the wiring and the control and everything wasn't in the fire zone for the fire?

MR. STOREY: Right. If --

MR. MICHELSON: Can we do that?

MR. STOREY: If that ventilation system is necessary to achieve safe shutdown.

MR. MICHELSON: Safe shutdown has a regulatory meaning. It means the equipment required to cool the core and so forth. That equipment is not what I am talking about. I am talking about the equipment required to ventilate the fire. If ventilation of the fire is thought to be an essential process, then you could put it in a safe shutdown --

MR. STOREY: Right. That comes in --

MR. MICHELSON: I haven't heard the staff ever say it was an essential process to mitigate the fire and that sort of thing.

MR. STOREY: That comes in the area of a support system which is included in Appendix R and BTP.

MR. MICHELSON: Where in Appendix R do I find that? Appendix R never defines safe shutdown systems to include the equipment required to mitigate the fire.

MR. MADDEN: Let's --

MR. MICHELSON: If it's there, please point it out.

MR. MADDEN: I think what we need to do is clarify the question. I think what you are saying is, and let me see if I have it right, do we look at ventilation systems and their ability --

MR. MICHELSON: For smoke removal.

MR. MADDEN: -- and their ability for smoke removal and the protection of those cables associated with those HVAC systems.

MR. MICHELSON: To be a safe shutdown function.

MR. MADDEN: I am not going to define it as safe shutdown. If it's a safety-related fan and it comes under the standard review plan guidelines and if it is considered a safety-related --

MR. MICHELSON: It's not a safety-related fan necessarily because you have never said you are going to use only safety-related equipment to remove the smoke. You use what you have.

MR. MADDEN: I understand that. What I am trying to say is that the guidelines require complete separation to some degree, physical and electrical separation, for safety-related components. Those fans may be available. But for non-safety fans, we have -- I don't believe that we have --

MR. MICHELSON: I think you will find on further reflection that is not true. If we have two trains of equipment and we might have put in two trains of ventilation, one for each train, and the fire is in train A the ventilation system for train A has potentially the wiring going through it and meets all the separation requirement. The ventilation fan for Train B is working fine. It will cool the equipment in train B. But it will not remove the smoke from the Train A area.

MR. MADDEN: I understand your question.

MR. MICHELSON: What I am asking though is, has there ever been a requirement that the equipment used for mitigation in train A, smoke removal in train A and so forth, is it even operable. Has an analysis even been done to determine that it is operable. Depending on where you put the fire, I think it is highly likely it would not be available.

MR. MCCRACKEN: No, that analysis --

MR. MICHELSON: Fire protection is in the same category, see. I am not sure you have assured yourself that the fire protection for train A when the fire is in Train A will necessarily work unless you have done the analysis to show that the power is not there, the control is not there and so forth.

MR. MCCRACKEN: We don't permit them to use train A if the fire was in train A. We don't permit them to assume they went in a room and made it better.

MR. MICHELSON: Since we don't have trained eyes to fire protection systems, how do you assure this? You can do an analysis to assure it, you can go through and see where you have power and how you have run the control and so forth. Ventilation is even more complicated, because there for sure you even have some common ventilation systems for both train A and train B.

MR. MCCRACKEN: What they had to do in their fire hazards analysis was demonstrate the ability to safely shut down in any fire area.

MR. MICHELSON: Yes.

MR. MCCRACKEN: Part of what licensees initially tried to do was say I can suppress this fire in 15 minutes and go and turn this switch. We said no, you can't do that. We assume that you cannot get in there -- I think what we use pretty much standard is about one hour -- that you can't get a fire suppressed and cooled down in a room in less than an hour.

So, we did not have any requirement that they be able to ventilate that room to go in and take actions. If they --

MR. MICHELSON: Smoke removal is not a requirement.

MR. MCCRACKEN: No. They have to --

MR. MICHELSON: Mitigation is --

MR. MCCRACKEN: -- have means of shutting down outside of this room.

MR. MICHELSON: So, we don't need to talk about smoke removal because it is a non-requirement. It may or may not be available in that area. How about mitigation, is mitigation a requirement? Is the mitigation of the fire in that zone a requirement? It better be.

MR. MADDEN: You mean detection suppression.

MR. MCCRACKEN: You mean detection suppression, yes.

MR. MICHELSON: It is also a requirement then to make sure that the detection suppression is independent of the zone in which the fire is ignited, so that it can function properly even though there is a fire started there.

MR. NOTLEY: If you are talking about the control circuitry that would -- that controls the detection suppression equipment, NFPA code requires that those be outside the area that they are installed in.

MR. MICHELSON: The equipment is outside, but is it required that all the power and the control and everything come from outside that zone?

MR. NOTLEY: Yes, that's what I just said, Carl.

MR. MICHELSON: I am surprised if NFPA proscribes that way.

MR. NOTLEY: Why are you surprised?

MR. MICHELSON: Because it's not clear to me that they wrote these for nuclear plants. You convince me they didn't.

MR. NOTLEY: That is what we are trying to say, they are not written for nuclear plants but they are adequate for nuclear plants.

MR. MICHELSON: Which requirement do I read then?

MR. MADDEN: Seventy-two D.

MR. MICHELSON: Seventy-two D.

MR. MADDEN: For detection capability. It will show you that you have an --

MR. MICHELSON: Give us a copy of that, and we will look it over. That shows me everything is power control from outside the zone where you postulate the fire.

MR. NOTLEY: Likewise, if you are talking about a Halon system, the control panel for that will be outside the area that you are protecting.

MR. MICHELSON: And the power to it and all that will all be outside the area --

MR. NOTLEY: All outside the area.

MR. CATTON: Pat, how much more time do you need to finish this?

MR. MICHELSON: Which item?

MR. MCCRACKEN: How many more questions?

MR. MADDEN: Yes, how many more questions? I mean, we have one question in back from the public. I don't know if you want to entertain that or not.

MR. ROTELLA: We have to recognize that from the Chairman. That's his decision.

MR. MCGREGOR: I am sorry. If it were that complicated, maybe I wouldn't have bothered. I just wanted to say that I had an occasion to look at the ventilation requirements in --

MR. CATTON: Please give your name and affiliation.

MR. MCGREGOR: Must I?

MR. CATTON: Yes.

MR. MCGREGOR: My name is Mcgregor, of Winston and Strawn. In 0800 or your SRP, indeed, ventilation specifically requires the power cables be outside the fire zone or fire area in question.

MR. MICHELSON: By that, you mean the ventilation of the fire area, the cables and so forth are outside.

MR. MCGREGOR: That's right.

MR. CATTON: Thank you.

[Slide.]

MR. MADDEN: The next slide is emergency lighting. We require minimum of eight hours. IAEA requires just reliable lighting systems --

MR. CATTON: Can we stipulate -- can we just read this one?

MR. MADDEN: Sure.

[Slide.]

If you want to look at surveillance, we require surveillance programs. Several other countries, their surveillance programs are not as rigorous as ours.

MR. WYLIE: Let me ask you this general question. Is there any reason that you didn't address France on any of these?

MR. MADDEN: We didn't get the guidelines from

France.

MS. CONNOR: Pat, could I answer that?

MR. MADDEN: Yes.

MS. CONNOR: Lynn Connor, SAIC. The French requirement endorses the EDF document RCCI, which is design requirements for fire protection. The regulatory requirement in France is strictly an endorsement of the EDF document. We have not yet by today received the EDF document which they said they would send us.

MR. CATTON: When you get it, I would be interested in seeing it. The French have come up with some analytical capabilities that seem to be a little bi better than what we use.

MS. CONNOF My understanding is the EDF document basically follows Appendix R.

MR. STOREY: We will get a copy of that to ACRS when we get it.

MR. CATTON: Okay, thank you.

[Slide.]

MR MADDEN: Fire brigade requirements, there is a whole host. We are proscriptive. We require five -- everybody, to some degree, requires them. The Russians have 135 fire fighters assigned to nuclear plants. They use a military division to provide fire protection.

MR. CATTON: They also have the surrounding villages, fire brigades, trained to help fight the fire.

MR. MICHELSON: They also probably have the worst fires.

MR. CATTON: The Soviets.

MR. MADDEN: Yes, they also have the worst track record.

MR. CATTON: But their fire fighters also charge right into the middle of the fire.

MR. MADDEN: They have a choice; either they do that or they get shot.

MR. CATTON: Right.

MR. MADDEN: That's the only other choice.

[Laughter.]

MR. MADDEN: That pretty much covers it for the comparison. I mean, if you have some specific questions about -- the only thing that is unique about the comparison is all these requirements are out here, and they apply to plants that are either under construction or haven't been built yet. None of the requirements by any of these countries were ever backfitted to existing power plants. Our country only deemed it necessary, and we are the only ones that backfitted fire protection and backfitted fire protection of safe shutdown capability to existing power plants.

MR. CATTON: I think it's lunchtime.

MR. MICHELSON: Let me make one comment before lunch. I found the section that was pointed out. They have covered ventilation very nicely. I don't find the comparable provision though for mitigation. Although the ventilation has been done with controls outside the fire area, the mitigation isn't proscribed to require that.

MR. MCCRACKEN: It's in the code.

MR. MADDEN: It's in the code.

MR. MICHELSON: I was just looking at the standard review plan.

MR. CATTON: Maybe during lunch you could point that out to Carl.

MR. MICHELSON: Find it in the code.

MR. MADDEN: I will be glad to mark up a section and send it to Mr. Michelson.

MR. MICHELSON: Okay, that will be fine.

MR. CATTON: Thank you.

We are going to break for lunch, and we will gather together at quarter until. Thirty minutes until lunch.

[Whereupon, at 12:18 p.m., the Subcommittee recessed, to reconvene at 12:45 p.m., this same day.]

AFTERNOON SESSION

[12:55 p.m.]

MR. CATTON: Let's take a look at time before you get started. We want to hear about the Brunswick event, and the times that we have down on this sheet show that we are going to have a bit of trouble. Can you shorten up your isolation talk to --

MR. MADDEN: I can go very fast through my isolation talk, if you will allow me to go very fast through my isolation talk.

[Laughter.]

MR. CATTON: Maybe you could slip past a few of the viewgraphs now and then, because it seems that every one that goes up Carl has a question on -- an important question.

MR. MADDEN: I will try to go as fast as possible.

MR. CATTON: Carl indicated that he had to leave at 4:15. I would kind of like to wind it up right about then, if I could. Some of these other things need to be shortened up too, and I have heard the Brunswick PRA won't take two and one-half hours?

MR. MCCRACKEN: I don't think so.

MR. MICHELSON: I just have a few questions. I can read the document, it's pretty straightforward. Where will this start? Is this in the big package or a separate package?

MR. MADDEN: It's in that big package.

MR. CATTON: Okay, let's get moving, Pat.

MR. MADDEN: Let me go on quickly.

[Slide.]

We have a couple of definitions in the standard review plan. One is fire area and the other is fire barrier. The fire area is the portion of the building or plant area that is separated from other areas of the plant, and it is bounded by fire barriers. The definition of a fire barrier in the standard review plan is basically components of construction, wall, floor and ceilings, including beams, columns, penetrations, seals, doors, that are rated by approving laboratories, for example UL and FM, in hours of resistance to fire and are used to prevent the spread of fire. Those are the definitions that we impose on the industry.

We have to go back to the time of Browns Ferry in a little discussion of why we chose three hours. Generally, our guidelines specify three hour fire barriers or fire areas. Why? At the time, we thought it was a conservative application based on the fire and fuel load. Fire resistive technology and components available to the nuclear industry in the 1976 timeframe designed greater than three hour were not being manufactured or tested. Three hour fire barrier designs, we chose three hour due to the fact that they were constructed of all non-combustible materials. Designs of lesser than three hours, you can use combustible components.

[Slide.]

Examples that the SRP recommends as far as fire areas, containment, control room, cable spreading rooms, electrical switch gear rooms, battery rooms, safety-related pump rooms, diesel generator rooms, and rad waste fuel storage areas. That is not an inclusive list, that's just examples of some that are quoted directly from the standard review plan.

[Slide.]

Dr. Catton and Michelson have seen this slide before. When we call a fire area three hours we mean that electrical conduit is either grouted or filled with a sealant material, cable trays have fire stops and the openings are sealed with a sealant material, fire doors are rated doors, walls are typically rated, and HVAC ducts are installed with dampers and the damper insulation is regulated by the test criteria for the fire damper, the way it was tested in the configuration.

MR. CATTON: What about conduit and pipe?

MR. MADDEN: Conduit in pipe is sealed. The pipe you can't seal inside, you have to have a liquid go through it. If it's something that is required, if it is a fluid pipe, it depends on the system. We don't require a valve on a pipe, for example, for fire protection measures. For conduit though, we do require internal seals.

MR. CATTON: I understand, but if you are isolating this area because it is going to burn up, don't you have to check to make sure that you don't have a pipe that goes into it so that you will just drain some of your water away for nothing?

MR. MADDEN: Well, if you are assuming piping failure or piping integrity failure, there would be other manual valves somewhere in that system outside of the envelope that you could isolate.

MR. MICHELSON: But they are not required.

MR. CATTON: Part of complete isolation means that you are going to be sure that there is no communication between inside and outside. You are not going to have critical fluids or anything.

MR. MADDEN: Depending on the fluid system, the fluid systems are not required to have an isolation valve at the barrier boundaries, for example. There is no requirement for that.

MR. MICHELSON: Is there any requirement on an air line for instance, that you be able to isolate -- the air lines easily open up and the fires are relatively modest temperature, particularly the copper jointed lines. Are you worried about air lines fanning a fire?

MR. MADDEN: The small, minute --

MR. MICHELSON: These can be four inch. Air lines are big in nuclear power plants. These are used for a lot of things including service of various sorts, and their headers are like four inch copper or may be steel, depending on the particular utility. They may be solder or they may be braised. In the case of Browns Ferry fire, one of the air lines did open up and it is just further aggravation to the problem.

MR. MCCRACKEN: There isn't any requirement of pipes going through an area other than if they are the alternate safe shutdown train you have to address them. If they are not, you don't.

MR. CATTON: It seems to me this ought to be looked at, particularly for the air.

MR. MCCRACKEN: The rooms, when you are saying sealed, are not air tight. There is no requirement that they be air tight. The door has air under it.

MR. CATTON: If you have a line like Carl is talking about that is four inches and it's an air line, you better have a lot more than four inches of open space for it to leak through.

MR. MICHELSON: You mean you pressurize the room -

-

MR. CATTON: You open up a line in a room like that that's been sealed shut because there's a fire in it --

MR. MICHELSON: Presumably they have looked at the pipe break of an air line. It doesn't over-pressurize the room. Generally, rooms aren't that tight. What I would worry about is the fanning effect of even a one inch line breaking.

MR. CATTON: It would blow all the smoke out of the room.

MR. MICHELSON: It wasn't so much that, it was aggravate the fire. Our fire tests and fire propagation rates certainly --

MR. MCCRACKEN: You have to relate to the fuel load.

MR. CATTON: There's no fuel in there, there's not going to be any fire.

MR. MCCRACKEN: If there isn't any fuel --

MR. MICHELSON: That's right.

MR. MCCRACKEN: If you happen to have a small amount of fuel when you rupture one air hose it doesn't bother you.

MR. MICHELSON: That's right.

MR. MCCRACKEN: So, you are talking about two or three rooms in the entire power plant where you would be concerned about that issue.

MR. CATTON: What about the electrical conduit coming out, what is the copper cross-section in that and how much are you going to heat the pipe up outside the room? Or, does it matter? Has anybody analyzed these kinds of things to be sure?

MR. MADDEN: With respect to -- we do have electrical separation. There has been tests done that we only need physically one inch of air space between even from a dead short cable inside a conduit creating any heat or transmission to the next conduit. As far as a fire, conduits are generally in the overhead. The rod of the conduits are generally not routed with trays. When the actual assemblies were fire tested, part of that was is that you had an internal fire stop and there was no allotment of fire propagation.

MR. CATTON: I am just going to cite something that occurred. don't know if it's really even important, and maybe you can tell me. There was two apartment houses and there was a fire in one, and it cooked the electrical cables. The gases went through the conduit to the adjacent building. You don't isolate. There was an arc, and they blew up and killed a fireman.

MR. MADDEN: Internally, the conduits we do isolate. There is guidance in the standard review plan that requires certain size conduits to be sealed with fire resistant material either at the barrier, and if they are a small diameter they are isolated -- there is a fire stop in the conduit.

MR. CATTON: In the conduit?

MR. MADDEN: Yes.

MR. CATTON: So that it would stop the flux of combustible gases?

MR. MADDEN: Right.

MR. MICHELSON: I thought they only had to seal the termination points and not the penetration points.

MR. MADDEN: There are some termination points, but it depends on the size of the conduit. I can't quote the standard off the top of my head, but there is a section in the standard review plan under electrical construction that specifically requires conduit to be sealed internally.

MR. MICHELSON: Of a certain size probably.

MR. MADDEN: Yes.

MR. QUINTIERE: I would like to come back and just review the fire physics related to this situation. One, you are prescribing a three hour fire rating for this envelope. The presumption is that the fire is not going to get out of this space, and that very likely you have a fuel load in this space that may not even burn for three hours.

If one goes back and looks at how such requirements got into practice in the first place, they originated for building fires in which you wanted the structure to last for three hours, or if you had an internal dcor and a fire in a room with windows broken to the outside you didn't want that fire to propagate through that door.

In all of those cases it presumed that there was some ventilation, some natural ventilation due tc windows breaking. Here, you have buttoned this whole thing up. If it really stayed buttoned up, what would happen is that you would have a fire that could develop in this room possibly, smoke would fill at the ceiling and then descend downward, and eventually smoke as it reached the floor might push through the undercut of the door which is probably the only likely opening if everything else tightens up. If not, it is just kind of oozing out.

At some point that fire, if it still wants to grow, will look for oxygen. The oxygen in this space, unless you have a pipe coming in, is in initial stages there is not going to be any flow of oxygen in. Consequently, the fire is going to die down to some smoldering like fire which will occur, in practice. And then, it's very likely that someone will come along and open the door.

This is w' re firemen experience what they call back draft explosion.

MR. MADDEN: Yes, I am fully familiar with that. Our approach is to intervene and mitigate before we get to the degree that you are talking about.

MR. QUINTIERE: But I mean, that is what is going to be happening in a fire scenario. Another way that one might look at this is say, what is the likely vent that would be opened to such a room. Say there's one door or two doors. That is the maximum vent size that you could have, assuming somebody comes along and opens those doors. You don't have a barrier anymore.

What energy release can be generated by such a fire? One can calculate the air flow into such vents. That is known. One knows that the heat of combustion per unit mass of oxygen is about a constant. You get, in a sense, the ventilation limited fire size which has gone into some of these calculations relating endurance time with fuel load. If you presume that you have the worst situation and the vents open and natural convection through the vents, you can calculate a rate of consumption of fuel. If you know how much fuel you have inside, then you know how long your fire is going to last.

That, in turn, gives you some sense of connection to three hours. It also says that you are going to have a dump of products to the rest of the building. One might see, based on what the temperature of those products are or how much there are over time, whether that is a hazard. One could sort of do a little bit more maybe with this three hour specification and make some estimate as to what is the nature of the real hazard that you have there, not if you have three hours --

MR. MCCRACKEN: What am I going to do with that?

MR. QUINTIERE: What you are going to do with that is, you are going to determine whether all these other things fail; suppression detection, what kind of fire you are going to have likely going into the next phase.

MR. MCCRACKEN: I have already put in another system to shut the plant down independent of that. I have taken care of protecting the public health and safety.

MR. QUINTIERE: What you would determine from that is where these products are going in the rest of the building and how that might impact where your second shutdown facility is.

MR. CATTON: Let's take --

MR. MCCRACKEN: I am not going to alter it, it's already built.

MR. CATTON: Let's take the ABWR for example where you have interlaced fire zones. When the door opens the other zone is immediately impacted.

MR. MCCRACKEN: When what door opens?

MR. CATTON: One of these fire doors, of which there are many in the ABWR.

MR. MICHELSON: Between the --

MR. CATTON: They showed us some nice color pictures and they are like this -- as you go up vertically through stairways and through doors, you go from one zone to another. It's not a nice, clean separation. Some of these scenarios could well occur. The smoke comes out from underneath that door and goes right into the other zone and screws things up.

Unless you track through this kind of analysis you are not going to know what kind of damage you can do.

MR. MCCRACKEN: You are presuming that the smoke is going to cause damage when you do that.

MR. CATTON: Or interfere with whatever is going on in the redundant system zone.

MR. QUINTIERE: You may derive from such analysis that you don't need to be concerned. It goes both ways.

MR. MCCRACKEN: What I am saying is that for the nuclear plants that are out there we have looked at all these fire areas and fire hazards analysis. There are very few areas that have a lot of fuel sources in them. I don't need a sophisticated code to tell me that, we can see them by looking at them.

You are telling me I need to develop a code to solve a problem that I don't believe exists.

MR. CATTON: I didn't hear anybody telling you to develop a code.

MR. MICHELSON: There are some areas in every plant that have very high fuel loadings, so you would certainly not deny that.

MR. MCCRACKEN: Absolutely.

MR. MICHELSON: Every plant has a few areas.

MR. MCCRACKEN: They have automatic suppression and they have very good detection. We have a fire brigade to put out fires.

MR. MADDEN: I have some examples of some areas and it won't take very long. Floor, ceiling and walls, concrete, concrete block primarily, filled concrete block, penetration seals -- I got a little parenthesis ASTM E-119 out to the side there. That is the test criteria used to qualify silicone, and there's three different formulations of silicone; low density, high density, and a boot type gel configuration.

Doors, we look for UL listed three hour doors, and that means the hardware locking mechanism, hinges, door closure. Dampers, three hour UL listed fire dampers.

[Slide.]

We do have in some older plants what we call fire barrier enclosures --

MR. MICHELSON: Excuse me. On the fire dampers, how tight do you think they are from the viewpoint of heat and smoke penetrating through the dampers?

MR. MADDEN: They are not smoke dampers.

MR. MICHELSON: No, they are not smoke dampers at all. How about heat?

MR. MADDEN: Heat, they have --

MR. MICHELSON: If smoke can propagate through, certainly a certain amount of thermal energy must probably be getting along with the smoke.

MR. MADDEN: They are probably as good as a fire door, and a fire door is qualified at 650 degree temperature rise on the cold side.

MR. MICHELSON: With positive pressure or negative pressure?

MR. MADDEN: Whatever furnace pressure --

MR. MICHELSON: The test pressure is usually negative, so you are not talking about anything but conduction, I think. You are not talking about pressure building up and pushing smoke out through dampers.

MR. MADDEN: It's direct flame impingement to the device in the test room.

MR. MICHELSON: It's negative pressure on the test side, so you don't have propagation of smoke through the cracks. Air is coming in the other direction --

MR. QUINTIERE: It's not a smoke barrier.

MR. MICHELSON: No, it's not a smoke barrier. Therefore, not necessarily a heat barrier either.

MR. MADDEN: Enclosures, we use thermal lag in intumescent material, and they are utilized primarily for component protection in accordance with 10 CFR 50 Appendix R, Section III G.

I will talk about the fire test ittle bit. What was available or is available to the industry, and what is available to manufacturers, what is accepted by various building codes in construction. ASTM 119 is generally accepted by the fire protection industry. It is a controlled gas fired furnace used in various configurations in the wall or floor. The floor is probably a more severe test.

Specimen is installed in a wall or floor with a known fire resistive rating like a concrete slab for example.

MR. MICHELSON: Excuse me. Floor means basemat of the room?

MR. MADDEN: Right.

MR. MICHELSON: Why is that more severe?

MR. MADDEN: A slab test horizontally, you have gravity --

MR. MICHELSON: The fire is on top -- the heat is on the top.

MR. MADDEN: No, the fire is on the bottom.

MR. MICHELSON: It's a ceiling and not a floor then.

MR. MADDEN: Yes. I'm sorry. Your standard -- we are looking at the furnace and you are standing on top, it's considered --

MR. MICHELSON: Okay. You are testing the bottom side of a slab or a floor assembly.

MR. MICHELSON: That would be more severe.

MR. MADDEN: The specimen assembly becomes a boundary wall of the furnace or it becomes a top of the furnace if it's in the floor slab type test configuration. Specimen is exposed to fire flame impingement during the duration of the test. Temperature on the unexposed side --

MR. CATTON: Do they specify the magnitude of the fire and the distance of the fire from the surface and all that kind of stuff?

MR. MADDEN: Not from the surface, direct flame --

MR. MICHELSON: These are gas fired --

MR. MADDEN: Gas fired furnace.

MR. MICHELSON: They proscribe the --

MR. MADDEN: Temperature on the unexposed side is moderate. Our acceptance criteria is 325 degrees up for penetration. Component enclosure, 650 up for a door or damper.

MR. MICHELSON: What is the pressure on the test side?

MR. MADDEN: This is -- I can't tell you that.

MR. MICHELSON: That was the only --

MR. MADDEN: ASTM controls the furnace pressure in the standard.

MR. MICHELSON: Yes, and it's a negative pressure, it was my understanding.

MR. MADDEN: It depends on the specimen and who requires the --

MR. MICHELSON: The reason it's a negative pressure is because they want to exhaust the heat and everything from the test side, so they put it out through a stack and creates a slightly negative pressure.

MR. MICHELSON: That is one of the arguments, because the positive pressure in that room would make -- would potentially make a difference.

MR. MADDEN: We also have to protect the furnace too.

MR. MICHELSON: Here, they have to protect the test equipment.

MR. MADDEN: You can't build a $ 2 million furnace in one prototype.

MR. MICHELSON: In reality, a real fire -- is it true, a real fire is generally a positive pressure on the fire side? It depends though.

MR. MCCRACKEN: I can be both.

MR. MICHELSON: On the configuration.

MR. MCCRACKEN: I've seen cases of a closed house where you break a window and you suddenly let air in, and it just explodes.

MR. MICHELSON: That's a different phenomena.

MR. MCCRACKEN: It had obviously been sitting there under a negative pressure.

MR. CATTON: Somehow I have a little trouble with that.

MR. MADDEN: Implode.

MR. MCCRACKEN: Implode.

MR. CATTON: If I have a fire inside and it is sealed up --

MR. MICHELSON: The energy has to be doing something.

MR. MADDEN: Thermal dynamics says it has to be -- the pressure has to be going up. If I break the window and the air rushes in, then I have close to an explosion because this stuff is combustible that's in the air. That could take the roof off.

MR. MICHELSON: The air rushed in because --

MR. CATTON: What happens is that the hot air goes out the top of the break and the cold air comes in the bottom, and then it explodes.

MR. QUINTIERE: What you have is, you have the in rush of air causing the rapid release of heat inside this losure now with the bigger vent. But now you have the potential of further increase in pressure due to that rapid rise in --

MR. MADDEN: We are looking at catastrophic fires here based on fuel loads that are -- in a house the fuel load is much greater than most of the compartments of a nuclear power plant. Yes, I can see that complete combustible interiors of structures, that you are going to get to that type of magnitude of damage.

MR. MICHELSON: Is there a problem of smoldering type fires which could just very likely develop into -- like opening a door and causing in rush of air.

MR. MADDEN: No.

MR. MICHELSON: Are these smoldering fires producing combustible gases now from incomplete combustion?

MR. MADDEN: No, this is after the flame propagation stage. We got into what they call the smoldering stage, where the fire is oxygen starved -- this is what you are talking about. If we are talking about a back draft, as soon as we have the back draft condition the door is open and the oxygen is introduced to the fire. You have combustible gases that are given off by the fire, and you have rapid ignition of the space. Sometimes it reverses into a small explosion that is sometimes called a smoke explosion.

Fire test continued. We used the NSB fire test and developed the standard time temperature curve developed through full scale building fire tests and analysis of the data, developing a relationship. From this standard time temperature curve and these building tests they developed a relationship between the temperature curve and the fuel loading.

MR. MICHELSON: Is that the temperature on the surface of the test specimen?

MR. MADDEN: This is the temperature of the furnace.

MR. MICHELSON: How does that relate to the test specimen?

MR. MADDEN: The test specimen is one wall of the furnace. That is the average temperature inside the furnace. The one side is exposed to the furnace, the test specimen.

MR. MICHELSON: The burners, in other words, are not impinging on this test specimen?

MR. MADDEN: Yes, they are.

MR. MICHELSON: The test specimen is hotter than the mixed mean of the air around it.

MR. MADDEN: The gas burners are in the direction of the test specimen.

MR. MICHELSON: The test specimen is hotter than these temperatures by some amount.

MR. MADDEN: That may be very possible.

MR. MICHELSON: Certainly not cooler.

MR. MADDEN: It's definitely not cooler. At three hours you can see this curve -- you start out five minutes at 1,000 and at three hours you are at 1,925 degrees. That's how they take the temperature up in the furnace.

MR. MICHELSON: Do they monitor the other side, the surface of the test specimen on the --

MR. MADDEN: Both sides, yes.

MR. MICHELSON: Do we have numbers on those?

MR. MADDEN: Three twenty-five degrees fahrenheit, temperature rise 650 fahrenheit.

MR. MICHELSON: Three twenty-five in the three hours?

MR. MADDEN: Six fifty in three hours.

MR. MICHELSON: Six fifty rise.

MR. MADDEN: Right, above ambient. Fire resistive rating fuel load comparison, this is what NBS did and this is relatively not new. It has been around for a long time. Thirty minutes relates to -- this would be the hourly resistive rating that would be given to a device. A thirty minute rating basically equates to a structure or a compartment with a five pound per square foot loading.

MR. MICHELSON: Let me --

MR. MADDEN: About 40,000 btu's per square foot.

MR. MICHELSON: The 650 degree rise, are they purposely attempting to keep the cool side of the test specimen from having any air convection around it or anything?

MR. MADDEN: The 650 rise --

MR. MICHELSON: This rise depends upon what the heat flux is through the door.

MR. MADDEN: The 650 rise, the original intent of the rise was that if something came in contact combustible such -- maybe cotton waste to keep it from igniting.

MR. MICHELSON: My main interest and concern in this case, of course is, given fire door how much of a heat source is that fire door to the room that it is protecting. In other words, how much does it heat up the room by getting up to 650 degrees on the surface?

MR. NOTLEY: The test furnace is located in a large enclosure. It is kept at ambient temperature.

MR. MICHELSON: On the outside of the test specimen.

MR. NOTLEY: Yes.

MR. MICHELSON: By ventilation or something.

MR. MADDEN: Yes, by ventilation.

MR. MICHELSON: This is being cooled by air flow past the --

MR. MADDEN: Normal air flow in the room.

MR. MICHELSON: It still reaches 650. It is already experiencing a high heat flux probably through it.

MR. MADDEN: That is 650 on the surface of the doors.

MR. MICHELSON: That's probably a good indicator. It may get a lot hotter than that in a confined room on the opposite side. The air isn't necessarily circulating around the door at all in the real world, and maybe no heat removal. The 650 was with an induced cooling on the cool side of the door.

MR. MADDEN: No, there's no --

MR. MICHELSON: I misunderstood. I thought you said you had fan cooling.

MR. MADDEN: Sitting in this room --

MR. MCCRACKEN: The furnace in this room --

MR. MICHELSON: The room is -- what is the air temperature in the room?

MR. MADDEN: Ambient.

MR. NOTLEY: Whatever we have here.

MR. MICHELSON: You mean it's 650 in the room?

MR. MADDEN: No, ambient.

MR. MCCRACKEN: Ambient to this room. You put the furnace in this room --

MR. NOTLEY: Seventy-eight degrees.

MR. MICHELSON: Then I'm back to my question. You have done whatever it takes to keep this room at normal temperatures.

MR. MADDEN: With normal HVAC.

MR. MICHELSON: For normal HVAC. The door experiencing the test is going to be 650 degrees fahrenheit on this room side; is that right? If I hadn't provided --

MR. MADDEN: For certain enclosure devices --

MR. MICHELSON: The point is, if I hadn't provided ventilation to my room here during the test that door would have got a lot hotter in the real world case. But it passed the test because you did ventilate the room.

MR. MCCRACKEN: The majority of rooms in power plants have ventilation.

MR. MICHELSON: Under these circumstances, I don't know that you can even make that statement. I don't know. You would have to look to see whether they are ventilated in that area or not.

MR. MCCRACKEN: We are not hypothesizing that this is a four foot enclosure.

MR. MICHELSON: No, but we are hypothesizing that this is a fire. Unless you analyze what all the ventilation systems are lost -- a normal ventilation system might very well be lost because it's not two train. Only emergency ventilation is two train. Emergency ventilation is only in certain areas, not in all areas. You can't say how hot that room is until you look.

The meaning of the 650 and the 650 is with keeping normal ambient temperatures on the cool side of the test.

MR. CATTON: Convection cooling is not very good anyway, Carl. Heat transfer coefficient of one --

MR. MICHELSON: It depends on how that cooling --

MR. CATTON: With the door size what it is --

MR. MICHELSON: He didn't say natural convection, he said he had heating and ventilating systems to keep the room at normal temperature on --

MR. CATTON: Still, a surface in this room -- and this room is ventilated -- that wall over there, heat transfer coefficient is one. With the amount of heat that I am going to transfer into a room this size is not too great.

MR. MICHELSON: The 650 can be pretty substantial.

MR. CATTON: If you get 650 on this side.

MR. MICHELSON: These are big doors. It gets 650 on the cool side. That is what he is saying.

MR. MADDEN: Some of these doors --

MR. MICHELSON: How cool the air was kept to --

MR. CATTON: Hopefully when we get all this documentation like the ASTM and whatever, when we read them we should know what they do, right?

MR. MCCRACKEN: I think you need to go through the slides to understand in perspective what that means.

MR. CATTON: Okay. Go for it.

MR. QUINTIERE: I would still like to come back to this point though. I think you have this criteria and you are doing all these tests. I think what you are even saying is that you are never going to get a three hour fire --

MR. MADDEN: That is correct.

MR. QUINTIERE: This is such overkill that is not the real hazard that you are talking about.

MR. MADDEN: Right.

MR. QUINTIERE: I tend to agree with that for the most part. What I say the real hazard is, is some understanding of where the smoke and hot gases are going that will leak past all of these barriers whether they are closed or not or, in the case where you come and open up this room it will go out the doors. I think that is the more serious thing, and it doesn't necessarily mean that you have a hazard there but it means that you ought to think about analyzing the problem that way.

MR. MADDEN: Getting back to the slide again There is some correlation between fuel load and the hour resistive rating and combustible loading in compartments. This is assuming that all of this stuff instantaneously goes up in flames and combusts completely. A major of the fuel combustibles are contributors to the nuclear facility. A majority I would classify as ordinary combustibles such as cable insulation.

[Slide.]

If you will look at -- I tried to go back and do a quick look at about -- I took ten facilities and just took them off my shelf. I calculated what an average, approximate average fuel load for the cable spreading would be which is probably our most densely combustible area in the plant. It equates to be about 25 pounds per square foot.

MR. CATTON: What is the typical area of a spreading room?

MR. MADDEN: You mean as far as square footage?

MR. CATTON: Yes, just to get an idea.

MR. MADDEN: Four or 5,000 square feet, maybe.

MR. CATTON: They are that big?

MR. MICHELSON: At least. Of course, you have to watch what you call a cable spreading room. Some plants have vast amounts of cable in areas that they don't even call spreading rooms.

MR. MADDEN: Yes, I understand some of them have cable -- some have corridors that have vast amounts of cable. There are a lot of plants that run a lot of their cables and conduit which have very minimal combustibles exposed. There are some plants which use what they call rigid cable or armored cable.

MR. MCCRACKEN: Whatever you do, don't say armored cable.

MR. MICHELSON: No.

[Laughter.]

MR. MADDEN: Excuse me. We treat them as combustibles.

MR. MICHELSON: They are combustible.

MR. CATTON: Are we going to get a lecture, Charlie?

MR. WYLIE: You get anything hot enough and it will burn.

MR. MADDEN: We have a three hour barrier -- fire area around the cable spreading room. We also provide some other fire protection for that enclosure; fire and smoke detection, fixed automatic suppression, and manual fire suppression capability for that.

MR. CATTON: Is the number of 25 pounds per square foot, is that big number or a small number?

MR. MADDEN: That's a big number.

MR. CATTON: From the point of view of isolation and so forth, is that big number or small number?

MR. MADDEN: I think it's fairly large. I am not -- if you go back to this slide and use this as some kind of

-- what am trying to do is keep it apples to apples as far as the comparison goes. Twenty-five is somewhere around two and one-half hours in the standard time and temperature curve. The total amount of energy that could have been released by that combustibles if it was instantaneously all burned up and ignited.

MR. MICHELSON: You are talking about pounds per square foot of floor area. If you go into a cable spreading room and you look up through five, six, seven trays and look at a square foot all the way up through those trays, I am surprised there aren't a lot bigger loadings than this. Cable is heavy and sometimes it's in two, three, four cables deep in those trays.

MR. MADDEN: We are only looking at the insulation and not --

MR. MICHELSON: This is the density, excuse me. This is density -- yes, that sounds reasonable.

MR. MADDEN: If you look at a charging pump room for example which is pretty critical to keeping RCS makeup within its bounds charging pump, one train, I am only concentrating on that. I count on average about 1.5 pounds per square foot. That would be required to have a three hour fire area around it, fire and smoke detection backed up by manual fire suppression capability.

MR. MICHELSON: Have you looked at transformer vaults at all inside of reactor buildings?

MR. MADDEN: Have I looked at -- the only ones that I have looked at or are familiar with are the vaults in Sequoyah.

MR. MICHELSON: Yes. For instance, that's a good example. That's liquid filled, those are oil filled transformers.

MR. MADDEN: That's correct.

MR. MICHELSON: I am just wondering, from that recent experience in downtown New York City on two occasions in the last year when those transformers blew up, they claim they got a whole lot of heat and smoke and fire and whatever from both cases.

MR. MADDEN: Those transformers are vented directly to the outside. The structure -- one side of them has --

MR. MICHELSON: You are talking now about Sequoyah.

MR. MADDEN: Yes. What does ventilating to the outside have to do with the explosion and fire --

MR. MADDEN: Even if you do have an explosion, it does provide a vent path for an explosion.

MR. MICHELSON: I was thinking of spreading the oil all over the room, and apparently those transformers -- the oil does burn while it is propagating from the --

MR. MADDEN: It is diked and sumped.

MR. MICHELSON: Oh, no. When the transformer blows up it is sort of a small fireball until -- it depends upon cooling down on surfaces to become below the flash point of the material. In other words -- if all you say were true, then they wouldn't burn when the transformers faulted.

MR. MADDEN: With oil those transformers can burn at Sequoyah. The redundant train is separated.

MR. MICHELSON: If you concede they burn, then what kind of provisions do they have to take care of, first of all -- before the fire they blow apart, they literally explode when they fault. A small you can accommodate with relief, big faults the transformer blows up.

The fire is a result of that explosion until such time as the area is cooled down, the oil is cooled down enough not to burn. If it's a good oil and some of the PCB's that have very high flash points -- you can't even use those oils anymore. Do you look at all the transformer fires?

MR. MADDEN: We look at internal transformer and oil transformers in the structure. The only one that I am really familiar with in detail is Sequoyah.

MR. WYLIE: Are there any other plants that use oil fuel transformers inside the plant?

MR. MADDEN: Yes, there are a few other plants that do.

MR. MICHELSON: Quite a few, I have seen.

MR. WYLIE: Quite a few? I have never seen them except Sequoyah.

MR. MICHELSON: There is quite a few of them.

MR. WYLIE: Inside the plant?

MR. MICHELSON: Yes.

MR. WYLIE: Most of them use dry types.

MR. MICHELSON: Most of them now use dry types.

MR. WYLIE: We always used dry types.

MR. MICHELSON: I don't want to name names, but if you would like I will name some names.

MR. CATTON: The core melt probability that was out of --

MR. MICHELSON: These were even still -- these were PCB transformers yet and weren't diked besides, which is double whammy against them.

MR. MADDEN: Going back to the slide now --

MR. MICHELSON: You do look at transformers.

MR. MADDEN: Yes.

MR. MICHELSON: When people put oil fuel transformers you do the analysis.

MR. MADDEN: The guidelines do not -- our standard review plan guidelines do not convey to the licensee to use oil filled transformers. There is existing plant conditions out there that, yes, they were there before the guidelines were written. Like I said, I am familiar with Sequoyah's design. The compartments are not on the outside, there is suppression, there is diking and sumping in that room. It is one-train oriented. There is another train in another location of the plant, and they are separated from one another.

MR. MICHELSON: There is a wall between them. You have actually looked at the explosion potential and whether the wall stays there, keeping in mind there are four transformers in the one room and five in the other. Those walls aren't designed to keep the effects from getting to all four of the transformers in a given room.

[Slide.]

MR. MADDEN: Back to the slides. I looked at a battery room that has about four pounds of combustibles per square foot, one train again. Switch gear room, three pounds of combustibles per square foot on average.

MR. MICHELSON: Are these the plastic battery cases that are the combustibles?

MR. MADDEN: Primarily, yes, sir.

MR. MICHELSON: How prevalent is the plastic case used now as opposed to glass?

MR. MADDEN: Plastic, I believe it is used quite a bit in the facilities.

MR. MICHELSON: I don't know, but I have seen a lot of glass and have seen some plastic.

MR. MADDEN: It is used quite a bit.

[Slide.]

The last area that usually raises eyebrows and everybody asks questions about is the diesel generator area. There is approximately 14 pounds per square foot average. Fire protection consists of three hour envelope, fire detection, automatic fire suppression, manual fire suppression capability of the area, and special protection for the day tank or fuel source in the fuel transfer capability.

MR. MICHELSON: Does the fuel load include the fuel oil?

MR. MADDEN: It depends on the scenario. In all cases no, in these cases it was not included.

MR. MICHELSON: The 14 is the cabling and stuff in the room but not the fuel oil. The fuel oil varies from plant to plant, I am sure, anywhere from a few hundred gallons up to a couple of thousand gallons in the room.

MR. MADDEN: No. The 550 gallons --

MR. MICHELSON: Each compartment, I should say.

MR. MADDEN: Five hundred and fifty gallons is --

MR. MICHELSON: As I recall, South Texas had four enormous oil tanks right below the diesel engines.

MR. MADDEN: Below the diesel engines?

MR. MICHELSON: Yes.

MR. MADDEN: In another compartment?

MR. MICHELSON: It's the same compartment, but it's all called the diesel compartment. It had two --

MR. MADDEN: If you look at South Texas, that floor slab probably between the diesel and the diesel fuel tank is a concrete slab which is fire rated.

MR. MICHELSON: I wasn't so much worried about the diesel associated with the fuel as I was the fuel coming out into the corridor outside where the fuel tanks were.

MR. MADDEN: The fuel tanks should be diked and sumped.

MR. MICHELSON: They were not underground, and they weren't diked to take the full capacity of the tanks. As I recall, that was the problem and raised this issue when we looked at South Texas. We also looked -- the day tanks generally are on the order of two to 300 gallons at least.

MR. MADDEN: Maximum allowed by the guidelines, SRP guidelines is 550 per --

MR. MICHELSON: Five-fifty, that's a lot of fuel oil to ignite if it got spread around. There's a lot of igniters, high pressure oil from the injectors --

MR. MADDEN: You have to get it out of the tank.

MR. MICHELSON: You have to break an injection line. There are lots of them.

MR. MADDEN: That's why we have a redundant diesel also, and another cubicle.

MR. MICHELSON: I am talking about the fire resulting now, not the redundancy question.

MR. MADDEN: That's the defense-in-depth approach. The hose stream test, there is a hose stream test done on these specimens. Basically, they fire test the second specimen for up to one hour, they pull the specimen off the furnace, and they immediately apply a hose stream to the exposed side. That hose stream -- this is the criteria for that hose stream -- it has to be 20 feet in distance from the specimen. It's a two and one-half inch hose with an inch and one-half discharge nozzle calibrated national NBS nozzle. The nozzle pressure is 30 psi, and a discharge duration of two and one-half minutes onto the specimen.

There's a note on the bottom here, any water passage through the specimen is considered a failure, any minute or even trace of water.

MR. CATTON: What is this test for?

MR. MADDEN: This is for integrity after fire exposure of penetration seal or a door.

MR. CATTON: Okay.

MR. MICHELSON: Does this mean then that the flamastic coating on the cable tray for instance would resist this impingement?

MR. MADDEN: Flamastic is not a fire resistive or fire --

MR. MICHELSON: It's used for the fire barrier where the cable tray penetrates through the three hour wall.

MR. MADDEN: Flamastic is used as a coating on a fire barrier and, yes, it would have to pass that.

MR. MICHELSON: That barrier is where the cable penetrates the wall if I were to turn the hose spray on for this period of time. Are these the -- is this a proscribed device then for spraying water and you can't use other devices that might give you larger, heavier impingements?

MR. MADDEN: I am not saying that you can't use heavier impingements. This is a device which would -- an inch and one-half slug of water at 30 pounds is significant. It is probably equivalent to that you would expect to see out of an inch and one-half fog nozzle in a power plant being applied by a fire brigade member.

MR. MICHELSON: Is that a typical hose size in the power plant or are there bigger hoses?

MR. MADDEN: No, an inch and one-half is typical hose size.

MR. MICHELSON: This is a typical worst case you think.

MR. MADDEN: Yes.

MR. MICHELSON: For a power plant, okay.

MR. QUINTIERE: Pat, I just want to make a comment. In all those previous slides where you use sort of equivalent fuel load, pounds per square foot, I just want to point out that the original work was done in terms of wood cribs. You are linking it to a proscribed time temperature curve.

In these spaces, the way the fire will develop would depend on the particular fuel that you have there and on its configuration. Its time temperature curve in that space could be quite different.

MR. MADDEN: Granted.

MR. QUINTIERE: To accentuate this, if you had a liquid spill fire in a space or transformer fire, you would have a very large temperature in the early minutes of that fire which would be in contrast to the standard E-119. That's why the petroleum industry for structures uses a different curve.

MR. MADDEN: There is no disagreement there.

MR. QUINTIERE: In addition, if you at some point in the fire's development the fire will become ventilation limited. What really determines the rate of fuel consumption is not how much fuel that you have on the floor but the size of the vents that you have.

MR. MADDEN: That's why I tried to make a correlation here that in the power plant in the actual what I call auxiliary building -- and I'm not talking about the diesel generator structure, I am talking about the auxiliary building where we have the majority of the safe shutdown related components. We are looking at ordinary combustibles -- I am not going to say are equivalent to wood but closely resemble wood as far as burning characteristics.

If you are looking at a crib fire versus a bundled cable tray, probably the crib fire is going to be more severe in burning characteristics than bundle cable in a cable tray.

MR. QUINTIERE: I don't know the answer to that. One thing that I point out to you that maybe could be used constructively is, if you know what the fuel content is in terms of heat of combustion and in terms of loading and you assume that there is going to be a vent that opens to this space, whether it be the size of the door or whatever, that vent allows you to calculate an upper limit on the rate of burning.

Knowing what fuel content you have in the room, then you can come up with a duration. That is the shortest time that this fire can burn at relatively maximum temperature. Then, you can relate that back to your three hour barrier.

MR. MADDEN: I think we do that. That has been done. We have been doing that in some degree. We do know the heat values of all the different materials. This is just an apple to apple correlation. If we have a highl, volatile material that puts out its heat load the first five minutes of the fire for example and let's say it goes r'ght to 1,925 degrees fahrenheit up in fi nutes, theoretically the three hour boundary .s just a five minute barrier.

We have looked at that to some degree. Not five minute, but we have looked at that to some degree. We have looked at factoring in with the fuel load the different burning characteristics or heat values.

MR. CATTON: The three hour door that we heard about from GE on the diesel -- it was GE, wasn't it?

MR. MICHELSON: I was just going to raise that.

MR. CATTON: It must be different than the three hour door used elsewhere?

MR. MADDEN: No. The three hour door --

MR. CATTON: The oil certainly burns different than cable.

MR. MADDEN: Yes, if you want to look at it --

MR. MICHELSON: The gap under the door is a bit of a problem too.

MR. CATTON: How else would they look at it? I am repeating back to you what you just said.

MR. MADDEN: What I am indicating to you is that -- what I am trying to indicate to you is that our door ratings are three hours in relation to an ASTM E-119 test.

MR. CATTON: Right.

MR. MADDEN: Now, there are situations as Jim nas just brought forth, that the fuel characteristics are the burning characteristics of material. When you equate it, the temperature rise or temperature may go drastically high before -- it doesn't follow standard time temperature curve.

MR. CATTON: I understand.

MR. MADDEN: It goes greater in the first few minutes of the fire. Sometime out there it flattens out and probably comes close to paralleling the standard time temperature curve. I guess where I am leading with this is, we would limit those volatile materials in those locations. We would reduce the fuel load in those locations that closely match the characteristics of that three hour door.

MR. MICHELSON: Have you ever done that in the case of a diesel generator compartment?

MR. MADDEN: The diesel generator compartment, for example, I think we just demonstrated right here that the fuel load is way below that of what would be required to --

MR. MICHELSON: We just established though that that didn't include the fuel oil in the room. It's the fuel oil that would burn quickly and provide this --

MR. CATTON: The 550 gallons.

MR. MADDEN: We do not arbitrarily rupture the tank and spread the 550 gallons throughout the room. The reason we didn't do that is generally these day tanks are -- if we do have a rupture of a tank it is sumped, the sump is drained to a safe location.

MR. MICHELSON: I think it's the pipe that you would worry about, and the pipe isn't necessarily sumped.

MR. MADDEN: That may be true. You may be adding -- but you have sprinkler protection there, and that's the other envelope of the protection of diesel generator.

MR. MICHELSON: You don't do anything -- you do not give a diesel compartment any special consideration from the viewpoint of the requirements for the door.

MR. MADDEN: No.

MR. MICHELSON: In other words, you don't require that it be leak tight door from the point of fuel oil running across the floor. At South Texas they had to -- we postulate an interesting event which occurred about a month after we postulated it. That was the case where you would overflow -- they have a room above where they have the pumping system and so forth. Somebody was transferring oil from one tank to another and they didn't pay attention, and the oil ran over the floor and ran down to the room below and started running all over the floor there.

Now, that's the starting of the event and the next thing is the ignition source. That is not always that difficult to find. Oil can get away from you when you may be a little uncareful in what you are doing. It happened, and in that case it was 1,500 gallons as I recall that ended up being released in the room.

Those are the kinds of things that you worry a little about. We are trying to establish no special requirements on the doors. This gives me a great deal of pain in the case of Westinghouse APWR or in the diesel generator compartment is on the same floor as the control building and just down the hall from the control room. With no special requirements on that door and no provisions for possible ignition, that might even be explosive in nature. It looks like you are putting the control room in --

MR. MADDEN: There are some other considerations.

MR. CATTON: Carl, something of interest that Tom just handed me in response to this concern when it was raised. The staff has not in the past considered and does not now consider credible an explosion in the EDG room of sufficient size to cause catastrophic failure to the reinforced concrete enclosures of these rooms.

MR. MICHELSON: It's the door that I am worried about and not the room.

MR. CATTON: I understand that, but somehow in response to the concerns that were raised they missed that.

MR. MICHELSON: You worry about the door coming off. The doors come off -- they can't even take about a pound of positive pressure generally. These are not heavy duty pressure doors, these are simply fire barriers. The concern is that a relatively modest rise in pressure in the room will blow the door off. This has happened when people have set off CO2 inadvertently in two charges instead of one, and there was enough pressure then to blow the door off the room. That happened at Sequoyah a few years back as you recall.

These doors are not -- you don't talk about the concrete walls, you talk about the doors and you talk about the proximity of the control room to this event which is just down the hall.

MR. CATTON: I guess in this case, isn't the control room just down the hall from the --

MR. MICHELSON: Yes. This is the one where it is directly down -- it was down the hall and around the corner, probably about 40 to 50 feet of hall length.

MR. NOTLEY: Those words you just read are the ones that I supplied to the project manager on that.

MR. MICHELSON: Okay.

MR. CATTON: What about the doors?

MR. MICHE'SON: As opposed to the walls.

MR. NOTLEY: As I was looking at the print on that, you talk about it being just down the hall. My recollection is that it was somewhere between 100 and 150 feet down the hall and around two bends.

MR. MICHELSON: It was around one bend to the door of the control room. Two bends, if you want to enter the control room, yes. When you open the door and walk in, that's the second bend. It was straight out, turn and there's the door to the control room. My scale didn't show 150 feet, it showed more like about 50 feet, but I will concede the 150 feet and say that's irrelevant. How about the doors? Will the doors withstand whatever happens in the diesel compartment? Are there any special requirements on these doors from the viewpoint of the hazard?

MR. NOTLEY: No.

MR. MICHELSON: Then, I think we have our answer.

MR. MADDEN: From the standpoint of a diesel generator explosion in the -- let's talk about a fire in a diesel generator building. One end of the diesel generator building is generally open to the atmosphere.

MR. MICHELSON: This is a diesel generator compartment within the auxiliary building, and the control room in this case is also within the auxiliary building. It is all in one building. The control room is in one corner and the diesel compartment is up the road.

MR. NOTLEY: The combustion air coming in the -- I wish I could remember more clearly what it looked like.

MR. CATTON: I would like to save it for when we take a look at the plant again. We are running out of time again.

MR. GWAL: Pat, I have just a fast clarification on the statement you made.

MR. MICHELSON: Who are you?

MR. GWAL: My name is Gwal, I am from the Defense Safety Board. You stated that flamastic will take the fire rating and all that. I just want to clarify that flamastic is only used to bring the cable to IPEEE 383 qualifications.

MR. MADDEN: Some fire stop designs use flamastic as a top coat. I think that's where Mr. Michelson was talking --

MR. GWAL: The one he was talking was the tray.

MR. MADDEN: He was talking about a penetration seal that flamastic is used as a top coat.

MR. GWAL: He was talking about the seal then.

MR. MADDEN: The seal.

[Slide.]

I would like to move on to the Brunswick fire, unless you --

MR. CATTON: I would too, because if we don't we won't hear it.

MR. MADDEN: On December 4, 1990, Brunswick had a small fire in a drywell personnel airlock. What I would like to do is kind of paint the picture to you and describe the conditions of the plant at the time of the fire.

At the time of the fire the plant was in a refueling maintenance outage. The plant was defueled, there was no fuel in the reactor. It was going through recirculation pipe replacement. This is a disclaimer note here, that the licensee is still in the middle of their investigation as far as putting together the exact cause of the fire, and the extent of damage is still being looked at and clean up activities are still being looked at.

[Slide.]

Personnel airlock configuration at the time of the fire. Personnel lock was used as a primary point for -- penetration point for cables, hose and ducting, which would support the drywell activities or internal to the drywell activities. One side of the airlock, there was a metal air ducting which held hepa filters and that was installed in one side of the airlock. At the top portion of the airlock there was a cable tray constructed of plywood, held up with metal scaffolding. The plywood was a fire retardant type of plywood treated with a fire retardant material.

The cables and hoses transversing that plywood tray were wrapped in a plastic that resists contamination. All the hoses and cables were sleeved going from the point of entry into the drywell to their termination point into the drywell with a thin plastic sleeving.

MR. WYLIE: These were construction cables?

MR. MADDEN: They were all construction cables. I am going to get to that. What was in the drywell or onto the drywell in the penetration or penetrating through the access hatch, 36 post-weld heat treatment cables. There were six post-weld heat treatment systems in operation at the time -- not at the time but were operating at any given time during this phase of recirc pipe replacement and six cables each to each one of those units.

There were 24 post-weld heat treatment thermocouple cables going through that area. That area from the plywood to the top of the drywell liner was about three feet. You had about three feet and all this stuff was going through that three feet.

Twenty-four hydraulic hoses for machining equipment. We will talk a little bit about the hydraulic fluid going through those, it was a water based hydraulic fluid. There were nine cables for the hydraulic power units. Hepa duct hose for the work that they were doing on reactor water clean up valve, F-001 and HPCI valve F-002.

Then there is air hose, drop cords, some welding leads going through there, argonne purge hose and cables for recording various activities that were occurring on the F-001 and F-002 valves.

[Slide.]

Drywell activities at the time of the fire, this is somewhere around close to 4:00 in the morning. Post-weld heat treatment was being performed on the G&K nozzle, recirc nozzle. Primarily the G nozzle was being looked at, at the time of -- being worked on at the time of the fire.

For your familiarization with post-weld heat treatment, it is a machine that is very similar to a welder. It works real good with a dead short across it, that's what it is supposed to do. The output cables that were running through the access hatch are connected to resister pads. Those resister pads are attached to the nozzle itself to go ahead and heat treat the weld, and they generate about 1,100 degrees up as far as temperature goes.

Like I said, resister pads are used to apply the heat to the nozzle or the weld for heat treat.

[Slide.]

The sequence of events that occurred. These are not all inclusive. These are some that I have picked up a lot of information on this fire and have kind of put this into some kind of perspective. At 3:55 a health physics or physicist or HP notifies the control room of smoke and the control room dispatches an auxiliary operator to go down and start investigating.

At 3:57 the HP decides that he wants to use the lead HP, he wants the drywell evacuated and goes ahead and decides to evacuate the drywell. Power to the post-weld heat treatment equipment, at this time they started securing that power. Project coordinator which is like the project engineer, he was there. He also notifies the control room that they have smoke. Control operator in the control room at 4:02 acknowledges that they received a fire alarm on the firm alarm panel.

At 4:10 the project coordinator sees the small fire approximately about one foot long with flames three-quarters to one inch high on wiring in the personnel access hatch overhead. At 4:11 the shift foreman, he goes down to do some investigation. He is briefed on the fire and goes back to the control room to start the ball rolling. At 4:16 the shift fire commander and fire brigade leader, they are heading for the fire.

At 4:18 the commander enters the reactor building and does a size up. He tries an initial attack on this congested opening, and it was very congested, with a fire extinguisher. At 4:20 the fire alarms are sounded and the fire brigade is summoned.

[Slide.]

At 4:22 a second fire brigade member enters the reactor building. He is fully dressed out. Somewhere in that one minute timeframe the whole brigade arrives there, and it's not clear as the sequence, as far as one, two, three, four, five. They had seven people total that dressed out and responded to this alarm.

The second brigade members arrives. The brigade leader and that member, they go ahead and try with three more extinguishers. Now, you have to -- I have to put this in a little perspective for you. Between the hepa filter metal ducting going through the personnel access hatch and the wall of the liner there was about two and one-half feet. So, the guy that is either my size or Dr. Catton's size -- I am not going to pick on him -- with an air cylinder on the back in full fire fighting turnout gear, it would be very cumbersome or awkward for him to get in there and get up into the overhead to put extinguishing agent onto the fire.

Also at the time of the fire -- this is another critical thing -- the drywell purge fans were operating. We will get down here and you will see the drywell at 4:32 the fans were secured. The air flow was from reactor building to drywell, so there was air flow through the access hatch. I don't know the exact velocity of the air flow but it was high in nature because of the constricting of all the equipment going through it.

At 4:25 reactor building evacuation alarm is sounded. At 4:29 unusual event is declared. At 4:32 the drywell purge fan was secured, and this was done to isolate the air flow through and the spread of fire within the airlock.

[Slide.]

I had to go back a little bit and say at 4:22 when the fire brigade still used the initial hose line on it, it was somewhat successful of knocking down the fire in there, but they couldn't get complete extinguishment. At 4:32 a decision was made to bring in a second hose line. The second hose line was brought in from the equipment hatch side. I am going to try to give you some bearings here as to what went on exactly. Let me see if I got this right.

[Slide.]

See this area here, this area is what was involved in the fire, this little box right here. The original fire brigade members, the two that initially showed up two minutes after the fire alarm was sounded, they brought in the fire hose through this opening from this hose station and tried to extinguish the fire from this side. Due to the congestion in that area, it made it very difficult for them to actually get into the personnel access hatch and actually get water directly onto the fire.

They brought in a second hose line, added hose at

4:32 and brought it around into this configuration into the hatch.

[Slide.]

At 4:33 reactor building ventilation was secured, basically a smoke control measure not to draw the flames and the smoke back into the reactor building because the air flow had been in the opposite direction now. Since the drywell purge fans were of greater capacity than the reactor building ventilation system. You always had an air flow into the drywell whenever the drywell purge fans are operating.

MR. MICHELSON: Smoke control was to keep it from getting back into the containment and not to protect the workers?

MR. MADDEN: No. Not to get it back into the reactor building. The smoke flow was into the drywell itself. I will get into this a little bit.

At 4:35, personnel accountability evacuation of the reactor building was complete, all the people were out and all accounted for that was necessary. At 4:37 they were in position to commence the fire attack again from the inside of the drywell. At 4:42 there was a report that they were being successful, that they had water on the fire on the drywell side in the drywell.

[Slide.]

Going on. At 4:45 it was reported that all the temporary power cables were secure. At 4:59 there was another note in one of the logs that said that the fire intensity was decreasing. At 5:10 they went ahead and started up the RB or reactor building ventilation system again. I think that was primarily for airborne contamination they didn't want to have a lot of airborne contaminants in that area.

At 5:12, fire fighting efforts from the reactor building side of the airlock were discontinued because the internal drywell hose line had the fire under control and knocked down, and virtually extinguished at this point.

MR. MICHELSON: Did they ever see the flame that was resulting from the fire or just a lot of smoke?

MR. MADDEN: No, they saw the flame.

MR. MICHELSON: How big was the flame now? You talked about the earlier flame.

MR. MADDEN: The flame from what I understand -- I wasn't there to investigate -- was maybe three to four feet on the drywell side coming out of the drywell.

MR. MICHELSON: You say four feet of flame?

MR. MADDEN: Flame.

MR. MICHELSON: Flapping out?

MR. MADDEN: Yes, about this high coming out of the side of the drywell.

MR. MICHELSON: That's a pretty good development then. For that kind of cabling, that's a pretty good development.

MR. MADDEN: Yes, there were 72 cables going through the area. We will get into the cause and why this fire was a little different than the normal power plant.

MR. MICHELSON: Wood was burning too?

MR. MADDEN: No.

MR. MICHELSON: No, that's a pretty good development then for cable.

MR. MADDEN: It was the plastic sleeving that was on the cable that was a major fuel contributor for decontamination purposes. There was a light plastic sleeving put on there. We will talk a little bit about the fire propagation and how long it went down these cables here in a second.

At 5:27 they started the drywell purge again. At 5:30 the fire was declared under control. They only ran -- at 5:27 the drywell purge for two minutes, and that was purely a smoke control measure. At 5:40 they restarted the drywell purge fan and left it running. At 5:49 they determined that the fire was completely extinguished and overhauled, and the UE was secured at 5:52. Unusual event. It's an emergency classification for a facility.

[Slide.]

Let's talk a little bit about the description of the fire. The fire origin was just inside the first airlock door and the originator was the post-weld heat treatment cables, cables which were carrying the most ampere. The fire was confined to the cables and the airlock overhead supported by the plywoods and the scaffolding. Due to increased airflow, this was a contributor that contributed to the propagation of the fire in the air well toward the drywell side.

On the point of fire origin, you can see that pretty good, the fire propagated approximately 12 feet horizontally in the airlock along the plywood tray.

MR. MICHELSON: An air line was shut off, I assume.

MR. MADDEN: The airlock?

MR. MICHELSON: The air line. There was an air line in there I though --

MR. MADDEN: Yes, it probably wasn't being used at the time.

MR. MICHELSON: I mean, it was depressurized.

MR. MADDEN: Yes. Description continued. Cabling was enclosed in continuous plastic sleeving to limit contamination. This was probably one of the major contributors to fire propagation in the drywell, and there was some heat deformation to that plastic sleeving approximately four feet into the drywell itself.

MR. WYLIE: What was the plastic, polyethylene?

MR. MADDEN: Yes, exactly. For contamination purposes, they routed the cable in there so when they pulled the cable out it wouldn't be an extensive decontamination process that they would have to go through.

The speculated cause of the fire right now is due to cable overload. The output power cables associated with the G nozzle post-weld heat treatment process, those were the guys that it has been determined they were overloaded. Cracks in the D and G nozzle required a special heater to perform the post-weld heat treatment. The G nozzle heater drew up to 150 amps and the de-rating of the cables due to the bundling in the sleeving, that was never considered and should have been considered.

Based on the as-built configuration net maximum amp capacity should have been probably 50 percent of the rating of those cables. Those cables were rated somewhere in between -- they were rated for 100 amps.

MR. WYLIE: Were they welding cables?

MR. MADDEN: They are welding cables.

MR. WYLIE: They are not fire retardant cables?

MR. MADDEN: No, sir, they are not IPEEE 383 cables.

MR. WYLIE: Probably hypalon?

MR. MADDEN: My guess would probably be that they were poly vinyl chloride of some type.

MR. WYLIE: They were rubber, weren't they? Welding cables are usually rubber.

MR. MADDEN: It has a rubber jacket, yes.

MR. WYLIE: It has a rubber insulation, too.

MR. MADDEN: Right.

MR. WYLIE: Ethylene propylene normally and then has a hypalon jacket.

MR. MADDEN: If you want to know what the material is, I can probably find that out for you and get back to you.

MR. WYLIE: It would be interesting.

MR. MADDEN: Okay, I will.

MR. MICHELSON: You ran an experiment here in which you find out how cable burns, and it would be nice to know what kind of cable we are dealing with.

MR. MADDEN: They are not IPEEE 383 cables and they are not -- the power cable that we think with regard to power application.

MR. MICHELSON: The interesting question, of course, is how close to IPEEE 383 type cable might have that have been. It depends on how that was made and so forth.

MR. MADDEN: I seriously don't think they are very close at all.

MR. MICHELSON: I don't know.

MR. MADDEN: The effects of the fire on equipment, taking a look at the top inside the liner itself after they got in and they started cleaning up the area they did an evaluation and investigation of the liner. The top coat of paint blistered inside the liner directly above the fire. The primer on the liner was still in tact. This, from fire investigative techniques, suggests that the peak temperature was in the range of 400 and 450 degrees inside that little box where that fire was burning.

Fire retardant plywood, minor contributor to the fire. Minor char and no burn through for that cable tray. You had some cables sitting up there shortening and sparking and we didn't get any burn through, which is a pretty significant test of the plywood I would say.

December 5, 1990, after they got everything out of the personnel access hatch or airlock, they went ahead and subjected it to an LLRT. It passed its LLRT. There was no damage to the seal of the airlock or the airlock itself. From everything that I read here, they didn't do any fixing before they performed the LLRT.

MR. WYLIE: Was that an epoxy paint?

MR. MADDEN: Yes. The airlock itself, the material is SA-516 grade 70 carbon steel. They performed hardness tests on it and found it acceptable on the airlock liner. The standard ASTM standard suggests that 392 tc 481 hardness range -- found when tested it was 399 to 425, so there was no structural deformation done to the steel due to the fire.

MR. MICHELSON: These cable trays that were made out of wood, were they solid bottom?

MR. MADDEN: Just a sheet of plywood.

MR. MICHELSON: And, sides on it as well?

MR. MADDEN: No sides.

MR. MICHELSON: Just a sheet of plywood.

MR. MADDEN: Sheet of plywood.

[Slide.]

Going into the drywell side looking at penetrations, 1X101D and 1X101F which contain the power cables to the recirc pump B, they were located approximately five feet above the liner or above the drywell liner on the drywell side. My guess is that it would be somewhere around a 32 foot level, and you are looking at 20 foot level. Twenty-eight foot is top of the -- 28 and 29 foot is top of the airlock line.

They went in and opened the penetration boxes and inspected the cabling. No internal heat or smoke damage, and they were heavily sooted. Those were the heavily -- most heavily sooted components in the area of the fire. The MSIV did not exhibit any signs of damage, they were in the general area. Specifically associated AC/DC pilot solenoid that was near the airlock had been tagged with a paper tag. There was no effects or damage to the paper tag, no effects from the fire.

SRM/IRM are immediately adjacent to the airlock, and there was no damage to the SRM or IRM.

Do you have any further questions on the fire?

MR. MICHELSON: One question. Apparently water was used on this fire for about an hour or so?

MR. MADDEN: I wouldn't say water was used for an hour straight.

MR. MICHELSON: Water was there.

MR. MADDEN: It was there. It was not applied. These guys in their fire brigade training -- if I would have gotten through the other part and went through a little bit of their training with you -- when they see smoke they just don't generate a hose train and leave it pour.

MR. MICHELSON: How much water did they use on it, how long a duration did they try to wet it down? It must have been a long time. I mean, they brought the second hose in even.

MR. MADDEN: The second hose was brought in for accessibility purposes. It was determined that the fire brigade could gain better access to actually putting the water on the flame and hitting the seat of the fire from inside the drywell than it could from the RB side of the --

MR. MICHELSON: Okay, but that was done for about an hour that they had that second hose in for about an hour. How much did they use?

MR. MADDEN: I don't know the exact amount, but I could ask the licensee that and respond back.

MR. MICHELSON: That does puzzle me why they weren't able to cool this thing down real quick once they put the water on it, unless they couldn't get the water to it.

MR. MADDEN: I don't have any times for you as far as nozzle on and nozzle off. We don't monitor that type of stuff. MR. MICHELSON: We do know when they brought the second hose in.

MR. MADDEN: Yes, we know when they laid the second hose. They laid it, they used it, and that's what extinguished the fire. They used the fire hose line, and I imagine that they saw they weren't making significant headway and they terminated that application and just held it there in standby until the second hose line was put into position.

MR. CATTON: It was about an hour.

MR. MADDEN: I would not take this information as an hour of straight application of water.

MR. MICHELSON: I was just kind of puzzled as to why this thing went on so long.

MR. CATTON: Why it took so long.

MR. WYLIE: As I recall, at Browns Ferry it only took about 20 minutes once they got the water on.

MR. MICHELSON: Once they decided to use the water, yes.

MR. MADDEN: Like I said, I will try to make --

MR. MICHELSON: That was true of the McGuire fire of the transformer -- the switch gear out on the turbine building.

MR. CATTON: Catawba.

MR. MICHELSON: Yes, Catawba. They used 300 pounds of chemicals and 150 pounds of CO_2 and finally turned the water on, and it went right out when they turned the water on.

MR. MCCRACKEN: I think what that tells you on here is that they didn't have the water on the fire.

MR. MICHELSON: Yes.

MR. MCCRACKEN: I think if you got the water on the fire the fire would have been put out relatively quickly.

MR. MADDEN: It was a problem of accessibility to get the water to where the fire actually was in the reactor building side.

MR. MICHELSON: They were helped out a little bit with a sheet of plywood, kind of confining the water and directing it.

MR. MADDEN: I don't think it was that easy with the access hatch configuration the way it is. If my memory serves me right --

MR. CATTON: Does that mean on the new reactors you have to be careful about where your combustible materials are relative to their access for fire fighting?

MR. MADDEN: Primarily, in a refueling outage for BWR they use the personnel access hatch which is a smaller access hatch for equipment access. They use the equipment hatch as personnel access.

MR. MCCRACKEN: I think the thing you don't want to forget about this particular event is that they were fully defueled.

MR. CATTON: I understand that.

MR. MCCRACKEN: If they had not been fully defueled, they could not have been in the condition they were in because you have to have the capability of re-establishing containment. The reason they fully defueled was so they could do this a lot more expeditiously. If they had to have everything set up so they could re-establish containment integrity, you would have had a different set of cables going through here.

MR. MICHELSON: We are looking at the fire I think, and not the condition of the plant at the time.

MR. CATTON: I understand. There are just many other areas that the access is difficult to get to, where you have stuff that could burn. Is that a concern?

MR. MADDEN: That's kind of a loaded question. I mean, as far as --

MR. CATTON: No, it's a question from ignorance. It's not meant to be loaded.

MR. MADDEN: If I say yes, you nail me and if I say no, you nail me.

[Laughter.]

MR. CATTON: That's life.

MR. MADDEN: Yes, I know. I would say that there was probably -- in a congested area there is multiple ways of handling a fire such as what this is. They used their preplans and came up with this second scheme if access couldn't be gained this way, go ahead and move in position another hose line. They actually implemented the basically what their preplan guided them to do.

Obviously, it worked but it took a little time. I don't know if you are familiar with the drywell at Brunswick, but it is very congested.

MR. CATTON: Not at Brunswick, but I am familiar with others.

MR. MADDEN: For them to get that in there and get across there it took a little time.

MR. MICHELSON: Aren't cable spreading rooms very congested in some plants and in some areas?

MR. MADDEN: Yes, but they also have automatic suppression systems.

MR. MICHELSON: Yes. I am just saying there --

MR. CATTON: A cable tray, it seems to me you could just put the water right up on it.

MR. MICHELSON: You saw St. Lucie. You look around a little bit and imagine how you are going to get into some of those areas with a cable tray, particularly in a confined room when the fire is burning in that room.

MR. MADDEN: I want to go back to --

MR. MICHELSON: They had a good ventilation system here at least. The guys fighting the fire weren't too bad off from a visibility viewpoint.

MR. MADDEN: This is an example of a preplan that was put into place. T' e drywell purge fan, the starting and the stopping was by the direction of the fire brigade leader using his preplan information. Yes, they thought a little bit about smoke and smoke control. They just didn't arbitrarily shut down all the fans and let the building fill up with smoke. The fans did stay functional.

MR. MICHELSON: Let me ask a little different question about cabling though. Admittedly, the safety related functions are hopefully now cabled with cabling meeting IPEEE 383. To what extent do you allow non-safety related cabling to be in the same cable trays, and if it is allowed in the same cable trays what kind of materials do you allow for the non-safety cabling?

MR. MADDEN: It is my understanding that all cables, safety related or non-safety related are IPEEE 383.

MR. MICHELSON: You would think that in a nuclear power plant, all cables are 383?

MR. WYLIE: If they are associated and in the same cable tray, they become associated.

MR. MIC.ELSON: Do they go back and recable these old plants then?

MR. WYLIE: I suspect all the plants were designed with the same cable throughout. From an economic standpoint that's the way to do it.

MR. MICHELSON: It's the older plants that I was wondering about.

MR. MADDEN: The older plants, let's talk about older plants. Let's talk about Browns Ferry. It has --

MR. MICHELSON: I am talking about Sequoyah.

MR. MADDEN: That gives it the equivalency to -- it's a fire retardant coating, and that coating is supposed -- it is imposed on them because they don't have IPEEE 383 cabling.

MR. MICHELSON: If the utility doesn't have it, then they have to provide coating on the cables?

MR. MADDEN: That's correct, sir.

MR. CATTON: We are running a little short of time again.

MR. MADDEN: I am done.

MR. CATTON: Let's take a ten minute break, and then we will hear about the PRA.

[Brief recess.]

MR. CATTON: Somewhere I have sheet --

MR. MCCRACKEN: Before we get started on the next agenda item, during three, four, or five presentations over the last year and one-half, I have told you that when the five methodology was ready, the simplified industry methodology for alternate methodology for fire protection, we would come and present it. That is in. It is my understanding that we sent you copies.

MR. CATTON: Yes.

MR. MCCRACKEN: When do you want to hear that.

MR. CATTON: The next time we can schedule the Subcommittee we would like to hear it. I notice just looking over here, there are seven items on the list. I want to make sure that we have time to explore these things.

MR. MCCRACKEN: The reason I am bringing it up here is that there would be a scheduling difficulty with industry. We will be sending out Generic Letter 88020 Supplement 4 probably at the end of next month or so. Industry then has to respond within 180 days, telling us specifically in all the areas what the are doing and methodology.

So, we need to have gotten all comments reviewed, back to them, and find acceptable by the staff the five methodology before they are going to commit to using it.

MR. MICHELSON: What date would that be then that it would need to be done if we want to look at it?

MR. MCCRACKEN: For us all to be done, the whole regulatory process to be done, I would assume that we need to be done in about three or four months from now, worst case.

MR. MICHELSON: When would you have to have ACRS comments?

MR. MCCRACKEN: A month would be nice --

MR. MICHELSON: A month from now?

MR. MCCRACKEN: Yes. Or at least having had you listen to it and telling us whether you have major heartburn.

MR. CATTON: So, we should try to schedule a meeting sometime during February.

MR. MICHELSON: Or March.

MR. MCCRACKEN: February would -- I would love

February.

MR. CATTON: Why don't we see if we can't do that.

MR. MICHELSON: That's a good time to do it, because I am going to be gone.

[Laughter.]

MR. MCCRACKEN: I insist on February.

MR. CATTON: You will be gone for all of February?

MR. MICHELSON: Half of February, at least.

MR. CATTON: The Committee is one week and there's still three weeks left. We will have to get back to you. I understand what you would like, but I am not sure I can accommodate it.

MR. MCCRACKEN: Industry is going to do the majority of the presentation. I also will be not available in March and April. We were discussing the eye earlier this morning, and I am going to go and get my eyes operated on so I get rid of this nearsighted nonsense. I will be gone for a while.

MR. CATTON: How long will that take?

MR. MCCRACKEN: It will take about four weeks. If you are over age 50, they have a different process than they do for younger people.

MR. CATTON: We will see what we can orchestrate. Certainly, I think both you and Carl need to be at the meeting. The next topic is the Brunswick Fire PRA. We are going to hear from Arthur Buslik.

There are a couple of questions that I would like you to address that you weren't here to hear about it this morning. One of the concerns is the high probability of core melt due to fire that keeps being reported in PRA's and why. I think some of the discussion this morning sort of led us to kind of conclude what the why is all about, that there is a disconnect between the PRA's and their use of the data.

The data that is collected about fire frequency is not in the right form to be used in the PRA. Something is not right. If you could kind of tell us a little bit about that.

MR. BUSLIK: Do you think, in other words, the fire PRA's over estimate core damage frequency?

MR. CATTON: Fire PRA's apparently over estimate the impact of fire. If they are not over emphasizing it, then something is wrong with what we are doing about it.

MR. MICHELSON: Some people think we are.

MR. BUSLIK: I don't know offhand that it isn't over estimated from what I have seen, but maybe as we go through this you can point out to me where --

MR. CATTON: I am not sure that I am going to see that from what you do.

MR. BUSLIK: Okay, but maybe I will.

MR. CATTON: We have NUREG-1150 which says that fire is a major contributor. We have industry PRA's which say fire is a major contributor. Yet, it doesn't seem to be, so there's a disconnect.

MR. BUSLIK: What do you mean, it doesn't seem to be?

MR. CATTON: From what the NRR fire people are doing, there seems to be a disconnect. If the probability is high as the PRA's say it is then there ought to be some more activity out there.

MR. MCCRACKEN: Let me respond a little bit. I think I must have somehow mislead you a little bit this morning. I believe that the PRA's are showing that there are vulnerabilities due to fire. I fully believe that we need to do, in the IPEEE process, an examination of all these plants. There are issues that have not been picked up by the current rules and regulations that we need the IPEEE to find.

There are vulnerabilities out there. What I was saying is the absolute value, the number that you come up with, I don't believe may be as accurate as it could be. The relative effect --

MR. CATTON: NUREG-1150 shows fire is a major contributor to core melt.

MR. MCCRACKEN: Yes.

MR. CATTON: If it's a major contributor, we ought to be paying a lot more attention to it.

MR. MCCRACKEN: We should be identifying why it's a major contributor and then do our cost benefit analysis to see if we can get them fixed.

MR. CATTON: They question then is where does the why come from, does it come from examination of a plant, does it come from doing further examination of the database? Where does it come from. That is really what I was looking for, and I thought that is what led us to conclude that some of it might be coming from the database that is input into the PRA's being inconsistent of how the PRA's use it.

MR. MCCRACKEN: I think some of what we are showing, some of the vulnerabilities that we have shown -- for instance the assumptions we have on fire barriers -- I think are overly conservative in what they have done in some of the PRA's.

MR. BUSLIK: I don't remember -- I just spoke to John Lambright today, and he told me that in NUREG-1150 failure of fire barriers was not considered to essentially contribute to the risk.

MR. CATTON: Fire barriers is a separate issue. The thing is that he stood right here -- I think it was him -- and said fires are a major contributor to core melt.

MR. MICHELSON: Do you know when the LaSalle Fire

PRA will be available?

MR. MURPHY: It's essentially momentary.

MR. MICHELSON: It's been momentary for about a year now. Is it still momentary? It's been that way for about a year and I have been trying to get it. Everybody says that is the state of the art PRA for fire. I was anxious to see what it looks like.

MR. MURPHY: I guess it's obvious that we have been having a little bit of a problem with our contractor on that, in that we are not exactly happy with how slow it is in coming out either.

MR. MICHELSON: That's because you are not agreeing with the results, or because of the slowness of the work?

MR. MURPHY: No, it's because the staff that did it, in all honesty, took on more work than they had time for. One of the things that is slipping is documentation of the results. It is something that we are exceedingly unhappy about and something that will not happen again.

MR. MICHELSON: Presumably for 1150, it is the first time that you have really tried to do a true fire PRA as opposed to Peach Bottom, where it was a pseudo fire PRA at best.

MR. MURPHY: Certainly, the LaSalle fire PRA is the most detailed one that I am aware of.

MR. MICHELSON: If it isn't done there, then it probably is not state of the art yet.

MR. MURPHY: I would s what was done in 1150 is about consistent with the type of analysis that was typical at the time --

MR. MICHELSON: That was four or five years ago or something.

MR. MURPHY: Yes.

MR. MICHELSON: I am anxiously awaiting the LaSalle. That's the only state of the art one existing, if I get my information correctly.

MR. CATTON: Maybe we better get you underway.

MR. BUSLIK: What I am going to do is basically discuss fire analysis in a fire PRA analysis with a comparison between the NUREG-1150 analysis and the Brunswick fire PRA analysis. As far as the Brunswick fire PRA analysis, my first contact with it was about a week ago when I was told that I had to give this presentation associated with it. I have some familiarity with fire PRA's generally.

[Slide.]

These steps here are NUREG-1150 type steps. You first eliminate zones that you don't want tc consider and you find out what the initiating event frequency for fire is in each zone that you will be considering. I will discuss these steps in a little more detail later.

For the sequences which were not screened out, you have determined the probability of damage to let's say targets by the fire. For example, cable, so you have a pilot fire starting somewhere in a room and it damages cables or a fire in an electrical cabinet. You determine the probability of random events. What is meant here by random events are events which are independent of a fire. Obviously, even the initiating event of a fire itself is a random event, but this is the way it is used.

You assess recovery actions. I say you add to cut sets, in a sense you multiply by the cut set into the cut set and you quantify, and then you perform an uncertainty analysis.

[Slide.]

To identify the relevant fire zones, in a sense you look at the zones which contain safety-related equipment which is needed to mitigate what we might say as possible initiators or conceivable initiators which could occur during a fire. For example, in a pressurized water reactor you may decide that the only kinds of initiators that you would be considering are transients or transient-induced small LOCA, a PORV opening up or for example a reactor coolant pump sealant LOCA coming from a lack of cooling to the reactor cooling pump seals. Perhaps you would consider the possibility also of a large LOCA if you thought that a fire could cause failure of interfacing system valves, the interfacing system LOCA kind of stuff.

You would identify those zones. In NUREG-1150 you would take your internal event, fault trees and event trees, and you would attach using the computer code sets as a fault tree code, you would attach to each basic event a location identifier so that you could come out in a sense with location cut sets, zone cut sets and cut sets containing fire zones and random failures. You might then truncate the number of fire zones. If it requires three or four fire zones you might say that's too many barriers to fail for it to be plausible. Or, if the random failure probability was less than one E minus four, then considering the initiating event frequency for the fire, that may be considered of so low probability that you are not interested in it.

MR. MICHELSON: When looking at these sets of components that are affected by the fire, you have a particular zone or area in which the fire is located. Are you looking at all those components within that area --

MR. BUSLIK: Yes.

MR. MICHELSON: -- that are experiencing some kind of failure mode?

MR. BUSLIK: In this screening analysis you are assuming that if a fire starts in a zone it fails all the components in the zone.

MR. MICHELSON: Actually though, I think we refer to these as fire areas since the zone is a part of an area but is not environmentally separated. Everything within the fire -- I have to go out to the fire boundary before I reach the three hour barrier; is that right?

MR. BUSLIK: I believe this is within the three hour barrier.

MR. MICHELSON: This is not the same terminology used.

MR. MCCRACKEN: The one thing you have to be very careful when you look at a fire PRA is, they use zone and area interchangeably which is not what we do in the regulations.

MR. MICHELSON: No. The regulations have unique identification.

MR. MCCRACKEN: Every time I see zone, I sit here with exactly the question you came up with.

MR. MICHELSON: What did you assume concerning all the equipment within the zone?

MR. BUSLIK: In this part of the analysis which is a screening analysis, you assume that everything has failed within the zone.

MR. MICHELSON: You are not using probability of failure or anything, just within a zone it fails.

MR. BUSLIK: To eliminate the zones you don't have to look at. If it doesn't survive this, you know you don't have to quantify it.

MR. MICHELSON: You assume though that none of that equipment in that zone would create an unwanted action, and that sort of thing from the result of heating up in that fire area?

MR. BUSLIK: I am not sure that is considered in the analysis. You are using as your basis your internal event, as I understand it, your internal event fault trees. These may not have been added.

MR. MICHELSON: If you are not looking for any system interaction possibilities, then you can do what you are doing here.

MR. BUSLIK: You are looking for, in a sense, the spacial --

MR. MICHELSON: You are not looking for system interaction.

MR. BUSLIK: That is not done well in --

MR. MICHELSON: I know it's not done well if at all, but you have to recognize then when you get to the bottom line what the bottom line really means, what you have left out of the analysis.

MR. BUSLIK: That is, in fact, a generic issue.

MR. CATTON: GE told us that they assumed that these things failed in the worst possible way, which would include what Carl was describing.

MR. BUSLIK: It may be, I am not sure. Do you know, Joe?

MR. MURPHY: In general what is in the models, you start with the model that you use for the random failures for the internal events. If an interaction was modeled in the internal events it would be available in the fault trees and, therefore, it would be covered in the fire PRA. If it was not modeled in the internal, it won't be in the fire either.

MR. BUSLIK: I think it's possible to --

MR. MURPHY: What it amounts to is, before I had a cut set that said pump A fails and pump B fails --

MR. CATTON: I understand that.

MR. MURPHY: -- all I have done is transformed variables and now I have it in fire zone A or fire zone B.

MR. CATTON: You have the same kinds of failures.

MR. MURPHY: Yes.

MR. CATTON: So, if you didn't consider failure due to being at 300 degree fahrenheit before, you wouldn't consider it in the fire PRA.

MR. MURPHY: Right.

MR. MICHELSON: The fire might generate such a temperature in the vicinity of the equipment.

MR. MURPHY: That's correct. Now, if it caused failure then it will be picked up in this, because we are assuming that the failure --

MR. MICHELSON: No. Failure --

MR. MURPHY: -- unwanted action that was not failure, that will be missed.

MR. MICHELSON: That is the concern, that it doesn't decide to quit, it decides to open a valve you didn't want to open.

MR. BUSLIK: In fact, when I --

MR. CATTON: Or, send a signal to some solid state device that is out of range so it's little computer program goes bananas like in Canada.

MR. MICHELSON: Or, maybe the operator even goes bananas when it starts giving him a lot of strange looking information.

MR. CATTON: Usually he can think about that. The computer doesn't if it's not built into the logic.

MR. BUSLIK: When I did a kind of rough PRA back in France, a fire PRA, I did consider the possibility of a short to ground causing opening of interfacing system valves. It can be considered, but I didn't do it in a very systematic way. I saw it, so I put it in.

MR. MICHELSON: Did you consider the possibilities of water being sprayed on the equipment from the fire protection viewpoint, keeping in mind that the equipment was not in the fire zone necessarily?

MR. CATTON: It wouldn't Carl --

MR. BUSLIK: This is, again, a generic issue.

MR. MICHELSON: If it's in this zone you also have to consider it, because sometimes there are several fire protection devices with a zone each spraying its own particular area.

MR. BUSLIK: There are all sorts of things that can occur. You don't know where the water is going to go to basically.

MR. CATTON: How about the LaSalle PRA. In the LaSalle PRA, did they do it the same way, this state of the art PRA that we are eventually going to see?

MR. BUSLIK: I am not too familiar with that.

MR. MICHELSON: I understood from Sandia that they were attempting to address some of these issues, and that's why I was anxious to see if they ever really did.

MR. BUSLIK: I don't know, for example, about where water goes to and if it is going to be addressed.

MR. QUINTIERE: Could I just try to clarify something? Not being a risk person, some of these terms are sort of escaping me. Do I understand you correctly that first one does an overview of what events could cause failure to the reactor?

MR. BUSLIK: That's right.

MR. QUINTIERE: And then, using that identified set of failure indicators, then one overlays that on these fire zones to determine how a fire might be relevant to trigger such an event?

MR. BUSLIK: You have a market, you have a algebraic expression let's say, which gives the core melt probability as a sum of products of basic events. This is done with a computer. You can have a marker on the basic events which will allow you to say let me assume that everything in -- you should excuse the expression -- zone has failed. I don't know which is the correct term.

MR. QUINTIERE: This is how one determines how fire might initiate?

MR. BUSLIK: This is how you go through a screening analysis to see what you don't have to look at in more detail.

Brunswick didn't really do a computerized analysis insofar as I can tell. They used judgment. They looked to see where they -- I guess familiarity with other PRA's -- they looked to see where they thought it would be likely to have difficulty, places where you would have cables coming together from different trains or the control room, or single failure point like in their case the service water pumps were all in a single area and they could fail.

That is basically the way they did that. You need to determine the fire initiating event frequency. You have a database of fires. The one that was used for NUREG-1150 was developed by Wheelis. I don't have the NUREG CR number. It was through June of 1985. For example, you may have the numbers of fires that occurred in an auxiliary building, but you may be interested in the number of fires that occurred in one part of that auxiliary building.

So, you have to decide how you are going to determine that number. You may decide to partition it on the basis of the area, the area of the room containing the motor driven auxiliary feedwater pumps may be a certain fraction of the total area of the building, total floor area of the building. You may use that ratio.

Sometimes people us a combustible loading ratio, cable loading ratio or electrical equipment ratio. In fact, the uncertainty analysis in NUREG-1150 for this parameter was done by looking at it in these different ways. You have to be careful.

In the Diablo Canyon PRA, they assumed that the frequency of fires on the turbine building operating deck was a certain frequency for the building times the area of the turbine -- the ratio of the turbine building operating deck to the total turbine building. That is low compared to operating experience. Most of the fires in the turbine building occur in the operating deck.

MR. MICHELSON: Most of them occur at a particular portion of that operating deck, in fact; don't they?

MR. BUSLIK: Right. Yes, that's right. There's the hydrogen and the --

MR. MICHELSON: And the Control oil.

MR. BUSLIK: Yes, the fuel oil. What happened in Diablo Canyon is that a fire on the operating deck, if it were large enough, could cause smoke to go down to the floor below through vents and fail switch gear. It turns out that all three trains of safety-related switch gear are on the floor below the turbine operating deck at Diablo Canyon.

MR. MICHELSON: The safety-related equipment in the turbine building?

MR. BUSLIK: Yes.

MR. BUSLIK: They have a way of making that part of it seismically qualified even to very high standards, whereas the other part isn't. I can't --

MR. CATTON: We will have to ask Jay about that.

MR. MICHELSON: They did some kind of mickey mouse, I am sure.

MR. BUSLIK: I don't know.

MR. MICHELSON: Is that directly below the head end of the turbine?

MR. BUSLIK: I guess it's off to the side, but it is the floor below. I didn't really finish this slide. You want to make use of plant-specific data when possible. What NUREG-1150 did was to use a procedure due to IMAM, which I believe is completely equivalent to Stan Copeland's two-stage bayesian update.

MR. MICHELSON: What source though did they use for the information, where were they getting their fire events from?

MR. BUSLIK: The Wheelis database.

MR. MICHELSON: Certain kinds of reporting systems already, I guess.

MR. BUSLIK: Yes. You can run it on a PC.

MR. MICHELSON: Let me ask, is it the LER database that they are using?

MR. BUSLIK: No, it's more than that. He also has I guess American Nuclear Insurers or something like that.

MR. MICHELSON: Yes, it has a few others on it. I do have it on a PC.

MR. BUSLIK: You will find that some of these from other sources, you don't know which plant is involved. You know the event but you don't know which plant.

MR. MICHELSON: You don't know locations too well or anything.

MR. BUSLIK: Sometimes you don't, no.

MR. MICHELSON: It's not as nice as you are trying to indicate you would need.

[Slide.]

MR. BUSLIK: Someone once called me and wanted to know if there was no plant named, does that mean it was the same plant before it in the database. I said no, it's --

[Laughter.]

MR. MICHELSON: Just an event.

MR. BUSLIK: You use the two-stage bayesian updating. This will also help give you an uncertainty spread later. You are talking into account plant-specific information. What Brunswick did was something else. They said let's find out what an ignition frequency, a small fire let's say is, in the different types of equipment. You may have a motor control center or some other sorts of equipment, and you just consider it by these various kinds of equipment.

Then they said, in order to have a fire you not only have to have this small fire, but you have to have a reasonably sizeable amount of combustible material nearby. That will determine the probability of having -- there are two probabilities associated with that. One is the probability that you will have it at any time in that area, and the other is within a zone or area such if you have the ignition source it could ignite that. That's a space fraction. Also, the materials may not always be there, and that's a time fraction.

I am not sure how these numbers were obtained in the PRA, but there is a table of them. You would be able to -- you can at least look at them. I am trying to find the location of the table. It is either Appendix F or a table in Section 2.

As far as NUREG-1150 is concerned, you now look and you may see that some areas don't have a very high fire initiator frequency. Some cut sets or zone combinations which have so far survived the screening process may be eliminated at this point by just a very low initiating fire event frequency.

MR. MICHELSON: What did you do about the existence of a fire barrier such as a three hour wall and door?

MR. BUSLIK: In the NUREG-1150 studies basically I think what they did was use a screening probability of .1, a failure of a fire barrier. If it survived under those circumstances, they would have looked further but it never did. In the case of the Brunswick PRA, they did have numbers for the probability of failure of a fire barrier, and then they had an additional number as you will see, which gives the probability of a fire propagation through the fire barrier. These, I think, are just obtained by judgment.

MR. MICHELSON: What did they do in the case of a

20 foot separation zone as their fire barrier?

MR. BUSLIK: There is a table. They have a table for determining barrier type and the propagation probabilities across the failed barriers. They have something called the separation zone, but the probabilities for failure there -- this is Table 2-5 -- the probability of failure for a separation zone is rather small. It's like 1E minus three for cable insulation. I don't know if that's valid or not.

MR. MICHELSON: These are propagation failures which I had read into it fire propagation.

MR. BUSLIK: Yes, that is correct.

MR. MICHELSON: That is the probability that you will start a fire on the other side of the barrier such as the other si of the 20 foot.

MR. BUSLIK: Yes, that's right.

MR. MICHELSON: It doesn't mean that the equipment on the other side may not be damaged or even become inoperable. It just means that they won't ignite and burn.

MR. BUSLIK: Yes, I am not sure --

MR. MICHELSON: They did not address the inoperability of equipment due to heat up at all.

MR. CATTON: It sounds like they didn't look at the geometry or anything if they just picked E to the minus three.

MR. BUSLIK: You have to multiply that by the fire probabilities which are in table 2-4, the failure probabilities.

MR. CATTON: That almost becomes a no number --

MR. MICHELSON: It becomes a non-no never mind, if you have 20 foot of space.

MR. BUSLIK: It doesn't have it for separations.

MR. MICHELSON: It is probably right.

MR. CATTON: That 20 foot of space then is more effective than a three hour barrier door.

MR. MICHELSON: It seems to be, doesn't it?

MR. CATTON: Where you assume a ten percent failure probability.

MR. MICHELSON: They didn't use ten percent.

MR. CATTON: That seems kind of silly.

MR. MICHELSON: I don't think they use ten, I think they use --

MR. CATTON: They used ten to the minus --

MR. MURPHY: The ten percent came from what we did in 1150 rather than Brunswick.

MR. MICHELSON: I think Brunswick used E to the minus two for doors.

MR. CATTON: And, E to the minus three for space?

MR. MICHELSON: That's what I am trying to remember, what they used for doors. I know what they used for space. Barriers for mechanical seals and electrical penetrations are ten to the minus four, five or six, depending on the fuel available to fire. It has to be better than that or just as good as that, so they are using extremely low probability, essentially none.

MR. BUSLIK: I don't know where these come from, to tell you the truth.

MR. MICHELSON: Essentially none. Dampers are also ten to the minus four. For fuel oil, it's one in 100 for other things, one in 1,000, for cable insulation fires it's one in 10,000 that you penetrate the door. Water curtains are also very good. That's good stuff.

MR. BUSLIK: There is a lot of subjective judgment apparently that is done in this. You might argue that in Brunswick the initiation frequency was done well because it was done on a plant-specific basis, but the problem is that there is a lot of subjective judgment on whether that propagates into a large fire.

[Slide.]

You have to determine the probability of damage to the targets by a fire. NUREG-1150 used a modified version of COMPBRN 3 which determines the target temperature, for example, cables, as a function of time. The way it's used is, you may consider for example in a cable spreading room you may consider a pool fire of oil or combustible material in the floor, and then consider the probability that it will damage the target within a certain specified time. You determine the target temperature as a function of time, and you use as a damage criteria let's say a certain temperature of the target and time for ignition.

The fire was assumed to be either a large pool fire or a small pool fire with waiting which came I guess partly subjectively from the database. If you look at the database of reported fires, maybe 30 percent of them are relatively large and 70 percent relatively small. Usually small pool fires didn't cause damage or small fires.

MR. MICHELSON: By damage, you mean here I think, ignition of --

MR. BUSLIK: Ignition --

MR. MICHELSON: What is the failure threshold then? How did they determine the vulnerability and, therefore, the -- MR. BUSLIK: There was a certain temperature somewhat lower than the ignition temperature for cable.

MR. MICHELSON: Do you know what that temperature was? Was it arbitrary or component by component?

MR. BUSLIK: The only case I remember they are using this for is for cables.

MR. MICHELSON: As I recall it was around four or 500 degrees for cables, wasn't it?

MR. BUSLIK: No. Brunswick used 700 degrees fahrenheit, I believe.

MR. MICHELSON: Seven hundred, okay.

MR. BUSLIK: I think the number was somewhat lower for damage in the NUREG-1150 studies.

MR. MICHELSON: Okay, but way above damage in the sense of operability of equipment like electrical cabinets.

MR. BUSLIK: Electrical equipment, I am not sure exactly. I am not sure exactly how the Brunswick fire PRA did it. In NUREG-1150 they assumed that if a fire started in an electrical cabinet that it failed all the equipment in that cabinet.

MR. MICHELSON: I was thinking more in terms of damage to targets. I assume the target was something further out from the core of the fire.

MR. BUSLIK: That's right.

MR. MICHELSON: Ten feet away, 20 feet away. These are targets that would be damaged by convection and radiation of heat, I guess, and maybe smoke deposition, maybe water, depending on what --

MR. BUSLIK: The heat damage might have been considered. You are using a certain temperature criteria. I don't think that they ever considered water damage or anything like that.

MR. MICHELSON: Even heat damage, you don't need to go to 400 degrees to effect electronic components.

MR. BUSLIK: Yes. I am not so sure how well that was done. Incidentally, it is not a conservative assumption to neglect it obviously.

[Slide.]

The time to damage which is called T sub G or TGROWTH in some of the NUREG-1150 studies and perhaps also in the earlier stuff on fire propagation --

MR. MICHELSON: Why in Brunswick are these sprinkler heads located below the cable trays? I guess they are not trying to protect the cable trays, or are they just trying to put the fire out that is on the floor and not assuming any fire originating in a cable tray?

MR. CATTON: Maybe because the PRA assumes that the pool is on the floor and they need to put it out.

MR. MICHELSON: Then that would make sense. If the ignition source is up in the cable tray like a faulted cable, then you would want to put the sprinkler higher up, I would think.

MR. BUSLIK: To me it's a little puzzling, because I don't know how many fires there have been in cables that have been caused --

MR. MICHELSON: I thought this was a misprint really, from what it says.

MR. BUSLIK: I am not sure what the applicability to a certain extent of these codes are in some cases where they use them. The just give you, perhaps, an idea of the time for growth of the fire.

There was an interesting case. In the Peach Bottom NUREG-1150 analysis there was a possibility of a switch gear fire resulting in open flames above a cabinet and failing some cables. The way that was done was, they again modeled the switch gear -- the fire in the switch gear cabinet by a pool fire. There was like a chimney effect.

MR. MICHELSON: Brunswick did model switch gear fires?

MR. BUSLIK: They modeled switch gear fires, but I will show you something with the control room. For example in the control room as you will see a slide later, they had something like a .4 per year probability of a fire in the control room in one of the cabinets. They said that for the fire to be large there had to be combustibles nearby at a certain time. They got a very low conditional probability given a fire that it would be a relatively large fire.

I am not quite sure that I agree with that methodology there. More likely what I think was done in NUREG-1150 where may have a fire which essentially fails everything in a single cabinet but doesn't propagate beyond that, but which still may require evacuation of the control room because of heavy smoke being produced in the control room.

[Slide.]

Failure of automatic suppression. For water it was four percent in NUREG-1150 studies; for halons it was six percent; for carbon dioxide it was four percent. When I saw those numbers it surprised me a little. I didn't think that carbon dioxide would be as good as water or halons would be as good as water.

MR. MICHELSON: What do they mean by failure; failure to come on or failure to put out the fire?

MR. BUSLIK: Failure to suppress the fire, that's how it was used.

MR. CATTON: Isn't this highly fire dependent? We can think of an example where the CO2 and the halons failed completely to put out the fire. I would think that any fire like that, the probability would be one.

MR. BUSLIK: I don't think they took that into account. If the automatic suppression system were halons, then they would assume that the failure probability was .06 percent in NUREG-1150.

MR. CATTON: Is that the failure for it to come on, or the failure to put out the --

MR. BUSLIK: That is the failure for it to put out the fire.

MR. CATTON: For whatever cause?

MR. BUSLIK: From whatever cause.

MR. MICHELSON: Including not coming on.

MR. CATTON: Independent of the kind of fire.

MR. BUSLIK: Yes. You have a halons system in a cable spreading room, then if that --

MR. CATTON: I understand. It seems a strange kind of assumption, given that we know a little bit more than that.

MR. MURPHY: Let me say that there was a little bit of common sense used in using this. If you were in a situation where it looked like you had a fire that was beyond the design capabilities of the suppression system, you wouldn't use this kind of number.

MR. CATTON: Okay.

MR. MURPHY: But it was sort of the average number that was used for the average application. Basically, a failure to initiate, the assumption being that given initiation it worked.

MR. BUSLIK: You are assuming that it was designed properly for where it was, basically.

MR. CATTON: That's not a good assumption, is it? Was it Catawba where they couldn't put out the fire?

MR. MICHELSON: Yes, they have actually used water. They tried CO2 and chemicals first.

MR. CATTON: Neither one worked.

MR. MCCRACKEN: Wrong assumption. At Catawba they couldn't put out the fire with hand held CO2. That wasn't an automatic suppression system that was designed specifically with the discharge flow rate, time, quantity to fit into that room.

MR. MICHELSON: Also, the chemicals were used. They used. They used two carts of chemicals and one cart of CO2, that's what my LER I thought had said.

MR. MCCRACKEN: What I am saying is that you can't--

MR. MICHELSON: The chemicals didn't work either.

MR. MCCRACKEN: You can't use the suppression rate for hand held to compare with the suppression rate for an automatic system.

MR. MICHELSON: Yes, that is perhaps right.

MR. MCCRACKEN: They are clearly apples and oranges.

MR. MICHELSON: But you use hand held most of the places, I think. The automatic is a much more limited use.

MR. MCCRACKEN: The vast majority of fires are put out by hand held.

MR. MICHELSON: Yes. I am not arguing with that.

MR. BUSLIK: For manual suppression, NUREG-1150 estimated the time to suppression from generic data which they obtained, again, from this Wheelis base. There is a curve -- I think it's in the fire risk scoping study on page 827 in case you ever want to look it up -- which gives that probability of non-suppression as a function of time. COMPBRN III was used in NUREG-1150 to determine the damage.

[Slide.]

The Brunswick PRA used something in Appendix D, an equation -- it's on page D-1 in the Brunswick fire PRA -- it is an equation which purports to give the fire plume center line temperature and the layer temperature off center line based on combustible loadings in a given fire zone. I don't know where the equation came from. There are no references, no documentation. I just don't know where it comes from.

Pete Davis, working under subcontract with INEL, made a brief review of the Brunswick fire PRA. That basically was one of his comments too, that it was deficiency in the PRA.

MR. CATTON: Would it be possible for us to get a copy of that review?

MR. BUSLIK: Yes.

MR. CATTON: If you would get it to Tom, he will get it to the rest of us.

MR. MURPHY: Let me just mention in passing that I think it's obvious from Art's presentation that Art didn't do the review. The reason he is up there is that we had a short time -- we found out you wanted this in just a short period of time to organize it. There was another problem in that Pete cannot come in here as our representative and talk to you because he has a conflict of interest, since he is an ACRS consultant.

So, you can bring him in as your own consultant and talk about it, but we can't ask him to come in.

MR. MICHELSON: We can't do that either. He can't work both sides of the table.

MR. CATTON: Carl, the rules of the consultant are that as long as he doesn't review his own work. We can't ask him to take a look at the review.

MR. MICHELSON: I thought you wanted to look at his review.

MR. CATTON: I want to look at his review, yes.

MR. MICHELSON: That's reviewing his work.

MR. MURPHY: We can definitely get you the paper that he sent us. One of the reasons that we are not prepared as we would like to be is that this was done two years ago and, again, Pete wasn't really available to us.

MR. QUINTIERE: Is that equation in the text here anyplace?

MR. BUSLIK: It's on page D-1 of the Brunswick PRA, Appendix D, page one.

MR. MICHELSON: We don't have the appendix. I didn't get the Appendix.

MR. BUSLIK: I have a copy of that sheet here, and I think I could pass it around to you.

MR. QUINTIERE: If you show it to me, I might be able to identify where it came from.

MR. BUSLIK: I don't have it in front of me now, but you will notice that it doesn't have room parameters in it, it couldn't include a hot gas layer. I just don't know where it comes from.

MR. MICHELSON: Is that used to determine if the equipment reaches 700 fahrenheit, is that how it was used?

MR. BUSLIK: Yes, that's right.

MR. MICHELSON: Is that good if the equipment is near the floor versus near the ceiling with his equation, or could you tell what it was?

MR. BUSLIK: I am not sure. It is the distance from the pilot fire to the target in there.

MR. MICHELSON: Not only distance but --

MR. CATTON: There is no reason one couldn't just use an equation. I mean, the COMPBRN code is very simplistic.

MR. BUSLIK: I will discuss a little bit about the COMPBRN code and we can see whether -- you could just use an equation in principle, but you would have to ask yourself does it include at least all the parameters that are pertinent.

MR. QUINTIERE: I can make some guess where this comes from. There are two equations that I know of, one to give you the temperature of the center of a fire plume and that exists in literature.

MR. BUSLIK: Right.

MR. QUINTIERE: It may be caught in something like this. Another temperature that says given the size of the fire in a room and the dimensions of the room and the dimensions of the doorway, then you can calculate the average smoke layer temperature. That's another algebraic equation.

MR. BUSLIK: What was that?

MR. QUINTIERE: You can calculate the temperature of the smoke layer. In other words, not in the fire plume itself but some average temperature. Those two equations exist and are quite conventionally used in sort of fire technology. These might be some funny form of those, but I can't recognize them.

MR. CATTON: They could be just de-scaled. If I remember right, the analysis that leads to those are all non-dimensional variables and everything else. If you just put in the properties of air and a few other things you might get expressions, particularly those five-thirds exponents.

MR. MICHELSON: Are those equations any good as you get down near the floor?

MR. CATTON: No, and neither is COMPBRN. It's a plume assumption. Plume is no good near the floor. Where you can find this kind of analysis is in design of sewer pipe, where it dumps the stuff into the sea. It's the same equations.

MR. QUINTIERE: You could find it also in a fire protection handbook put out by the Society of Fire Protection Engineers, published by NFPA. It's more relevant to the fire. We are talking about fire and not source systems.

MR. BUSLIK: When you looked at it, did it look like it had the relevant parameters in there?

MR. QUINTIERE: Not completely, no.

MR. MICHELSON: There's the question of what do you do about equipment that is mounted near the floor or on the floor relative to predicting how hot it gets.

MR. BUSLIK: They take into account manual suppression instead of by needing to know the time to damage by some overall general probability depending on the type of fire in the Brunswick PRA.

Now that you know the probability of damage of the targets and you have the cut sets that you are interested in, you can determine the core damage frequency by combining the conditional probability of a fire causing damage to the targets with the probability of random failures and multiplying by the initiating event frequency for fire.

For multiple zone analysis, I spoke with John Lambright after I wrote this down. They did have this database of barrier failures, but they really I don't think ever used it, because nothing ever survived the screening analysis. There's a problem of the estimated number of -- they then estimated the number of barriers of each type in the plant population to obtain a barrier failure rate, but they did it per reactor year. The numbers given in the external events procedures guide for NUREG-1150 can't be used directly because you have to know the fault duration time. You have to know how long a barrier has been failed to get an idea of what the probability of failure of the barriers when the fire occurs.

That would require knowledge of the inspection frequency of fire barriers, and they didn't have that information available although they are trying to get that information now. There is another factor involved and that is, how do you know that if you look at a barrier and it seems to be okay that it really is, would it pass a test. In fact, John Lambright said that there were some pressure barriers at Surry which, when they tested, failed. These were barriers between the hot shutdown panel in the switch gear rooms and the control room.

These barriers apparently, a relatively large fraction of them, did not pass a pressure test.

MR. MICHELSON: The problem also is that the barriers may never have passed the proper test. The NFPA, the test on dampers I understand requires no flow through the damper when you perform the closure test on the damper. When they found out that flow through the damper causes the damper to deflect and jam and break, they found out that they had a real problem. We are trying to close them under duress, you don't do routine closures on dampers, not very often at least.

Under duress, namely under high flow rate which is what they normally experience, they found they deflected and jammed and broke. I don't think that ever gets into any of this analysis. Testing doesn't mean anything unless the test simulates what the device sees under the conditions of the fire.

MR. BUSLIK: The Brunswick fire PRA used a product --we discussed that already in table 2-4 and 2-5 -- barrier failure probability and barrier propagation probability. Then when you are finished, you may apply recovery of random failures for the cut sets that are not screened out by that point. This is similar to what is done in internal events PRA. You follow pretty much similar rules.

You recovered only one event in a cut set. You didn't try to recover every random failure in the cut set. You chose the one that was most likely to recover, unless it was a very long time sequence -- I guess over 24 hours -- in which case the rules were relaxed somewhat.

[Slide.]

The COMPBRN III code references NUREG-CR-4566. It is a zone code with two zones, a hot layer and an ambient layer. It uses mass and energy conservation for each zone. There is no energy transfer to the ambient layer basically, so that you don't have to consider that. It uses a cylindrical flame model for transfer. I have been told that is not as good as an isotopic model, and I guess the even more elaborate one. I don't think the burning rate is well modeled.

MR. CATTON: It's not modeled at all.

MR. BUSLIK: All right. I guess it's okay when it's ventilation control. A variety of errors were found by Sandia when they did the fire risk scoping study.

MR. QUINTIERE: Do you understand how the COMPBRN model was applied? In other words, is it applied as we see it in this picture here with the vent assumed in a compartment?

MR. BUSLIK: No. My understanding is that in most cases there is a kind of subset of the COMPBRN III code which has the door closed, and I guess just enough leakage to prevent pressure build up or something of the sort. I think, although I am not certain, that it was done in that way. Certainly, not with the door open.

MR. MICHELSON: I have a question. One of the assumptions on table 2-8 in this PRA talks about -- the assumption is that minor fires will not cause significant damage, and the justification for the assumption is that the fire plume temperature for minor fires does not approach the 700 degree threshold for cable damage.

MR. BUSLIK: If you have a small room with a hot gas layer, I guess even a small fire could start something.

MR. MICHELSON: It could. My main question though was, when we do have these smaller fires I think we are likely to actuate our fire protection devices, namely our water sprays or whatever in that area. When we do, then although the fire damage was trivial if any, the water damage might be quite significant. They do not seem to consider water damage at all in the process of their PRA.

There are a lot of things that I don't buy, but that's one of several.

MR. BUSLIK: There is clearly a possibility of water damage, and that's why I suppose some people would under certain circumstances not want to have automatic fire suppression.

MR. MICHELSON: That's right. You are damned either way, of course, because if you don't make it automatic then there's the delay required for people to go and check before they turn the water on. That's bad news too, if it is a fast developing fire.

MR. BUSLIK: It depends on where it is. If it is not very accessible then clearly you need an automatic system.

MR. CATTON: I think that most of us are familiar with this list. Maybe we could just --

MR. BUSLIK: Okay, fine.

MR. CATTON: I asked Apostalakis about this, and he didn't agree with them all.

MR. BUSLIK: Which ones didn't he agree with, I am interested to know.

MR. CATTON: I don't recollect. I found some delight in harassing him.

MR. BUSLIK: The one about not being able to ignite a cable tray directly over the fire, I thought was interesting because it was cooler there.

MR. MICHELSON: Sandia made some modifications to get some of these non-realistic conditions corrected. Did Brunswick use the original COMPBRN?

MR. CATTON: Brunswick didn't use --

MR. BUSLIK: Brunswick didn't use the --

MR. CATTON: They used an equation. The modified codes undocumented, so who knows?

MR. MICHELSON: Didn't it result in funny things like no fire over -- no ignition over the fire?

MR. BUSLIK: No, it didn't do that.

MR. MICHELSON: It took care of that.

MR. CATTON: You know these mathematicians statistician types. Some of these things just don't bother to--

MR. MICHELSON: Did he think it was real or true --

MR. CATTON: He had some reason for it.

MR. MICHELSON: -- that they don't ignite over a fire?

MR. BUSLIK: I think that --

MR. CATTON: I am not sure.

MR. BUSLIK: I am not sure it was COMPBRN III, but I know when Picket, Lowe and Garrick had some trouble one time using a COMPBRN code, they just modified the input a little. They moved the fire over, or something like that.

MR. CATTON: But that's what all PRA people do.

MR. MICHELSON: Sandia modified the model to give realistic answers, at least realistic in their minds.

[Slide.]

MR. BUSLIK: Here are some results of the Brunswick fire PRA which are interesting. Before Appendix R modifications, the fire frequency was about six E minus I have down here for Unit II. After the Appendix R modifications it was 7 E minus five, and then they took additional measures which brought it down to 2 E minus five.

There was a control room fire which was of importance. There was also I think a cable run area -- I have forgotten exactly where it is -- also the service water pumps, a fire in the intake structure containing the service water pumps failing all service water.

MR. MICHELSON: What bothers me a little bit is that they are getting these numbers down to respectable areas now, but there is the uncertainty introduced by omission in the models of a number of things that we have been talking about this afternoon which intuitively at least indicate to me that they are going to increase the probability and not decrease it.

MR. BUSLIK: The problem -- they may not affect the dominant accident sequences that much. On the other hand, there may be other sequences which have been --

MR. MICHELSON: It may or may not, we don't know.

MR. BUSLIK: Yes.

MR. MICHELSON: We would have to do the analysis first, using proper model.

[Slide.]

MR. BUSLIK: This gives an example of how, using both the NUREG-1150 methodology and using the Brunswick PRA methodology, you can come up with reasonably similar values for a core damage frequency for a sequence of a fire in the control room, but that the basic numbers that go in can be fairly different. They have different meanings, to a certain extent.

MR. CATTON: This is an excellent example of compensating error, isn't it?

MR. BUSLIK: Whatever.

MR. CATTON: I mean, you have orders of magnitude difference in each of the entries.

MR. BUSLIK: Yes, but they may not mean exactly the same thing. The fire frequency at the Brunswick PRA is essentially a kind of ignition thing. The model seems to be one where you have ignition in a cabinet, and if there isn't some combustible material say outside the cabinet, then you don't assume that you have a large fire, and you don't abandon the control room and you don't have a problem.

Whereas, the NUREG-1150 had a fire starting in a cabinet, and that came from data basically. Then they took a ten percent chance that the fire would cause abandonment of the control room. This would come about because of heavy smoke being produced. They have had experiments at Sandia which showed that it is quite possible -- in fact, in their experiments it did happen -- they got within five to ten minutes heavy smoke down to the floor of the control room. It would mean also that -- if you were there, you would have to abandon it. It would also mean that with a hose you would be just spraying everywhere.

MR. CATTON: Probably couldn't find it.

MR. BUSLIK: What?

MR. CATTON: Probably couldn't find the fire.

MR. BUSLIK: Couldn't find it, that's exactly right. In fact, there was a fire in France at a reprocessing plant, and I was told there that the firemen could not see the hose in front of them, the hose nozzle.

Before Appendix R there was a probability of like one of core melt if you had to abandon the control room. After Appendix R you had to lose one train. Apparently, you had only one train available to you from the hot shutdown panel. If you lose the B train RHR heat exchanger or the nuclear service water pump, then you would go to core melt. And, maintenance outages were apparently important for the heat exchanger. That was one of the dominant sequences.

MR. MICHELSON: Do the French do a more detailed PRA than they do for fire?

MR. BUSLIK: No. In fact, I did all that has been done so far, and that was -- they will probably get around to it.

MR. CATTON: I have seen a report describing their equivalent of COMPBRN, and actually it's a little bit richer than the COMPBRN code. I forget what they called it.

MR. BUSLIK: Is it the MAGIC code, the EDF?

MR. CATTON: MAGIC, yes.

MR. BUSLIK: That's a code of Rongier. It is, I think, a little bit better -- a little richer than COMPBRN III. He also has --

MR. CATTON: It has some of the same defects, in that it is just to their model and doesn't consider the --

MR. BUSLIK: He also has a field model which he uses for smoke propagation. One of the concerns there is you may have two pumps in the same room and the automatic sprinkler system over a pump should actuate if there's a fire on that pump. What happens is, if the wrong detector goes off because of the way the smoke goes and one pump is disabled because of the fire and the other pump is disabled because of the --

MR. CATTON: Because it's on fire.

MR. MICHELSON: It sounds like one we are going to look at.

MR. CATTON: It is interesting, the French have done a lot more work in this area I think than anybody else.

MR. BUSLIK: But they haven't done it in an integrated --

MR. MICHELSON: He worked for the French for a while.

MR. CATTON: No, I hear what he is saying. There is -- I think it's the December, 1990 Nuclear --

MR. BUSLIK: Does it have the word "international" in it?

MR. CATTON: No, it's the Dutch journal that Dick Leahy is one of the editors. I think it's the December, 1990. They describe the work in the thermal hydraulics area unlike here, where when you say thermal hydraulics you mean LOCA. In France, thermal hydraulics means everything that has to do with heat and mass transfer in a plant. They describe what they have done to deal with these kinds of problems. It's a stratification flow. They have computer codes that can deal with it, and they do.

MR. BUSLIK: He has accomplished this. My impression is that it is a rather long running code.

MR. CATTON: Yes. You don't run it all the time. If you were interested in this particular issue you might run it once.

MR. BUSLIK: Yes, that's right. The control room panel remote shutdown -- there is some fire risk scoping studies. The control room panel remote shutdown panel, interaction for example, is one. There is an interesting thing that occurred in the Diablo Canyon PRA. I had an idea it might be true, so I asked them whether the instrumentation at the hot shutdown panel was independent of the control room.

They replied, and I have a copy of the letter. The accession number on the nudoc system is 9005100234. The controls are independent from the control room, but the instrumentation is not. A fire in the control room can -- if an instrumentation circuit should fail, the instrumentation at the hot shutdown panel will fail, at least off scale. It doesn't fail mid scale, which is good.

MR. CATTON: They will be flying blind at the shutdown panel.

MR. BUSLIK: No. There is shutdown panel somewhere else which has instrumentation. It means that it controls one place and the instrumentation another place.

MR. MICHELSON: Is it independent of the postulated fire?

MR. BUSLIK: It would be independent of a fire in the control room.

MR. MADDEN: It is my understanding at Brunswick, the instrumentation that he is talking about -- the instrumentation that we rely on for fire in a control room, is independent of the control room.

MR. BUSLIK: But it is not at the hot shutdown panel.

MR. MADDEN: It is not at what you call the hot shutdown panel. They have a shutdown instrumentation panel in a reactor building.

MR. MICHELSON: Yes. They have to go to a local panel.

MR. BUSLIK: The controls are different.

MR. MADDEN: There are some controls on that. The procedure requires the operators to go to various control stations in the plant, like one goes out to the nuclear service water pump house. Through communication links that are independent of the fire area of concern, the operator at the shutdown panel will tell when they need the nuclear service water pumps started, stopped or whatever.

MR. MICHELSON: This is typical of the case, abandoning the control room doesn't mean it's as simple as flipping a switch and going somewhere else. Somewhere else is several somewhere else's.

MR. MADDEN: In the older plants that is generally a true statement, that it is not as simple as just throwing a switch. The thing that you have to focus on is that in the tech specs it requires certain manning level at the reactor for operators. Whatever their shutdown scheme is, it has to be done with that manning level of operators that are available in the control room.

If they have three normal operators on shift, they would probably only be able to man three remote control stations that are independent from the control room.

MR. CATTON: Communication links between them?

MR. MADDEN: Yes. Generally, you use independent sound power and headphones which are independent of the area under fire consideration, in some cases backed up by radio and in some cases backed up again by dedicated telephone systems.

MR. BUSLIK: Sometimes I would think that with the sound power telephone, if there is noise in a particular area you might have a problem. These are human factors issues which I didn't really look at very closely when I did the review of the Diablo Canyon PRA. As I say, with radio there is always the possibility of spurious actuation of equipment.

MR. MADDEN: I am not disagreeing with the statements you are making, but whatever communication scheme that a plant decides to take they have to test that scheme thoroughly to make sure that these things are considered. As a part of the Appendix R inspection process or that assessment process that the NRC does, we do have them test that communications equipment for us.

MR. BUSLIK: As I say, I didn't have very firm numbers for what the probability of failure of the instrumentation was given a fire in the control room and things like that. I just took rough numbers. But it didn't turn out to be that important at Diablo Canyon.

There is another one on manual fire fighting effectiveness, another generic issue. The first issue was GI-148. There, you know that oils and cables generate considerable smoke. You can misdirect suppression efforts, spray the wrong equipment. There is another thing, and that is an operator may be hesitant to use a hose on electrical equipment because of the safety.

There is then the possibility that they will just -- at least they were concerned about this in France -- that they will actually fail an entire train of equipment and cut off power to it, so that they can fight the fire. This can cause a problem.

MR. MICHELSON: You mean, that could cause a problem to deactivate it?

MR. BUSLIK: Because then you are dependent on only one other train, let's say. Then you could have random failure.

MR. MICHELSON: It wasn't a problem generated by the process of deactivation?

MR. BUSLIK: No, they were not considering that. The other problem they were worried about in France -- this total environment equipment survival. You can have -- an example would be the wrong automatic sprinkler comes on and fails things, or both come on. There is the possibility of flooding, water going down drains and you don't quite exactly know where.

MR. MICHELSON: This is an interesting event along that line, the -- I forgot the name for the valve. It's the valve that is like a clapper valve. It's held closed waiting to admit water into the dry pipe, and it is actuated by a solenoid valve which shuts off the pressure to it and allows it to fail in a flowing direction.

The concern I would have is what happens during a fire if there is an air line in the vicinity of the fire and the air line joints get melted and you start losing air pressure, do the clapper valves for other fire protections around the plant open up and you start spraying water around other parts of the plant because you have lost instrument air or service air.

Now, there has been an LER recently on such. In fact, there have been a couple of LER's on those clapper valves. I think people decided to get rid of them, but I don't know how extensively people decided that. It looks to me like you really have to worry about system interaction from loss of non-essential air opening up the deluge valves and deluging other areas of the plant which weren't involved in the fire but which can't stand the wetting down necessarily and if they are in a safe shutdown category.

I think there are things like that, that I just don't believe we have even addressed. It is hardware dependent, and I was surprised. I think even at the plant that we visited recently they had that -- did they have that type where -- I think they said -- they used electrical. They said the failsafe node was to spray. If it fails as is, you are okay. If they use air though to hold their clapper valve instead of electric energy, then you have a problem.

MR. MADDEN: Let me step in here a little bit about the failure mechanism. What you are trying to describe is a pre-action sprinkler valve.

MR. MICHELSON: Yes.

MR. MADDEN: It is a deluge valve, but you have to remember that first of all a valve is not held closed by air pressure, it is supervised by air pressure.

MR. MICHELSON: Yes.

MR. MADDEN: The only thing that does for you is tell you about the integrity of the piping. It has virtually nothing to do with the operation or --

MR. MICHELSON: My understanding of the way LER read is, when they lost the air pressure the valve opened up.

MR. MADDEN: There is -- some of these deluge valves are what they call a differential pressure valve, where there is a diaphragm in there that is held by air pressure. But the clapper itself is not. It is just a control device that --

MR. MICHELSON: When you lose the air pressure, are you saying that it doesn't open the valve?

MR. MADDEN: No, I am going to go one step further. It does open the valve, but the sprinkler heads are generally closed head configuration.

MR. MICHELSON: Deluge systems don't use closed head necessarily.

MR. MADDEN: Well, hang on. To my knowledge, there are no deluge systems installed in the auxiliary building. In the auxiliary building of a nuclear plant we like to see a pre-action system as --

MR. MICHELSON: You have not seen any LER's on deluge systems in the auxiliary building?

MR. MADDEN: There are deluge valves in the auxiliary building. They are associated with a pre-action sprinkler system. Pre-action sprinkler system utilizes the same valve that an open head deluge syste ould utilize on a transformer. The end piping result on the other side of the deluge valve is different than that piping configuration, in that it uses closed fusible head sprinklers in lieu of open nozzle.

MR. MICHELSON: Then why in the LER I read did it even named the number of sprinkler heads that opened and they sprayed the -- I forgot -- I think it was a HPCI turbine but I don't remember that, whether it was a HPCI or auxiliary feedwater turbine. It was a deluge system on a turbine, and when that valve opened it sprayed the whole thing.

MR. MADDEN: I am not familiar with that LER.

MR. MICHELSON: When I find it for you -- I will have to go back when I get back to Oak Ridge and dig it out of the file. It was an interesting one, because I think that all fusible links ought to be on all these heads. The fire experts tell me no, because they want to address the fire with more than one sprinkler at a time. They want a nicer array of sprinklers.

MR. MADDEN: Generally in safety-related areas, it's our position not to use open head design systems.

MR. MICHELSON: That is not a requirement, it is your preference; is that right?

MR. MADDEN: That's my preference, yes, or the position of staff.

MR. MICHELSON: It would be not surprising then to find people still do have deluge systems.

MR. CATTON: I bet he hammers them into his view.

MR. MADDEN: We would have --

MR. MICHELSON: I am sure he does. These people hammered themselves after they wet down the system and had the clean up job. It was caused by loss of air in that case.

MR. CATTON: Would you like to continue?

MR. BUSLIK: Okay. The adequacy of fire barriers, it is being prioritized now. My understanding is that again, John Lambright I think will be involved with that. They will be using some National Institutes of Standards and technology codes to assess what would happen if the barrier failed. I think there is one CCFM- -- something like that. I am not familiar with it. It can, apparently, treat propagation of smoke from one room to another and another code that they will be using to determine that -- they will also be trying to determine --

MR. CATTON: They will use a code to determine the adequacy of the fire barriers?

MR. BUSLIK: No, a code to determine what would happen if the barrier failed. so that you do have propagation from one room --

MR. CATTON: What kind of code are they going to u[illegible]

MR. BUSLIK: It's a National Institute of Standards and Technology code.

MR. CATTON: Okay.

MR. QUINTIERE: I could comment. Basically, it would be an extension of COMPBRN, where you would now have connections other rooms in which each room could now have a layer in it. With the ventilation system they would assume that the ventilation system is simply like a duct connecting two rooms.

MR. BUSLIK: It would still be a zone code.

MR. QUINTIERE: It would be a zone code connected to probably ducts that would either have hot gas in it or cold gas, in other words, a single zone in each of the ducts.

MR. BUSLIK: It's not a field code.

MR. QUINTIERE: It's not a field code, no.

MR. CATTON: Do they have such a thing as multiple zone codes? It seems to me that would be easy to do.

MR. QUINTIERE: By multiple zone, do you mean in a given room?

MR. CATTON: Yes, in a given room, two or three layers rather than one.

MR. QUINTIERE: No. The reason for that is because of the -- this two zone concept is consistent with fire behavior. It is really based on the physical conception of fire, and then selecting control volumes accordingly. Anything beyond that would be sort of a mathematical description, which would lead you into a more finite difference does which also exists in several forms like you were pointing out the French have one. There are several of those codes around that have been applied to fire problems.

MR. BUSLIK: There is also a code, FAST, which they said -- John Lambright said he would be using.

MR. QUINTIERE: FAST is a counterpart to CCFM code. The French code that you spoke of, this MAGIC, it is probably another version of that. There are at least a dozen models like this around the world that different people have built up. If we turn back to the German research going on in the reactor, they are actually testing a number of these computer models, zone and finite difference models, to see how well they predict motion of smoke and hot gas in a reactor facility given a fire in one space.

MR. CATTON: Is research following this?

MR. BUSLIK: Yes. Bill Farmer, I think, is following the German.

MR. FARMER: We have a small activity at Sandia where we are following both and interacting with the Germans on both the code work and on the fire tests. We will be conducting a few calculations for selected fire tests and verifying a zone code and a field code. The field code is the Notre Dame and the zone code is up in the air. It may be the CCFM from NIST or may be modified COMPBRN, we don't know yet.

MR. MICHELSON: When we use ventilation ducts or penetrations of a wall and we put a fire barrier in there which we call a damper I guess, what kind of test is done on that damper? I understood the door test this morning and I understood that you are looking for a certain maximum temperature on the back side of the door and stay below that, but all the dampers are is a set of veins with about equal temperature on each side, I would think.

We are talking about very high temperatures. The test chamber is 1,800 degrees or so.

MR. CATTON: But the area is small --

MR. MICHELSON: Those dampers sometimes are not big. It depends on what --

MR. CATTON: They are supposed to limit the flow.

MR. MICHELSON: Hopefully they are closed and the flow is zero, but the barrier now is just a set of veins.

MR. MADDEN: A fire damper is a curtain fire door. As a matter of fact, the original name of a fire damper, a three hour rated fire damper was never called a damper. A three hour fire damper came about because of the nuclear industry. There isn't any practical applications of a three hour fire damper in normal building construction.

That damper is really what was classified under UL listing prior to 1976 as a three hour door for ventilation ductwork.

MR. MICHELSON: But it is the same test of a door.

MR. MADDEN: Same test. Interlocking curtain damper which, when it falls down it's kind of like a roll up door for example, it comes down and locks in a set of locking guides in the bottom and makes a -- what do you want to call it -- a door configuration.

MR. MICHELSON: But there's no insulating layer in there, is there?

MR. MADDEN: There is no insulating layer.

MR. MICHELSON: So, how do you keep one side at 1,800 and the other side not to exceed 650?

MR. CATTON: They probably have a different criteria.

MR. MICHELSON: I think they do, probably. That's what I am kind of getting at, maybe the criterion is 1,800 on each side of it.

MR. MADDEN: I don't believe it's 1,800 on each side or it would be --

MR. MICHELSON: It is just a single metal vein.

MR. MADDEN: Yes. It is certain gage of steel. Usually the ductwork in a nuclear plant is of heavier gage than the damper itself.

MR. MICHELSON: These may be wall penetrations only, and no ductwork at all.

MR. MADDEN: I understand what you are saying.

They do go through a similar test of what was tested at the fire door.

MR. MICHELSON: Apparently some other acceptance standards --

MR. MADDEN: UL-555 is the damper --

MR. MICHELSON: Those things have got to be running red hot when they are being tested.

MR. MADDEN: They are. They are fairly -- they are red hot.

MR. MICHELSON: It's just thin metal.

MR. TROUTMAN: Could I talk to you a little bit more about these two codes from the Bureau of Standards? We have been talking to the developers about CCFM and FAST at the Bureau of Standards. Both of them wanted to put in something which is half way between the zone model and the field model; that is to say a plume with ceiling jet.

It is believed that Sandia, that adding this feature to one of these codes at least will be a big help to them in the question of how long and whether or not you will actually get under ventilation and currents, the actuation of alarms which may be below the ceiling -- we heard about smoke and the heat detection ones -- or whether you won't get actuation of them.

You are going -- we are talking and negotiating sponsorship of such research. They have the models for this plume and ceiling jet, and it's just a question of the timing and money and personnel.

MR. BUSLIK: This would be in the FAST code?

MR. TROUTMAN: The developers of CCFM would like to do that also, but we are most recently talking to FAST people about doing that.

MR. BUSLIK: These codes are both being developed at the --

MR. TROUTMAN: Actually, C-FAST I think is funded to do that now for the symmetrical plume, that is the one that would be in the middle of the room or the room is large that it doesn't matter. They are putting that in. In fact, I think you could get it from them now on a test basis. We hope to do that.

MR. BUSLIK: These codes, they are adequate for typical rooms in nuclear power plants, or were they designed originally for dwellings or what?

MR. TROUTMAN: They tried to deal with high aspect ratio rooms too, like hospital corridors and elevator shafts in tall buildings.

MR. QUINTIERE: Basically, these codes would seem to be generic and would not depend on size of the room. However, if you had some initial stratification in the room the plume may never rise to the ceiling, such as what you might have in an atrium. If you have situations like that, the nuclear reactor -- there are some issues. If the fire is big enough and has enough energy, it will propagate to the ceiling. Then, the codes generally applicable.

What you sacrifice is that you don't get a measure of the temperature varying spatially, you get a uniform temperature. If you put in a ceiling jet over the ceiling, you could sort of superimpose into these models with some variation of temperature outward from the plume along the ceiling. This could be a useful engineering approximation, particularly when you are talking about the activation of detectors.

MR. CATTON: I was reading one of the invited talks at the Fire Science Symposium, and they show where depending on the size of the room you get a temperature distribution from the floor to ceiling. That seems to be being missed here.

MR. QUINTIERE: You will always get a temperature distribution from floor to ceiling.

MR. CATTON: This showed very nice, almost linear, from the floor to the ceiling.

MR. QUINTIERE: That is probably a situation where there is not a large vent in the room, and the layer has propagated down toward the floor.

MR. CATTON: To the floor. There is a recirculation feeding back up into it. You could model that as well, because once the layer hits the floor it is a distribution that is just maintained as the temperature increases.

MR. BUSLIK: There's little else that I have to say.

[Slide.]

The seismic fire interactions is another issue. That will be prioritized in the -- that will be addressed rather, in the IPEEE. It may depend very heavily on plant-specific considerations.

Then, as far as the adequacy of analytical tools for a fire, I guess we are not doing that much except for the work associated with these NIST codes and following the German work. That's about all on that.

MR. CATTON: With Carl gone, I suspect there will be no more questions.

[Laughter.]

MR. MCCRACKEN: Is that a promise?

MR. CATTON: I think so, because we are all getting a little antsy.

MR. WYLIE: I think you can safely make that statement.

MR. CATTON: I think so, unless he is lurking around the corner.

MR. MCCRACKEN: Art, would you leave that last one up there, please, the last slide that you had?

MR. BUSLIK: Okay. Fortunately, I have it where I can still find it.

MR. MCCRACKEN: What I wanted to go through -- and I understand that I am talking to exactly the right person because my research compatriots were here last week on Thursday -- my understanding was that they said Mr. Catton was really on them about what they weren't doing in fire protection?

MR. CATTON: I was?

MR. MCCRACKEN: That's what they said. Maybe they misinterpreted the depth of your voice and you were just being interested. At any rate, I wanted to make sure that you understood from an NRR perspective where we are on all these issues, and give you a little bit of a summary statement which I think will probably help.

On these particular issues, Item 1 which is being prioritized, we read their initial prioritization, we commented extensively on it, and basically said that we didn't agree that it was a medium priority which they had come up with. We said it was either low or drop. A lot of the issues identified in there on what gives you the interactions are exactly issues that we review under the current SRP criteria.

What the fire risk scoping study said was, if you don't have separation, if you can't electrically independently isolate the control room, it can be a problem. We are saying we already do that under today's rules and regulations. That is not one that we need to go research. We have already told people. There was a case where one was found and we sent out information notices and tell industry that this is an example of one that was found. The rules and regulations tell them they are supposed to be separated. That is not one that we have a problem with.

The manual fire fighting effectiveness, number two on there and number four, we are currently writing a memo to research

MR. QUINTIERE: Could we just come back to number one and clarify it. This is coming out of the Sandia study, right?

MR. MCCRACKEN: That came out of the Sandia study, yes.

MR. QUINTIERE: When they talk about interactions they mean the propagation of fire gases that may hinder?

MR. MCCRACKEN: No.

MR. CATTON: I think it's the question of the instrumentation --

MR. MCCRACKEN: They are talking about an electrical interaction, where the control room indicator is not electrically isolated from your remote indicator, therefore, you lose both of them at the same time.

MR. CATTON: That is a different --

MR. QUINTIERE: A different issue.

MR. MCCRACKEN: Different issue.

MR. BUSLIK: There might be I suppose in some cases, the other kind of interaction. If you have one room directly underneath the other or something of the sort -- I guess at Surry there's this seals failing. I am not quite sure that I understand it completely. If there were a conflagration in the control room, then there might be some interaction.

It doesn't seem very likely, I don't think.

MR. MCCRACKEN: Again, item two and four we are currently preparing memos or a memo -- a single memo that will address both of them -- that would have been done, with the exception of it has taken us about eight man weeks to prepare for this meeting. That didn't get done. Again, saying why we disagree with those being prioritized than anything other than lower drop.

They haven't finished the prioritization. They knew we were preparing the memo and they said they will hold off and go through it. They will wait on our memo first.

MR. CATTON: What is your memo going to say?

MR. MCCRACKEN: Our memo is going to say, for the reasons I said earlier on these two items, that we don't think that there is anything that we need to address through any additional research or any other action than we currently have available in the rules and regulations. If there is an issue identified through the IPEEE process, we can tell them fix them.

It will go into some detail on how we review plants. What the fire risk scoping study didn't do was address how we review power plants, what is required of those power plants to demonstrate that we think they are safe enough to operate. That wasn't considered in any of these areas. We think that's an important part of whether it is a significant issue. You can't just say if this fails like when they are talking about this fire barrier and running a test, if you assume a fire barrier fails I can tell you the results. I don't need to run a research program.

If the room next door is a room that you need, you are in trouble.

MR. CATTON: But we had some concerns about the diesel room for example, because of the oil fire.

MR. MCCRACKEN: Right.

MR. CATTON: You use the same UL standard that is used everywhere --

MR. MCCRACKEN: That is an issue which we should pick upon the IPEEE process that wasn't addressed by the current rules and regulations, and at that point if that is a significant risk I should be able to justify it on a cost benefit basis to have them go fix it.

MR. CATTON: That's only assuming somewhere along the line it gets treated properly.

MR. MCCRACKEN: Right.

MR. CATTON: Because you can always just say no it doesn't matter, and then it goes away again without ever having addressed it.

MR. MCCRACKEN: Part of that process is you have to look at fuel available.

MR. CATTON: You have to look at fuel available, what the heat fluxes against the door are --

MR. MCCRACKEN: Sure.

MR. CATTON: This needs some kind of analysis to be done.

MR. KELLY: My name is Glen Kelly, with NRR Risk Applications Branch. Conrad is right, it would be nice if these are picked up in IPEEE. My understanding and anyone who knows better can correct me -- most of the fire PRA's do not consider very well the failure of barriers. Therefore, that is not even modeled in there.

MR. CATTON: That's what I gathered from what we heard about Brunswick, is that they don't do anything.

MR. KELLY: The five methodology proposes to effectively assume if you have some kind of procedure for checking barriers that the barriers will always work. Therefore, neither one of these as currently proposed would necessarily cover the type of thing you are talking about.

MR. CATTON: So, I think it needs to be addressed by somebody. I don't think it's a research but somebody needs to do some analysis to see if the test conditions are ever exceeded anywhere in the plant where a barrier is needed. That means that you have to address the fire.

MR. MCCRACKEN: What I am saying is, there are a very few number of areas in all the plants that would trip that criteria.

MR. CATTON: Okay, well one --

MR. MCCRACKEN: They are easy to see where they are. It's not a big unknown. I mean, a cable spreading room, it's a diesel room where you have a lot of fuel source or a diesel oil storage tank close to a building, yes.

MR. CATTON: I would expect then at some point we would see calculations demonstrating it either does or doesn't for those circumstances.

MR. MCCRACKEN: We would expect to see that addressed at some point, yes.

MR. CATTON: We didn't in Brunswick.

MR. MCCRACKEN: Right.

MR. CATTON: So, are you expecting the industry is going to do it? Are you going to tell Brunswick to go back and -- hey you didn't do this right, redo these calculations.

MR. MCCRACKEN: We haven't addressed what we are going to do with all the plants that have submitted and done PRA's if we come up with additional things on what you need to look at in your power plant for vulnerabilities. That is something that we, as a Commission have not done. We have said submit then and we will review them independently, but we haven't gone back.

We do know that no matter what we do in an area like that, we have to go through the backfit process. If we identify that as an issue as was done at South Texas --

MR. CATTON: But there are two parts to that. The diesel room was brought up because it is clearly a different kind of fire.

MR. MCCRACKEN: Right.

MR. CATTON: So, before you can tell them that they didn't do it right, you either have to ask them to go back and do the calculations -- this has nothing to do with the backfit -- are you going to do that.

MR. MCCRACKEN: Tell them to go back and do the calculations is a backfit.

MR. CATTON: No, no. Right now you have in your hand the Brunswick PRA.

MR. KELLY: I believe that if you request the utility to provide this information for the IPEEE under the 50.54 request under Generic letter 88-20 Supplement 4 -- as we did with the internal events, we indicated that there was a minimum level of the PRA that we expected to see from them. We basically outlined a minimum that the PRA should have.

We could do a similar type thing that we should expect that the fire PRA should have if the utility wants to submit that as their response to the fire portion of the IPEEE. I believe that would be similar to -- it would be reasonable, based on what we have done already in the internal events portion.

MR. CATTON: I would think so. Are you going to do it? You see, I don't think it's a difficult kind of analysis to do. It seems to me if the barrier plays an important role you ought to do it.

MR. KELLY: My personal opinion is that it is something that probably needs to be looked at. I believe that is something that the fire protection subcommittee has to come to a final decision on of what they feel is appropriate for going into the generic letter.

MR. QUINTIERE: I still think you are overlooking something relative to this barrier issue, and I probably said it twice earlier. I will try to say it again to see if we are on the same wavelength.

My understanding is that this concept of having this three hour barrier is to try to contain the propagation of this fire. If I assume that I have this closed space with this three hour containment and I have a fire in this space, that fire is going to burn using the oxygen within the space. As it releases heat and transfers that heat to the gas, the rate at which the heat is transferred to the gas and stays in the gas is going to control the leakage rate from that space.

Air is initially going to leak out, and then as the fire builds up in that room and smoke begins to fill it, smoke will leak out of that room through all cracks and crevices. This fire will last to the point where the oxygen level gets in this room of the order of maybe 13 percent, and then the fire will go into some sort of smoldering type mode and people who have done these experiments they have actually -- there will be flames floating around the room in various places. If the fire is going to persist, it would likely stay in that mode for some time and you have this leakage going in and out of this room.

The real issue to me is not whether fire is going to propagate from this room but how much stuff is getting out, and how much that impacts your surroundings in terms of visibility, in terms of heat damage. In many cases and maybe all cases that you control, the amount of combustibles and size of the room is such that there is no problem. It would seem to me that if you can show that by some calculations you would feel a lot more comfortable -- at least I would feel more comfortable -- and it would say something about the need or conservatism of this three hour barrier.

The other side of it is, if there is going to be some action to fight this fire and the contained automatic suppression system does not work, then someone is going to have to open a door to get into this space. Once that is done, the fire is going to be controlled in a different way, by the rate at which oxygen is supplied through that opening. Now you have a vent that is going to release these products of combustion into the rest of your building.

So, in a design scenario or in a risk analysis or hazard analysis, I think one can avoid dealing with an almost considered breech in this barrier. How else can you fight the fire?

MR. MCCRACKEN: I agree, you said that before, at least two or three times.

MR. QUINTIERE: It is a point of view that I have that I see as an inconsistency in the analysis.

MR. MCCRACKEN: I think I have responded to it, and I will respond to it again. There are only about three fire areas out of 50 fire areas in these plants that have a sufficient fuel source to handle the scenario which you are talking about. The scenario that you are talking about is basically where you have an unlimited fuel source sitting in a room and at some point that fire is going to start to become starved.

In those locations we have already required them to put automatic suppression systems. To achieve the scenario that you are talking about, you fire have to have a fire at some frequency. It has to ignite and it has to start. The automatic suppression system has to fail. The fire brigade, the fire detection system has to have failed or they would have detected it and they would be responding to it for it to get to that condition.

You have to go through a whole series of failures to get to the point you are talking about. When you do that probabilistically, it doesn't come up to be a big probabilistic number. You have to fail too many things that should have prevented you from getting into that situation.

MR. QUINTIERE: I would tend to qualitatively agree with you, but I was just going back Conrad, to the beginning of the presentation here where this phrase was listed that plants are required to demonstrate safe shutdown without repair, assuming total loss of any fire area three hour barrier.

That would presume then that you had these other failures. I was looking at that extreme. I grant that there's a lot of things in place that can come to mitigate the fire, very comprehensive --

MR. MCCRACKEN: We don't believe that is what is going to occur. We believe they are going to detect it and it will be suppressed, and they will still have the other safe shutdown capability. We are saying absent of all that, you still have to have that capability.

The fire brigades are trained in going into fire areas. It is not a surprise to somebody on a fire brigade if you get to a fire area and you touch the door and the door it hot, that you are going to have trouble when you open the door. They are trained. They are required to be trained fire fighters there. It is not your next door neighbor in an apartment building opening that door.

MR. QUINTIERE: I am not questioning the skill of the firemen. I am saying that when you open that door, now you have gases coming through.

MR. MCCRACKEN: Of course.

MR. QUINTIERE: Now, if you have a big fire, that fire is going to be fed by that air.

MR. MCCRACKEN: Right.

MR. MADDEN: I am not going to disagree with you there.

MR. CATTON: And, I am going to do something different. I am going to cut this off, because if I leave I can catch a 6:00 o'clock flight.

MR. MCCRACKEN: Let me make a real quick statement so that you know where NRR is coming from, because I don't want you to be mislead or think you are at a different place than we are.

MR. CATTON: It's kind of hard to misinterpret you, I think.

MR. MCCRACKEN: I try to make sure you don't. We believe that the GDC, the SRP criteria including the Appendix R with the codes and standards, provide us a process that gives us adequate fire safety that everything meets the rules and regulations. With the defense-in-depth that we have which is control of combustibles, which is controlled at all power plants, fire hazard analysis, detection capability, the automatic suppression capability were needed, the manual suppression capability, coupled with the IPEEE process that we will go through and systematically and look for places that we have missed - an example of a place that we missed could well be a place where you have diesel fuel oil stored where we don't have automatic suppression.

MR. CATTON: The two to three places where you have lots of combustibles.

MR. MCCRACKEN: Or, if we have missed a place, if we have a lot of diesel oil and we don't have automatic suppression for some reason. Areas like that can be picked up in IPEEE and we address them. I think that would be justified through the backfit process to fix. I think it would be relatively easy to justify on a cost benefit basis.

Doing those things, we believe that we in place the tools necessary to maintain the power plants that they are safe, and with the additional enhancements we have made on separation, three hour barriers everywhere on the new plants, we think we have addressed those and have clearly made them safer than the current generation which are adequately safe.

In looking at our fire history database on failure of barriers and issues of smoke propagation out of barriers and causing problems, we have not had that occur due to fires. I think it's primarily due to the fact that we have very small fires that are small fuel loadings. We have not failed our three hour fire barriers. We have not had initiation of automatic sprinkler systems due to fires, because they have been suppressed manually before we ever got to that point.

The fire protection history in the nuclear industry is outstanding. It is there for a reason, because Browns Ferry woke up people.

MR. CATTON: Just a piece of information flashed into my mind from our trip to St. Lucie. I think it was 1,700 fires and none of them were detected with their fire detection system.

MR. MADDEN: No, they had --

MR. CATTON: That's what they said, they wrote it down.

MR. MADDEN: They have 1,700 fire detectors in the plant.

MR. CATTON: I will give you the actual numbers. Anyway, it was one hell of a lot, and none of them were solved with the detection equipment.

MR. MADDEN: I have the slides, if you want to see them. There were 55 fires on site total. Somewhere around--

MR. CATTON: That's right. It was a large number of fires, 17,00 detectors, and none found with the detectors.

MR. MADDEN: Eighteen fires associated with the auxiliary building. All of the fires of the 18 -- and that's divided amongst two plants -- so that's nine within ten years of operating experience. Those fires were detected by plant personnel reported and the fire brigade handled those fires with no automatic suppression or detection actuation.

MR. MCCRACKEN: With 24 hour manning people roving around, you find most fires. Anytime they are doing things that could create fires, they have extra fire watches there.

MR. CATTON: So, the fire watches is safer than the detector.

MR. MCCRACKEN: It is not unreasonable. Sure, that's why you have the fire watch. I believe that there is adequate safety there. That is why research doesn't have a user need. That's why whatever they are doing, they do some certain programs on their own and we don't have to have a users need for. That's why we haven't been over there saying look, we need some big program to solve the program because I don't believe there is a problem out there.

There are other areas that I would much rather spend my resources on, like going out and inspecting the plants and make sure that they are doing what they told me they would do when I agreed to license them.

MR. CATTON: I hear you.

MR. QUINTIERE: I agree with the thrust of what you are saying, but I just want to cap it this way. If the chance of h[illegible]ing a large fire is small which we probably all believe in this case, then wouldn't it behoove us to really [illegible] all the consequences of such a large fire to see [illegible] what other things it might propagate?

MR. MCCRACKEN: I know the consequences. If I postulate a big enough fire I can get a core melt. I know that.

MR. KELLY: It is not exactly a PRA though. Again, I can be corrected by anyone who knows that area better than me. I believe that most of the fire PRA's do not analyze or do not take into account smoke damage. You assume if you have --

MR. CATTON: I understand. When I said PRA, I mean a PRA that is correctly done. As long as PRA is going to be a tool of choice for whatever reason, it should be done right.

MR. MURPHY: Dr. Catton, if I might, this is one of the reasons why we in research are continuing a relatively modest program still addressed toward the fire. It is to respond to the type of comments that we have gotten on NUREG-1150 from the Committee.

As Charlie Troutman indicated, we are starting to look at the type of codes available from NIST, and we are trying to bring our thermal hydraulic talent to bear in looking at these problems. Again, a suggestion that was made by the Committee, and I think you personally about a year ago, and we are trying to respond to that.

We have a program to get entry into the data coming from the German tests. Our efforts are relatively modest so that we can respond to PRA's even better, respond to any generic issue that comes up. We have a program going and it's a relatively modest one that would be expanded if Conrad thought there was a problem. We are aiming at our being able to be able to predict the risk at little bit better.

MR. CATTON: I think with that, I would like to go off the record.

[Whereupon, at 4:37 p.m., the transcribed portion of the meeting was concluded.]

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: Auxiliary and Secondary Systems

DOCKET NUMBER:

PLACE OF PROCEEDING: Bethesda, Maryland

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.

Mary C. Larkin

Official Reporter
Ann Riley & Associates, Ltd.

(1)

NRR STAFF PRESENTATION

TO

ACRS

SUBJECTS:

I. FIRE PROTECTION IN THE NUCLEAR INDUSTRY

II. NRC FIRE PROTECTION REGULATIONS AND GUIDELINES

III. OVERVIEW OF FIRE PROTECTION REQUIREMENTS FOR NUCLEAR POWER PLANTS IN SELECTED COUNTRIES

IV. FIRE AREA ISOLATION AT NUCLEAR POWER FACILITIES

V. BRUNSWICK PERSONNEL AIRLOCK FIRE

DATE: JANUARY 17, 1991

PRESENTERS:

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SUBCOMMITTEE: AUXILIARY AND SECONDARY SYSTEMS

FIRE PROTECTION

IN

THE NUCLEAR INDUSTRY

NUCLEAR POWER PLANT FIRE PROTECTION

- CURRENT FIRE PROTECTION PROGRAMS ARE COMPREHENSIVE, CONSERVATIVE, AND INCORPORATE DEFENSE IN DEPTH WITH RESPECT TO ENSURING SAFE SHUTDOWN CAPABILITY
- CURRENT RULES AND REGULATIONS ARE ADEQUATE TO ENSURE IMPLEMENTATION AND MONITORING OF PLANT SPECIFIC FIRE PROTECTION PROGRAMS

NUCLEAR POWER PLANT FIRE PROTECTION

- PRIOR TO THE 1975 BROWNS FERRY FIRE, NRC REQUIRED COMPLIANCE WITH THE BROAD GUIDANCE OF GDC 3
- IN 1976, NRC ISSUED CRITERIA TO ENSURE THAT POWER PLANTS WERE CAPABLE OF ACHIEVING SAFE SHUTDOWN IN THE EVENT OF A FIRE
- DUE TO THE RELUCTANCE OF SOME LICENSEES TO IMPLEMENT THESE GUIDELINES THE COMMISSION ISSUED A RULE IN 1981 REQUIRING:
  - FIRE PROTECTION OF SAFE SHUTDOWN CAPABILITY (III.G)
  - EMERGENCY LIGHTING (III.J)
  - RCP OIL COLLECTION SYSTEM (III.O)

IMPLEMENTATION STATUS

- PLANTS LICENSED PRIOR TO JANUARY 1,1979, HAVE IMPLEMENTED APPENDIX R
- PLANTS LICENSED AFTER JANUARY 1, 1979, HAVE MET BTP 9.5.1 WHICH INCORPORATES APPENDIX R
- CONSTRUCTION DELAYED PLANTS WILL HAVE TO MEET BTP 9.5.1
- ADDITIONALLY, GL 88-20 SUPPLEMENT 4 ENSURES THAT A SYSTEMATIC VULNERABILITY SEARCH WILL BE CONDUCTED

IMPLEMENTATION STATUS (CONT.)

- EVOLUTIONARY PLANTS ARE REQUIRED TO DEMONSTRATE SAFE SHUTDOWN WITHOUT REPAIR, ASSUMING TOTAL LOSS OF ANY FIRE AREA (3 HR BARRIERS)
- ABWR PRELIMINARY ASSESSMENT INDICATES ALL FIRE AREAS ARE SCREENED OUT
- PASSIVE PLANTS REQUIRED TO MEET SAME CRITERIA AS EVOLUTIONARY
  - CONCERN EXISTS WITH RESPECT TO IMPLEMENTATION, CONSIDERING THAT MANY SAFETY SYSTEMS REQUIRED IN CURRENT PLANTS TO ACHIEVE SAFE SHUTDOWN MAY NOT BE SAFETY GRADE
  - DO NOT UNDERSTAND FIRE PROTECTION CRITERIA FOR BOP

FIRE RISK SCOPING STUDY ISSUES

- ANALYTICAL CODES; ADEQUATE TO SEARCH FOR VULNERABILITIES IN CURRENT PLANTS, NOT NEEDED FOR FUTURE PLANTS
- SEISMIC/FIRE INTERACTION; PROCEDURALLY DIRECTED WALKDOWN AS PART OF IPEEE, DESIGNED OUT FOR EVOLUTIONARY, UNDER REVIEW FOR PASSIVE
- FIRE BARRIER QUALIFICATION; VERY CONSERVATIVELY DESIGNED, INDIVIDUAL PLANTS JUSTIFY EFFECTIVENESS OF MAINTENANCE AND SURVEILLANCE PROGRAMS
- MANUAL FIRE FIGHTING EFFECTIVENESS; INDIVIDUAL PLANTS JUSTIFY ASSUMPTIONS
- CONTROL SYSTEMS INTERACTIONS; REGULATIONS REQUIRE <u>INDEPENDENT</u> SHUTDOWN CAPABILITY AND PLANTS HAVE BEEN REVIEWED. LICENSEES WILL VERIFY IN'S AS PART OF IPEEE

FIRE RISK SCOPING STUDY ISSUES (CONT.)

- TOTAL EQUIPMENT SURVIVAL; GDC 3 REQUIRES THAT FIRE FIGHTING SYSTEMS BE DESIGNED TO NOT IMPAIR SAFETY SYSTEMS.
  - GI-57 RESOLUTION WILL BE A COMPLIANCE ISSUE, IF WARRENTED
  - SMOKE EFFECTS OF OPERATORS CONSIDERED IN IPEEE
  - SOOT EFFECTS ON EQUIPMENT, PRIMARILY A CLEANUP ISSUE AFTER A FIRE, DEFENSE IN DEPTH
  - SMOKE/SOOT TO BE ADDRESSED FOR ELECTRONIC EQUIPMENT IN ADVANCED REACTORS

FOCUS OF STAFF RESOURCES IN THE FIRE AREA

- CURRENT RULES AND REGULATION ARE ADEQUATE, THEREFORE, EFFORTS ARE NOT BEING EXPENDED TO MODIFY THEM
- INCREASED EMPHASIS ON INSPECTIONS OF OPERATING REACTORS TO ENSURE CONTINUED COMPLIANCE
- REVIEW OF PASSIVE REACTORS
- ADDITIONAL RESEARCH IS NOT NECESSARY

NRC REQUIREMENTS REGULATING FIRE PROTECTION AT NUCLEAR POWER FACILITIES

NRC NUCLEAR POWER PLANT FIRE PROTECTION REGULATIONS

10 CFR PART 50.34

REQUIRES THAT MINIMUM PRINCIPAL DESIGN CRITERIA
BE ESTABLISHED.

10 CFR PART 50, APPENDIX A

ESTABLISHES THE FACILITY PRINCIPAL DESIGN REQUIREMENTS

APPENDIX A, GENERAL DESIGN CRITERIA (GDC), CRITERION 3 ADDRESSES ....

FIRE PROTECTION

CRITERION 3 REQUIRES ....

THE PROBABILITY AND EFFECTS OF FIRES AND EXPLOSIONS ON STRUCTURES, SYSTEMS, AND COMPONENTS IMPORTANT TO SAFETY BE MINIMIZED.

CRITERION 3 ALSO ....

REQUIRES THE USE OF NONCOMBUSTIBLE AND FLAME RESISTANT MATERIALS; AND

ESTABLISHES THE BASIS FOR MINIMIZING THE ADVERSE AFFECTS OF FIRE THROUGH THE INCORPORATION OF FIRE DETECTION, SUPPRESSION, AND MANUAL FIRE FIGHTING SYSTEMS FOR STRUCTURES, SYSTEMS, AND COMPONENTS IMPORTANT TO SAFETY.

CRITERION 3 IS SATISFIED AT NUCLEAR POWER PLANTS BY MEETING THE FIRE PROTECTION PLAN/PROGRAM REQUIREMENTS OF 10 CFR 50.48.

10 CFR 50.48 REQUIRES ....

LICENSEES TO DEVELOP AND IMPLEMENT A COMPREHENSIVE FIRE PROTECTION PROGRAM.

PLANTS LICENSED PRIOR TO JANUARY 1, 1979

FIRE PROTECTION PROGRAMS MUST INCORPORATE THE FIRE PROTECTION/SAFE SHUTDOWN FEATURES REQUIRED BY 10 CFR 50, APPENDIX R, SECTION III.G, III.J, AND III.O.

IN ADDITION, SATISFYING THE NRC STAFF FIRE PROTECTION PROVISIONS SPECIFIED BY APPENDIX A TO BRANCH TECHNICAL POSITION APCSB 9.5-1, AUGUST 1976.

PLANTS LICENSED AFTER JANUARY 1, 1979

10 CFR 50.48 REQUIRES CRITERION 3 TO BE SATISFIED IN ACCORDANCE WITH THE PROVISIONS OF THEIR LICENSES.

STANDARD REVIEW PLAN (SRP), NUREG-0800, SECTION 9.5.1, "FIRE PROTECTION PROGRAM," WAS USED BY LICENSEES AND THE STAFF AS GUIDANCE TO ASSURE THAT GDC 3 WAS SATISFIED.

THE SRP FIRE PROTECTION PROGRAM GUIDELINES WHEN FULLY IMPLEMENTED PRODUCE A LEVEL OF FIRE PROTECTION EQUIVALENT TO THE PROVISIONS SPECIFIED BY 50.48 FOR FACILITIES LICENSED PRIOR TO JANUARY 1, 1979.

NOTE ....

"NRC" FIRE PROTECTION PROGRAM GUIDANCE AND AND ITS DEVELOPMENT IS BASED ON NUREG - 0050, "RECOMENDATIONS RELATED TO THE BROWNS FERRY FIRE," FREBUARY 1976.

THE FIRE PROTECTION DESIGN FEATURES (e.g., FIRE DOORS, FIRE DETECTION SYSTEMS, FIRE SUPPRESSION SYSTEMS, etc.) OF A NUCLEAR POWER FACILITY ARE DESIGNED, INSTALLED, TESTED, AND MAINTAINED IN ACCORDANCE WITH FIRE PROTECTION INDUSTRY STANDARDS DEVELOPED AND ESTABLISHED BY THE NATIONAL FIRE PROTECTION ASSOCIATION (NFPA).

THE FIRE PROTECTION "DEFENSE-IN-DEPTH" APPROACH" UTILIZED BY THE NRC STAFF FOCUSES ON ESTABLISHING AN ADEQUATE BALANCE IN ....

1. PREVENTING FIRES FROM STARTING;

2. DETECTING FIRES QUICKLY, SUPPRESSING THOSE FIRES, AND EXTINGUISHING THEM QUICKLY TO LIMIT DAMAGE; AND

3. DESIGNING PLANT SAFETY SYSTEMS SO THAT A FIRE THAT STARTS IN SPITE OF THE FIRE PROTECTION PROGRAM ACTIVITIES WILL NOT PREVENT THE SAFE SHUTDOWN OF THE PLANT.

THE "DEFENSE-IN-DEPTH" APPROACH IS ACCOMPLISHED BY THE NUCLEAR POWER INDUSTRY THROUGH THE IMPLEMENTATION OF A FIRE PROTECTION PROGRAM SATISFYING THE PROVISIONS OF NRC FIRE PROTECTION GUIDANCE (SRP 9.5.1, "FIRE PROTECTION PROGRAM").

FIRE PROTECTION INDUSTRY STANDARDS APPLIED TO THE NUCLEAR FIRE PROTECTION "DEFENSE-IN-DEPTH" CONCEPT OBJECTIVES ....

1. PREVENTING FIRES FROM STARTING

NFPA 6, "INDUSTRIAL FIRE LOSS PREVENTION"

NFPA 8, "EFFECTS OF FIRE ON OPERATIONS, MANAGEMENT RESPONSIBILITY"

NFPA 30, "FLAMMABLE COMBUSTIBLE LIQUIDS CODE"

NFPA 51B, "CUTTING AND WELDING PROCESSES"

NFPA 69, "EXPLOSION PREVENTION"

NFPA 70, "NATIONAL ELECTRIC CODE"

STANDARDS CONT.

2. DETECTING, SUPPRESSING, AND EXTINGUISHING FIRES QUICKLY.

FIRE DETECTION SYSTEMS

NFPA 72D, "PROPRIETARY PROTECTIVE SIGNALING SYSTEMS"
NFPA 72E, "AUTOMATIC FIRE DETECTORS"

FIRE SUPPRESSION SYSTEMS

NFPA 10, "PORTABLE FIRE EXTINGUISHERS, INSTALLATION, MAINTENANCE, AND USE"
NFPA 11, "FOAM EXTINGUISHING SYSTEMS"
NFPA 11A, "HIGH EXPANSION FOAM SYSTEMS"
NFPA 11B, "SYNTHETIC FOAM AND COMBINED AGENT SYSTEMS"
NFPA 12, "CARBON DIOXIDE SYSTEMS"
NFPA 12A, "HALON 1301 SYSTEMS"

STANDARDS CONT.

FIRE SUPPRESSION SYSTEMS - CONT.

NFPA 12B, "HALON 1211 SYSTEMS"

NFPA 13, "SPRINKLER SYSTEMS"

NFPA 14, "STANDPIPE AND HOSE SYSTEMS"

NFPA 15, "WATER SPRAY FIXED SYSTEMS"

NFPA 16, "FOAM-WATER SPRINKLER AND SPRAY SYSTEMS"

NFPA 20, "CENTRIFUGAL FIRE PUMPS"

NFPA 24, "OUTSIDE PROTECTION"

NFPA 26, "SUPERVISION OF VALVES"

FIRE BRIGADE

NFPA 4, "ORGANIZATION OF THE FIRE SERVICES"

NFPA 4A, "FIRE DEPARTMENT ORGANIZATION"

NFPA 7, "FIRE EMERGENCIES MANAGEMENT"

NFPA 27, "PRIVATE FIRE BRIGADE"

NFPA 197, "INITIAL FIRE ATTACK, TRAINING, STANDARD ON"

STANDARDS CONT.

3. PLANT DESIGN SUPPORTING SAFE SHUTDOWN

COMBUSTION PROPAGATION CONTROL

NFPA 80, "FIRE DOORS AND WINDOWS"

NFPA 92M, "WATERPROOFING AND DRAINING OF FLOORS"

NFPA 204, "SMOKE AND HEAT VENTING GUIDE"

NFPA 251, "FIRE TESTS, BUILDING CONSTRUCTION AND MATERIALS"

NFPA 259, "TEST METHOD FOR POTENTIAL HEAT OF BUILDING MATERIALS"

ASTM E-84, "SURFACE BURNING CHARACTERISTICS OF BUILDING MATERIALS"

ASTM E-119, "FIRE TESTS OF BUILDING CONSTRUCTION MATERIALS"

IEEE 383, "IEEE STANDARD FOR TYPE TESTS FOR IE ELECTRICAL CABLES, FIELD SPLICES, AND CONNECTIONS FOR NUCLEAR POWER GENERATING STATIONS"

OVERVIEW OF MAJOR ....
SRP "FIRE PROTECTION PROGRAM" AREAS

1. FIRE PROTECTION PROGRAM

* ESTABLISHED BY THE LICENSEE

* STATES THE PROGRAM POLICIES REGARDING THE LEVEL OF FIRE PROTECTION FOR STRUCTURES, SYSTEMS, AND COMPONENTS, IMPORTANT TO SAFETY.

* ESTABLISHES ORGANIZATIONAL RESPONSIBILITIES FOR THE FORMULATION, IMPLEMENTATION, AND ASSESSMENT OF THE PROGRAM.

* ESTABLISHES AND DEFINES THE PROCEDURES, EQUIPMENT AND PERSONNEL REQUIRED FOR PROGRAM IMPLEMENTATION.

SRP OVERVIEW CONT.

2. FIRE HAZARDS ANALYSIS (FHA)

* PERFORMED FOR EACH PLANT BY THE LICENSEE

* DEMONSTRATES THE PLANTS ABILITY TO PERFORM REQUIRED SAFE SHUTDOWN FUNCTIONS AND MINIMIZE RADIOACTIVE RELEASE IN THE EVENT OF A FIRE

* THE FHA MUST CONSIDER TRANSIENT COMBUSTIBLES AND THE CONSEQUENCES OF A FIRE ON THE ABILITY TO SAFELY SHUTDOWN

* DEFINES THE MEASURES TAKEN FOR FIRE PREVENTION, FIRE CONFINMENT, DETECTION AND SUPPRESSION, AND SAFE SHUTDOWN CAPABILITY AVAILABLE FOR EACH FIRE AREA

* DEVIATIONS TO NRC GUIDELINES ARE ADDRESSED IN EACH PLANT SPECIFIC FHA

SRP OVERVIEW CONT.

3. ADMINISTRATIVE CONTROLS

ESTABLISHED AT EACH FACILITY TO ....

* PROHIBIT BULK STORAGE OF COMBUSTIBLES INSIDE OR ADJACENT TO SAFETY-RELATED BUILDINGS OR SYSTEMS

* GOVERN THE HANDLING AND USE OF ORDINARY COMBUSTIBLES AND FLAMMABLE GASES AND LIQUIDS IN SAFETY-RELATED AREAS

* GOVERN HANDLING AND LIMITS OF TRANSIENT COMBUSTIBLES

* GOVERN THE USE OF IGNITION SOURCES

* ESTABLISH PERIODIC HOUSEKEEPING INSPECTION PROGRAM

SRP OVERVIEW CONT.

3. ADMIN. CONTROLS CONT.

* GOVERN LEAK TESTING METHODS FOR PENETRATIONS (NO OPEN FLAMES OF COMBUSTION GENERATED SMOKE)

* CONTROL OF SPECIFIC COMBUSTIBLES IN SAFETY-RELATED AREAS (e.g., WOOD, PLASTICS)

* ESTABLISHMENT OF FIRE WATCHES FOR INOPERABLE OR DISARMED FIRE PROTECTION FEATURES

* ESTABLISHMENT OF A FIRE PROTECTION SURVEILLANCE, TESTING, AND MAINTENANCE PROGRAM

SRP OVERVIEW CONT.

3. ADMIN. CONTROLS CONT.

* ESTABLISHMENT OF VARIOUS CONTROL ACTIONS TAKEN BY .. ...

PERSONNEL DISCOVERING A FIRE
(ALERT THE CONTROL ROOM, ATTEMPT TO EXTINGUISH THE FIRE)

CONTROL ROOM OPERATORS UPON NOTIFICATION OF A FIRE

FIRE BRIGADE ACTIONS TAKEN AFTER NOTIFICATION
(FIRE FIGHTING PRE-PLANS/STRATEGIES TO BE FOLLOWED)

SRP OVERVIEW CONT.

4. FIRE BRIGADE

* EACH SITE HAS A MINIMUM 5 MEMBER FIRE BRIGADE

* BRIGADE IS TRAINED AND EQUIPPED TO PROVIDE MANUAL FIRE FIGHTING CAPABILITIES FOR ALL AREAS OF THE PLANT

* COMPREHENSIVE TRAINING GIVE TO THE BRIGADES
  MAJOR AREAS COVERED BY THE TRAINING ....

  FIRE FIGHTING TECHNIQUES (INTERIOR ATTACK, ELECTRICAL, FLAMMABLE LIQUIDS AND GASES)

  SMOKE AND WATER CONTROL METHODS

  PLANT FIRE PROTECTION/CONTROL DESIGN FEATURES

  SEARCH AND RESCUE TECHNIQUES

SRP OVERVIEW CONT.

4. FIRE BRIGADE CONT.

* FREQUENT FIRE BRIGADE DRILLS, PRACTICE SESSIONS, AND TECHNIQUE REFRESHER TRAINING IS HELD

* FIRE FIGHTING STRATEGIES FOR EACH PLANT AREA IMPORTANT TO SAFETY ARE DEVELOPED

FIRE FIGHTING STRATEGIES ....

IDENTIFY COMBUSTIBLES IN THE AREA

RECOMMEND FIRE EXTIGUISHANTS BEST SUITED FOR THE COMBUSTIBLES IN THAT AREA

IDENTIFY THE MOST FAVORABLE METHOD OF FIRE ATTACK AND HOW TO GAIN ACCESS TO EACH AREA

ERP OVERVIEW CONT.

4. *FIRE BRIGADE CONT.*

FIRE FIGHTING STRATAGIES CONT.

IDENTIFCATION OF PLANT SYSTEMS WHICH SHOULD BE MANAGED TO REDUCE DAMAGE POTENTIAL (e.g., ISOLATION OF HYDRAULIC SYSTEM OR HIGH VOLTAGE EQUIPMENT)

IDENTIFICATION OF VITAL HEAT SENSITIVE EQUIPMENT WHICH SHOULD BE KEPT COOL WHILE FIGHTING A FIRE IN AN AREA

FIRE GROUND ORGANIZATION (e.g., TASKS TO BE PERFORMED BY EACH MEMBER - SMOKE REMOVAL, FIRE EXTINGUISHMENT, SEARCH AND RESCUE, etc.)

VENTILATION SYSTEM OPERATION FOR FIRE AREA ISOLATION OR SMOKE CONTROL OPERATIONS

IDENTIFICATION OF RADIOLOGICAL AND TOXIC HAZARDS IN EACH AREA

SRP OVERVIEW CONT.

5. GENERAL PLANT GUIDELINES

BUILDING DESIGN

FIRE BARRIERS: FIRE RESISTIVE RATING 3 HOURS

- SEPARATE SAFETY-RELATED SYSTEMS FROM FIRES IN NON SAFETY-RELATED AREAS WHICH COULD AFFECT THEIR SAFETY FUNCTIONS (e.g., WALL SEPARATING THE TURBINE BUILDING FROM THE AUXILIARY BUILDING)

- SEPARATE REDUNDANT DIVISIONS OR TRAINS OF SAFETY-RELATED SYSTEMS FROM EACH OTHER SO THAT THEY ARE NOT SUBJECT TO A SINGLE FIRE (e.g., RHR PUMP A AND B)

SRP OVERVIEW CONT.

BUILDING DESIGN CONT.

- INTERIOR WALLS AND STRUCTURAL COMPONENETS, THERMAL INSULATION, RADIATION SHIELDING, AND SOUNDPROOFING MATERIALS SHOULD BE NON-COMBUSTIBLE

- FIRE FIGHTING WATER RUNOFF IS FACTORED INTO THE PLANT DESIGN. FLOOR DRAINS, CURBING, EQUIPMENT PEDESTALS, AND SPRAY SHIELDS ARE USED

RP OVERVIEW CONT.

SAFE SHUTDOWN CAPABILITY

FIRE PROTECTION FEATURES ARE PROVIDED FOR SAFE SHUTDOWN FUNCTIONS.

ONE TRAIN OF SYSTEMS NECESSARY TO ACHIEVE AND MAINTAIN HOT SHUTDOWN/STANDBY CONDITIONS IS PROTECTED FROM FIRE DAMAGE

ROTECTION METHODS ....

* SEPARATION BY A 3 HOUR FIRE BARRIER

* 20 FEET OF HORIZONTAL SEPARATION FREE OF INTERVENING COMBUSTIBLES WITH DETECTION AND AUTOMATIC SUPPRESSION INSTALLED IN THE AREA

* ENCLOSURE OF ONE SAFE SHUTDOWN TRAIN IN A 1-HOUR FIRE BARRIER WITH DETECTION AND AUTOMATIC SUPPRESSION INSTALLED IN THE AREA

SRP OVERVIEW CONT.

ALTERNATIVE OR DEDICATED SHUTDOWN CAPABILITY

WHERE THE SAFE SHUTDOWN FIRE PROTECTION FEATURES CANNOT BE SATISFIED, SHUTDOWN CAPABILITY INDEPENDENT OF THE AREA AFFECTED BY THE FIRE IS PROVIDED.

ALTERNATIVE OR DEDICATED SHUTDOWN CAPABILITY PERFORMACE GOALS ....

- REACTIVITY CONTROL FUNCTIONS CAPABLE OF ACHIEVING AND MAINTAINING COLD SHUTDOWN CONDITIONS

- RCS MAKEUP FUNCTION
  - * ABOVE TOP OF CORE - BWR
  - * WITHIN THE LEVEL OF INDICATION IN PRESSURIZER - PWR

- REACTOR HEAT REMOVAL FUNCTION CAPABLE OF ACHIEVING AND MAINTAINING DECAY HEAT REMOVAL

SRP OVERVIEW CONT.

ALTERNATIVE SHUTDOWN PERFORMANCE GOALS CONT.

- PROCESS MONITORING FUNCTIONS PROVIDE DIRECT READING OF PROCESS VARIABLES

- SUPPORT FUNCTIONS SHOULD BE FUNCTIONAL TO PERMIT THE OPERATION OF SAFE SHUTDOWN EQUIPMENT

SRP OVERVIEW CONT.

CONTROL OF COMBUSTIBLES THROUGH DESIGN

* SAFETY SYSTEMS ISOLATED OR SEPARATED FROM COMBUSTIBLE MATERIALS

* BULK GAS STORAGE IS NOT PERMITTED INSIDE STRUCTURES HOUSING SAFETY-RELATED EQUIPMENT (e.g., HYDROGEN GAS STORAGE LOCATED OUTDOORS OR IN SEPARATE DETACHED BUILDING)

* HYDROGEN LINES IN SAFETY-RELATED AREAS DESIGNED TO SEISMIC CLASS I; OR SLEEVED WITH WATER PIPE VENTED DIRECTLY TO OUTSIDE; OR EQUIPPED WITH EXCESS FLOW CHECK VLAVE

SRP OVERVIEW CONT.

ELECTRICAL DESIGN

- ONLY METAL IS USED FOR CABLE TRAYS

- METALLIC TUBING IS USED FOR CONDUITS. NO THIN WALL AND FLEXIBLE CONDUIT IS USED FOR CONNECTION TO EQUIPMENT

- AUTOMATIC WATER SUPPRESSION RECOMMENDED FOR AREAS WITH HIGH CABLE CONCENTRATIONS NOT DIRECTLY ACCESSIBLE FOR MANUAL FIRE FIGHTING

- ELECTRICAL CABLE CONSTRUCTION, AS MINIMUM PASS FLAME TEST OF IEEE 383

SRP OVERVIEW CONT.

VENTILATION

* MEANS OF REMOVING SMOKE IS EVALUATED AND GENERALLY CONSIDERED THROUGH FIRE BRIGADE FIRE FIGHTING PRE-PLAN STRATEGIES

* THE USE OF AUTOMATIC SUPPRESSION AS A MEANS OF LIMITING SMOKE AND HOT GAS GENERATION IS CONSIDERED

* RELEASE OF SMOKE AND GASES CONTAINING RADIOACTIVE MATERIALS MONITORED

* FRESH AIR INTAKES FOR SAFETY-RELATED AREAS LOCATED REMOTE FROM EXHAUST AIR OUTLETS

SRP OVERVIEW CONT.

LIGHTING AND COMMUNICATIONS

* FIXED SELF CONTAINED 8-HOUR BATTERY POWERED LIGHTING UNITS LOCATED IN SAFE SHUTDOWN AREAS AND ACCESS/EGRESS ROUTES TO AND FROM ALL FIRE AREAS

* SUITABLE PORTABLE HAND LIGHTS ARE PROVIDED FOR EMERGENCY AND FIRE BRIGADE USE

* COMMUNICATIONS INDEPENDENT OF NORMAL COMMUNICATIONS INSTALLED AT PRESELECTED SAFE SHUTDOWN LOCATIONS

* PORTABLE RADIO COMMUNICATIONS PROVIDED FOR FIRE BRIGADE AND SAFE SHUTDOWN USE

SRP OVERVIEW CONT.

6. FIRE DETECTION AND SUPPRESSION

FIRE DETECTION

* FIRE/SMOKE DETECTION CAPABILITIES PROVIDED FOR AREAS THAT CONTAIN OR PRESENT A FIRE EXPOSURE TO SAFETY-RELATED AREAS

* FIRE ALARM AND DETECTION SYSTEMS DESIGNED TO BE FULLY SUPERVISED FOR CIRCUIT, DETECTOR, AND SIGNALING LINE TROUBLE CONDITIONS

NOTE - FIRE ALARM AND DETECTION SYSTEMS ARE CAPABLE OF OF RECEIVING AN ALARM WHILE THE SYSTEM IS IN TROUBLE

* PRIMARY AND BACKUP POWER SUPPLIES ARE PROVIDED

SRP OVERVIEW CONT.

FIRE PROTECTION WATER SYSTEM

* UNDERGROUND FIRE MAIN WATER DISTRIBUTION SYSTEM, WITH SECTIONAL ISOLATION VALVES
* FIRE HYDRANTS AND HOSE HOUSES
* TWO 100% FIRE PUMPS (ELECTRIC - DIESEL) WITH ADEQUATE INDEPENDENT WATER SUPPLIES (MIN. 300,000 GALS.)
* FIRE PUMPS ARE SEPARATED FROM EACH OTHER BY 3-HOUR FIRE BARRIER

SRP OVERVIEW CONT.

WATER SPRINKLER AND HOSE STANDPIPE SYSTEMS

* SPRi..KLER SYSTEMS AND MANUAL HOSE STATIONS HAVE CONNECTIONS TO THE FIRE MAIN SO A SINGLE FAILURE CANNOT IMPAIR BOTH

* CONTROL AND SECTIONALIZING VALVES ARE EITHER ELECTRICALLY SUPERVISED OR LOCKED OPEN

* SPRINKLER/HOSE STATION ACTUATION IS ALARMED IN THE CONTROL ROOM

* INTERIOR MANUAL FIRE HOSE STATIONS PROVIDED TO REACH ANY SAFETY-RELATED AREA WITH AN EFFECTIVE HOSE STREAM

SRP OVERVIEW CONT.

WATER SUPPRESSION SYSTEMS CONT.

* PROPER TYPE FIRE HOSE AND NOZZLE COMBINATIONS ARE PROVIDED BASED ON THE FIRE HAZARDS IN THE AREA (e.g., FIXED FOG IN HIGH VOLTAGE AREAS)

* SUPPLY OF WATER TO STANDPIPES AND HOSE CONNECTIONS FOR MANUAL FIRE FIGHTING IS AVAILABLE IN AREAS CONTAINING SAFE SHUTDOWN RELATED SYSTEMS FOLLOWING AN SSE

SRP OVERVIEW CONT.

7. GUIDELINES FOR SPECIFIC PLANT AREAS

CONTROL ROOM COMPLEX

* SEPARATED FROM OTHER PLANT AREAS BY 3-HOUR FIRE BARRIERS

* FIRE/SMOKE DETECTION PROVIDED FOR PERIPHERAL ROOMS, CONTROL ROOM, CABINETS, AND CONSOLES

* OUTSIDE AIR INTAKES FOR THE CONTROL ROOM PROVIDED WITH SMOKE DETECTION

* MANUAL FIRE SUPPRESSION CAPABILITY IS PROVIDED FOR CONTROL ROOM COMPLEX

SRP OVERVIEW CONT.

CONTROL ROOM COMPLEX CONT.

* SMOKE VENTING IS ACCOMPLISHED BY NORMAL VENTILATION. SUPPLEMENTAL SMOKE CONTROL SUPPORT MEASURES PERFORMED BY THE FIRE BRIGADE

* BREATHING APPARATUS AVAILABLE TO CONTROL ROOM OPERATIONS PERSONNEL

SRP OVERVIEW CONT.

CABLE SPREADING ROOM

* SEPARATED FROM OTHER PLANT AREAS BY 3-HOUR FIRE BARRIERS

* PRIMARY FIRE SUPPRESSION IN THE CABLE SPREADING ROOM IS PROVIDED BY AUTOMATIC WATER SUPPRESSION SYSTEM

* MANUAL SUPPRESSION CAPABILITIES ARE PROVIDED AND ACCESSIBLE TO THE AREA

* FIRE/SMOKE DETECTION IS PROVIDED IN THE ROOM

SRP OVERVIEW CONT.

SWITCHGEAR ROOMS

* SEPARATED FROM OTHER PLANT AREAS BY 3-HOUR FIRE BARRIERS

* REDUNDANT SWITCHGEAR ROOMS ARE SEPARATED FROM EACH OTHER BY A 3-HOUR FIRE BARRIER

* FIRE/SMOKE DETECTION IS PROVIDED FOR SWITCHGEAR ROOMS

* MANUAL FIRE SUPPRESSION IS PROVIDED AND ACCESSIBLE FOR SWITCHGEAR ROOMS

SRP OVERVIEW CONT.

REMOTE SAFETY-RELATED PANELS

* REMOTE SHUTDOWN CAPABILITY IS SEPARATED FROM THE CONTROL ROOM BY 3-HOUR FIRE BARRIERS

* SHUTDOWN PANELS ARE ELECTRICALLY ISOLATED FROM THE CONTROL ROOM. FIRE IN EITHER AREA WILL NOT AFFECT SAFE SHUTDOWN CAPABILITY

* FIRE / SMOKE DETECTION CAPABILITY IS PROVIDED

* MANUAL FIRE SUPPRESSION CAPABILITY IS PROVIDED AND ACCESSIBLE FOR SAFETY-RELATED PANELS

SRP OVERVIEW CONT.

SAFETY-RELATED BATTERY ROOMS

* REDUNDANT BATTERY ROOMS ARE SEPARATED FROM EACH OTHER AND OTHER AREAS OF THE PLANT BY 3-HOUR FIRE BARRIERS

* FIRE / SMOKE DETECTION IS PROVIDED FOR THESE AREAS

* VENTILATION SYSTEM IS CAPABLE OF MAINTAINING HYDROGEN CONCENTRATION BELOW 2% VOL. LOSS OF VENTILATION IS ALARMED

* MANUAL FIRE SUPPRESSION CAPABILITY IS PROVIDED

SRP OVERVIEW CONT.

DIESEL GENERATOR AREAS

* SEPARATED FROM EACH OTHER AND OTHER AREAS OF THE PLANT BY 3-HOUR FIRE BARRIERS

* AUTOMATIC FIXED FIRE SUPPRESSION INSTALLED IN THE DIESEL GENERATOR ROOMS

* FIRE / SMOKE DETECTION CAPABILITY IS PROVIDED IN THESE PLANT AREAS

* MANUAL FIRE SUPPRESSION CAPABILITY IS PROVIDED AND ACCESSIBLE

* DIESEL GENERATOR DAY TANKS ARE LIMITED IN SIZE (550 GALLONS) AND PROVIDED WITH SPECIAL PROTECTION

SRP OVERVIEW CONT.

SAFETY-RELATED PUMPS

* SAFETY-RELATED PUMP TRAINS SEPARATED BY 3-HOUR FIRE BARRIERS

* PUMP ROOMS ARE GENERALLY SEPARATED FROM OTHER AREAS BY 3-HOUR BARRIERS

* FIRE / SMOKE DETECTION CAPABILITY IS PROVIDED IN THESE AREAS

* MANUAL FIRE SUPPRESSION CAPABILITIES ARE PROVIDED AND ACCESSIBLE TO THESE AREAS

FIRE AREA ISOLATION

AT

NUCLEAR POWER FACILITIES

SRP 9.5.1, "FIRE PROTECTION PROGRAM," DEFINES ....

FIRE AREA

THAT PORTION OF A BUILDING OR PLANT THAT IS SEPARATED FROM OTHER AREAS BY BOUNDARY FIRE BARRIERS.

FIRE BARRIER

COMPONENTS OF CONSTRUCTION (WALLS, FLOORS, CEILINGS) INCLUDING BEAMS, COLUMNS, PENETRATION SEALS OR CLOSURES, DOORS AND DAMPERS THAT ARE RATED BY APPROVING LABORATORIES (UL, FM) IN HOURS OF RESISTANCE TO FIRE AND ARE USED TO PREVENT THE SPREAD OF FIRE.

FIRE AREAS ARE GENERALLY BOUNDED BY 3-HOUR FIRE BARRIERS ....

WHY 3-HOURS ....

* CONSERVATIVE APPLICATION BASED ON FIRE/FUEL LOAD

* FIRE RESISTIVE TECHNOLOGY AND COMPONENTS AVAILABILE TO THE NUCLEAR INDUSTRY (DESIGNS GREATER THAN 3-HOURS NOT BEING MANUFACTURED OR TESTED - 1976)

* 3-HOUR FIRE BARRIER DESIGNS ARE CONSTRUCTED OF NON-COMBUSTABLE MATERIALS (DESIGNS LESS THAN 3-HOURS USE COMBUSTIBLE COMPONENTS)

EXAMPLES OF SRP RECOMMENDED FIRE AREAS ....

CONTAINMENT

CONTROL ROOM

CABLE SPREADING ROOMS

ELECTRICAL SWITCHGEAR ROOMS

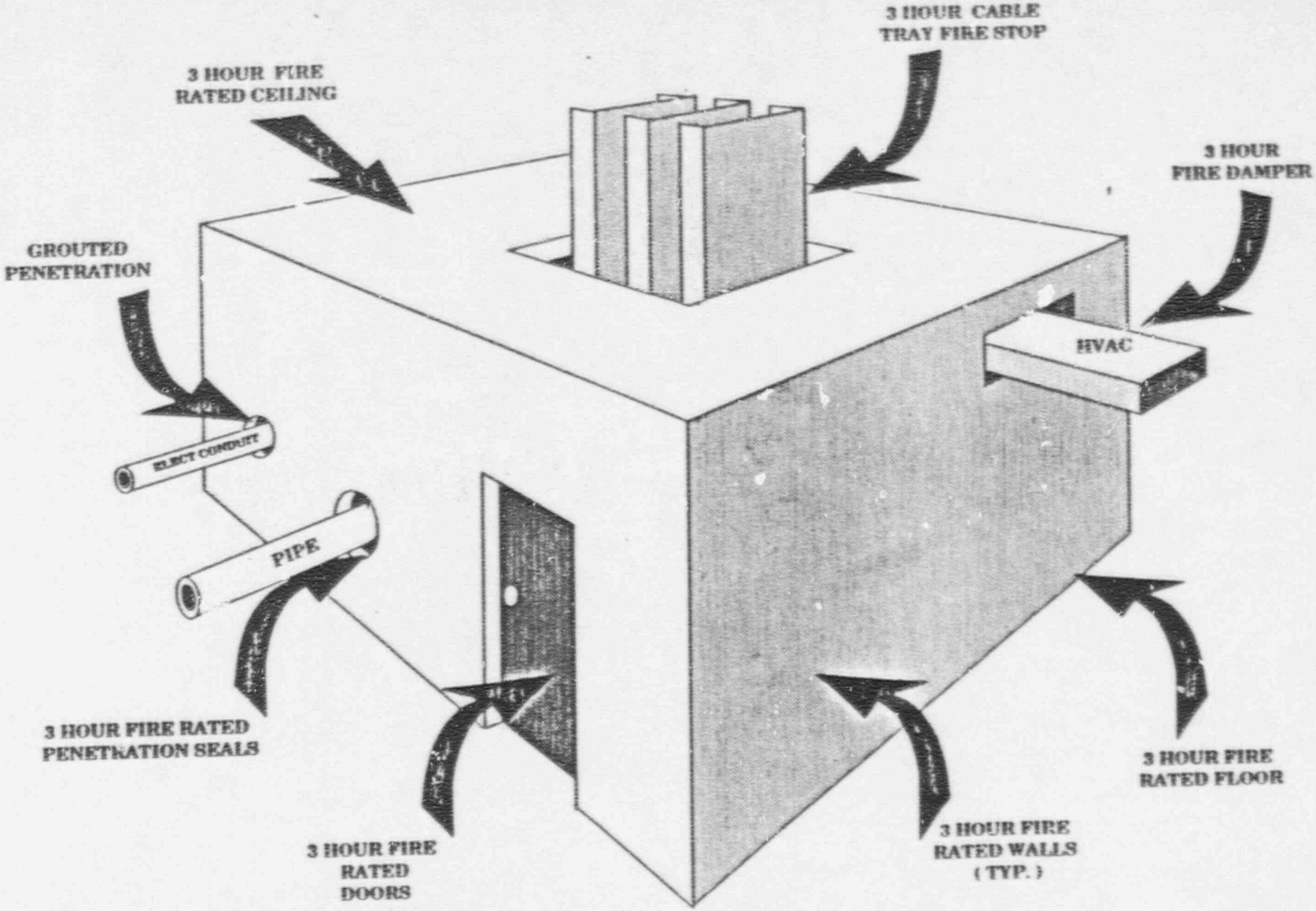
BATTERY ROOMS

SAFETY-RELATED PUMP ROOMS

DIESEL GENERATOR ROOMS

RADWASTE AND FUEL STORAGE AREAS

TYPICAL FIRE AREA



FIRE AREA BOUNDRY COMPONENTS

WALLS, FLOORS & CEILINGS

* CONCRETE
* CONCRETE BLOCK

PENETRATION SEALS (ASTM E-119)

* SILICONE - LOW DENSITY
  - HIGH DENSITY
  - BOOT / GEL

DOORS, FRAMES, HARDWARE

* UL LISTED - 3-HOUR FIRE RATING

DAMPERS

* UL LISTED - 3-HOUR FIRE RATING

FIRE BARRIER ENCLOSURES - APPENDIX R (ASTM E-119)

* "THERMO-LAG"
* "3M" INTUMESCENT MATERIAL

UTILIZED FOR RACEWAY AND COMPONENT PROTECTION GENERALLY

1-HOUR FIRE RESISTIVE RATING

FIRE TEST TO QUALIFY FIRE BARRIER COMPONENT DESIGNS

ASTM E-119 "FIRE TESTS OF BUILDING CONSTRUCTION AND MATERIALS"

OVERVIEW OF TEST

* CONTROLLED GAS FIRED FURNACE USED (TYPES WALL / FLOOR)

* SPECIMEN (e.g., PENETRATION SEAL, DAMPER, DOOR, RACEWAY OR COMPONENT ENCLOSURE) INSTALLED IN WALL OR FLOOR SLAB WITH KNOWN FIRE RESISTIVE RATING

* SPECIMEN ASSEMBLY BECOMES A BOUNDRY/WALL OF THE FURNACE

* SPECIMEN EXPOSED TO FIRE/FLAME IMPINGMENT DURING DURATION OF THE TEST

* TEMPERATURE ON THE UNEXPOSED SIDE MONITORED (325 F FOR PENETRATIONS AND COMPONENT ENCLOSURES - 650 F FOR DOOR/DAMPERS)

FIRE TEST CONT.

* TEMPERATURE RISE INSIDE THE FURNACE IS CONTROLLED OVER TIME FOLLOWING THE STANDARD TIME TEMPERATURE CURVE DEVELOPED BY NBS (NIST)

1000 F AT 5 MINUTES
1300 F AT 10 MINUTES
1550 F AT 30 MINUTES
1700 F AT 1 HOUR
1850 F AT 2 HOURS
1925 F AT 3 HOURS

* NBS (NIST) THROUGH ACTUAL FULL SCALE BUILDING FIRE TESTING AND ANALYSIS OF THE DATA COLLECTED DEVELOPED A RELATIONSHIP BETWEEN THE STANDARD TIME TEMPERATURE CURVE AND FUEL LOADING

FIRE TEST CONT.

FIRE RESISTIVE RATING/ FUEL LOAD COMPARISON

RATING	LOADING	BTUs / FT^2
30 MIN.	5 PSF	40,000
1-HOUR	10 PSF	80,000
2-HOUR	20 PSF	160,000
3-HOUR	30 PSF	240,000

NOTE - NBS (NIST) RELATIONSHIP IS BASED ON ORDINARY COMBUSTIBLES

THE MAJORITY OF THE FUEL CONTRIBUTORS AT A NUCLEAR FACILITY ARE CLASSIFIED AS ORDINARY.

CABLE INSULATION IS THE MAJOR CONTRIBUTOR WITHIN THIS CLASS.

REPRESENTATIVE FIRE LOADINGS AND FIRE PROTECTION FOR PLANT SPECIFIC AREAS (POWER OPERATIONS)

CABLE SPREADING ROOM

* APPROX. 25 PSF AVG.
  (SAFETY-RELATED AREA WITH HIGHEST EXPOSED FIRE LOAD)

  FIRE PROTECTION
  * 3-HOUR FIRE AREA
  * FIRE / SMOKE DETECTION
  * FIXED AUTOMATIC SUPPRESSION
  * MANUAL FIRE SUPPRESSION CAPABILITY

CHARGING PUMP ROOM (ONE TRAIN)

* APPROX. 1.5 PSF AVG.

  FIRE PROTECTION
  * 3-HOUR FIRE AREA
  * FIRE / SMOKE DETECTION
  * MANUAL FIRE SUPPRESSION CAPABILITIES

FUEL LOADINGS CONT.

BATTERY ROOM (ONE TRAIN)

* APPROX. 4 PSF AVG.

FIRE PROTECTION

* 3-HOUR FIRE AREA
* FIRE / SMOKE DETECTION
* VENTILATION - HYDROGEN BELOW 2%

SWITCHGEAR ROOM (ONE TRAIN)

* APPROX 3 PSF AVG.

FIRE PROTECTION

* 3-HOUR FIRE AREA
* FIRE / SMOKE DETECTION
* MANUAL FIRE SUPPRESSION CAPABILITIES

FIRE LOADINGS CONT.

DIESEL GENERATOR ROOM

* APPROX. 14 PSF AVG.

- FIRE PROTECTION
  * 3-HOUR FIRE AREA
  * FIRE DETECTION
  * AUTOMATIC FIRE SUPPRESSION
  * MANUAL FIRE SUPPRESSION
  * SPECIAL PROTECTION FOR DAY TANK

HOSE STREAM TEST

* SECOND SPECIMEN IS FIRE TESTED FOR 1-HOUR

* SPECIMEN REMOVED FROM THE FURNACE AND WATER HOSE STREAM IS APPLIED TO THE EXPOSED SIDE.

  - 20 FT. DIST. FROM SPECIMEN
  - 2 1/2 INCH FIRE HOSE
  - 1 1/8 INCH DISCHARGE NOZZLE
  - NOZZLE PRESSURE 30 PSI
  - 2.5 MINUTE WATER DISCHARGE TIME

NOTE - WATER PASSAGE THROUGH SPECIMEN IS CONSIDERED A FAILURE

BRUNSWICK UNIT 1

FIRE

DRYWELL

PERSONNEL AIRLOCK

DECEMBER 3, 1990

BRUNSWICK UNIT 1 CONDITIONS AT THE TIME OF THE FIRE ....

* IN A REFUELING/MAINTENANCE OUTAGE
* RECIRCULATION PIPE REPLACEMENT IN PROGRESS
* REACTOR DEFUELED

NOTE: LICENSEE'S INVESTIGATION AS TO THE CAUSE OF THE FIRE AND THE EXTENT OF DAMAGE IS STILL ON-GOING.

PERSONNEL AIRLOCK CONFIGURATION AT THE TIME OF THE FIRE ....

* THE PERSONNEL AIRLOCK (ENTRY HATCH) BEING USED AS PENETRATION POINT FOR CABLES, HOSES AND DUCTS

* METAL AIR DUCTING WAS INSTALLED ON ONE SIDE OF THE AIRLOCK

* A TRAY TO HOUSE NUMEROUS CABLES AND HOSES IN THE AIRLOCK OVERHEAD WAS CONSTRUCTED USING SCAFFOLDING AND FIRE RETARDANT PLYWOOD

* THE CABLES AND HOSES WERE WRAPPED IN THIN PLASTIC TO RESIST CONTAMINATION

IDENTIFICATION OF TEMPORARY EQUIPMENT ROUTED THROUGH THE OVERHEAD OF THE PERSONNEL AIRLOCK

* 36 POST WELD HEAT TREATMENT CABLES (6 SYSTEMS - 6 CABLES EACH)
* 24 POST WELD HEAT TREATMENT THERMOCOUPLE CABLES
* 24 HYDRAULIC HOSES FOR MACHINING EQUIPMENT
* 9 CABLES FOR HYDRAULIC POWER UNITS
* HEPA DUCT HOSE FOR RWCU F001 AND HPCI F002
* AIR HOSE FOR RWCU F001 AND HPCI F002

TEMPORARY EQUIPMENT CONT.

* DROP CORDS FOR RWCU F001 AND HPCH F002

* WELDING LEAD FOR RCWU F001 AND HPCI F002

* ARGON PURGE HOSE FOR RWCU F001

* CAMERA CABLES FOR RWCU F001 AND HPCI F002

DRYWELL ACTIVITIES AT THE TIME OF THE FIRE ....

* POST WELD HEAT TREATMENT WAS BEING PERFORMED ON THE "G" AND "K" RECIRC NOZZLE

NOTE:

POST WELD HEAT TREATMENT MACHINE IS SIMILAR TO A WELDER.

6 OUTPUT CIRCUITS ATTACH TO RESISTOR PADS.

RESISTOR PADS USED TO APPLY HEAT TO NOZZLE.

DECEMBER 3, 1990

SEQUENCE OF EVENTS ....

03:55 HP NOTIFIES CONTROL ROOM OF SMOKE. CONTROL ROOM DISPATCHES AO.

03:57 DRYWELL EVACUATION IN PROGRESS. POWER TO POST WELD HEAT TREATMENT EQUIPMENT BEING SECURED.

04:00 PROJECT COORDINATOR AT EQUIPMENT HATCH (NORTH SIDE OF DRYWELL) NOTIFIES CONTROL ROOM OF SMOKE.

04:02 CO INDICATES FIRE ALARMS RECEIVED ON FIRE ALARM PANEL

04:05 HP REPORTS BACK TO CONTROL ROOM DRYWELL HAS BEEN EVACUATED

SEQUENCE OF EVENTS CONT.

04:10 PROJECT COORDINATOR SEES SMALL FIRE APPROX. 1 FT. LONG WITH FLAMES 3/4 TO 1 INCH ON WIRING IN PERSONNEL AIRLOCK OVERHEAD

04:11 SHIFT FOREMAN ENTERS REACTOR BUILDING AND IS ADVISED OF FIRE LOCATION

04:15 SHIFT FOREMAN EXITS REACTOR BUILDING TO REPORT BACK TO THE CONTROL ROOM

04:16 SHIFT FIRE COMMANDER AND FIRE BRIGADE LEADER EXIT THE CONTROL ROOM

04:18 SHIFT FIRE COMMANDER ENTERS REACTOR BUILDING TO SIZE UP THE FIRE AND USES A FIRE EXTINGUISHER ON THE FIRE

04:20 FIRE ALARM SOUNDED, FIRE BRIGADE LEADER IN FULL PROTECTIVE EQUIPMENT ENTERS REACTOR BUILDING

SEQUENCE OF EVENTS CONT.

04:22 SECOND FIRE BRIGADE MEMBER ENTERS REACTOR BUILDING. 3 FIRE EXTINGUISHERS USED AND A FIRE HOSE LINE TO KNOCK FIRE DOWN IN THE AREA OF THE AIRLOCK. OBSTRUCTIONS HINDERED THIS OPERATION.

TOTAL BRIGADE ASSEMBLED.

04:25 RB EVACUATION ALARM SOUNDED

04:29 UE DECLARED

04:32 DRYWELL PURGE FAN SECURED (THIS WAS DONE TO ISOLATE AIR FLOW THROUGH AND THE SPREAD OF FIRE WITHIN THE AIRLOCK)

SEQUENCE OF EVENTS CONT.

04:32 SECOND FIRE HOSE BEING PULLED WITH EXTRA HOSE ADDED TO ATTACK FIRE FROM EQUIPMENT HATCH SIDE

04:33 RB VENTILATION SECURED (SMOKE CONTROL MEASURE)

04:35 PERSONNEL ACCOUNTABILITY FOR RB COMPLETE

04:37 COMMENCED FIRE ATTACK FROM INSIDE THE DRYWELL

04:42 REPORTED THAT WATER IS ON THE FIRE DRYWELL SIDE

SEQUENCE OF EVENTS CONT.

04:45 REPORTED THAT ALL TEMPORARY POWER SECURED

04:59 FIRE INTENSITY DECREASING

05:10 RB VENTILATION RESTARTED
(RADIATION CONTROL)

05:12 FIRE FIGHTING EFFORTS FROM RB SIDE
OF AIRLOCK DISCONTINUED

05:27 DRYWELL PURGE STARTED - RUN FOR
2 MINUTES (SMOKE CONTROL)

05:30 FIRE DECLARED UNDER CONTROL

05:40 RESTARTED DRYWELL PURGE FAN
(SMOKE/RADIATION CONTROL)

05:49 FIRE DECLARED OUT

05:52 UE SECURED

DESCRIPTION OF FIRE ....

* FIRE "ORIGIN" JUST INSIDE THE FIRST AIRLOCK DOOR IN THE PWHT CABLES

* FIRE WAS CONFINED TO THE CABLES IN THE AIRLOCK OVERHEAD SUPPORTED BY THE PLYWOOD AND SCAFFOLDING

* DUE TO INCREASED AIR FLOW CAUSED BY THE DRYWELL PURGE FANS THE FIRE PROPAGATED TOWARDS THE DRYWELL

* FROM THE POINT OF FIRE ORIGIN THE FIRE PROPAGATED APPROX. 12 FEET HORIZONTALLY IN THE AIRLOCK ALONG THE PLYWOOD TRAY

DESCRIPTION OF THE FIRE CONT.

* CABLING WAS ENCLOSED IN CONTINUOUS PLASTIC SLEEVING TO LIMIT CONTAMINATION. THIS SLEEVING CONTRIBUTED TO FIRE PROPAGATION INTO THE DRYWELL (APPROX. 4 FEET)

CAUSE OF FIRE

* CABLE OVERLOAD

  - OUTPUT POWER CABLES ASSOCIATED WITH THE "G" NOZZLE POST WELD HEAT TREATMENT PROCESS WERE ELECTRICALLY OVERLOADED.

  - CRACKS IN THE "D" AND "G" NOZZLE REQUIRED A SPECIAL HEATER TO PERFORM THE PWHT

  - THE "G" NOZZLE HEATER DREW APPROX. 150 AMPS

  - DERATING OF THE CABLES DUE TO BUNDLING AND SLEEVING SHOULD HAVE BEEN CONSIDERED

  - BASED ON THE "AS-BUILT" CONFIGURATION MAXIMUM AMPACITY SHOULD HAVE BEEN 50%

EFFECTS OF FIRE ON EQUIPMENT ....

- TOP COAT OF PAINT BLISTERED INSIDE AIRLOCK DIRECTLY ABOVE FIRE. PRIMER STILL INTACT. (SUGGESTS THAT PEAK TEMPERATURE 400-450 F INSIDE THE AIRLOCK ABOVE PLYWOOD)

- FIRE RETARDANT PLYWOOD MINOR CONTRIBUTOR TO FIRE (MINOR CHAR - NO BURN THROUGH)

- 12/5/90 PERSONNEL AIRLOCK PASSED LLRT

- SA-516 GRADE 70 CARBON STEEL MATERIAL (AIRLOCK LINER) HARDNESS TESTING PERFORMED AND FOUND ACCEPTABLE

  * 392 - 481 HARDNESS RANGE - STD.
  * FOUND WHEN TESTED 399-425

EFFECTS CONT.

- PENETRATIONS 1X-101D AND 1X-101F (POWER TO RECIRC PUMP "B") LOCATED APPROX. 5 FEET ABOVE AIRLOCK OPENING COVERED WITH LAYER OF SOOT.

  PENETRATION BOXES INSPECTED - NO INTERNAL HEAT OR SMOKE DAMAGE

- MSIVs DID NOT EXHIBIT ANY SIGNS OF DAMAGE. ASSOCIATED AC/DC PILOT SOLENOID NEAR THE AIRLOCK HAD BEEN TAGGED WITH A PAPER TAG. NO FIRE/SMOKE DAMAGE TO TAG.

- SRMs/IRMs IMMEDIATELY ADJACENT TO AIR LOCK. NO DAMAGE NOTED.

2

NRR STAFF PRESENTATION TO THE ACRS

SUBJECT: Overview of Fire Protection Requirements for Nuclear Power Plants in Selected Countries

DATE: January 17, 1991

PRESENTER: Patrick Madden

PRESENTER'S TITLE/BRANCH/DIVISION: Senior Fire Protection EngineerPlant Systems Branch Division of Systems Technology

DIVISION PRESENTER'S NRC TEL. NO: 301-492-0854

SUBCOMMITTEE: Auxiliary and Secondary Systems

SAIC
An Employee-Owned Company

PURPOSE: To provide the ACRS with an overview of the fire protection requirements in various countries.

SCOPE: A preliminary comparison of the regulatory requirements and supplementary guidance for fire protection in the

o United States	o France
o Canada	o USSR
o Japan	o U.K.
o Germany	

and the IAEA guidance.

Overview of Fire Protection Requirements for Nuclear Power Plants in Selected Countries

Country / Organization	Regulatory Document	Mandatory	Supplementary Guidance
U.S.	GDC 3 Appendix R C.1.0	Yes, exemptions permitted	BTP CMEB 9.5-1 Generic Letters
IAEA	Safety Series 50-SG-D2 "Fire Protection in Nuclear Power Plants"	no	
Canada	CAN/CSA N293-M87, " Fire Protection for CANDU Nuclear Power Plants"	Portions Mandatory	CAN3-N290.1-80 "Requirements for the Shutdown Systems of CANDU Nuclear Power Plants"
Japan	JEAG - 4607 "Fire Protection for Nuclear Power Plants"	Guidelines	
Germany	KTA 2101.1 "Brandschutz in Kernkraftwerken, Teil 1: Grundsatze des Brandschutzes"		
France	Basic Safety Rule Number V.2.j. "General Rules Applicable to Fire Protection"	Yes, alternatives permitted	RCC-I "Design and Construction Rules for Fire Protection in PWR Nuclear Power Plants." RCC-I is an EdF document approved by Basic Safety Rule
USSR	VSN 01-87 "Fire Protection Norms for the Design of Nuclear Power Plants"	Yes	
U.K.	Relevant Nuclear Installation Inspectorate Safety Assessment Principles (SAP)	As far as reasonably practical	IAEA 50-SG-D2 (Rev. 1 not in use yet)

* Specific to nuclear power plants. National and international building codes not included.

FIRE BARRIERS

U.S.	3-hour rating unless fire hazards analysis can justify lower rating.
IAEA	Minimum 1-hour rating unless fire hazards analysis demonstrates need for greater rating.
Canada	Minimum 1-hour and as determined by fire hazards analysis.
Japan	Information not obtained.
Germany	Minimum Class F90 (1 1/2 hour) fire-resistant bulkheads.
USSR	Minimum 1 1/2 hour.
U.K.	No specific requirement - reference to IAEA guidance.

GUIDANCE REQUIREMENTS FOR SUPPRESSION / DETECTION
STIPULATES DETECTION O
STIPULATES SUPPRESSION X

	Control Room	Auxiliary Building	Diesel Rooms	Containment	Turbine Building
U.S.	O X - App R III.L	O X - Switchgear Rooms, Cables	O X	O X - hoses	
IAEA	O - As determined necessary by fire hazards analysis X - As determined necessary by fire hazards analysis				
Canada	O - As determined necessary by fire hazards analysis X - As determined necessary by fire hazards analysis				
Japan		Specifics not obtained			
Germany	O - Plant Areas with Safety related equipment X - No Specific Requirements				
USSR	O	O X	O X		
U.K.	O - A reliable fire warning system should be provided for all parts of the protection system. X - No specific criteria				

PROTECTION OF SAFE SHUTDOWN CAPABILITY

U.S.	Separation of Redundant Train by: a. 3 - hour fire barrier or b. 20 feet with detection and automatic suppression or c. 1 - hour barrier and detection and suppression or d. Alternate capability independent of affected area
IAEA	a. "Fire containment approach" - segregation of redundant train or b. "Fire influence approach" - justifications of capability through fire analysis
Canada	a. Physical separation with 1-hour minimum barrier or b. Minimum 6-meter separation in open plant area with analysis c. Within enclosed spaces - 6-meter separation with suppression if combustibles are present and enclosure of 1 train of cables in 1 hour rating
Japan	Remote shutdown on a separate floor
Germany	"Safety systems shall be arranged in such a way to preclude fire damage of redundant system." "Fire rated bulkheads may be used where physical separation is not sufficient."
USSR	Separation of safety-related equipment by a mimnum of 1 1/2 hour barriers.
U.K.	"The reactor should be designed so that the reactor can always be shutdown and held shutdown." Reference to IAEA Guidance.

INADVERTANT SUPPRESSION SYSTEM ACTIVATION

U.S.	Normal or inadvertant operation of suppression systems should not affect the ability of a safety system to perform its intended function.
IAEA	"normal, spurious or inadvertent operation of fire-extinguishing systems must not impair required safety functions"
Canada	Factors that should be considered in design of exsisting systems, flooding, shorting of electrical equipment, cooling effects, oxygen starvation, pressurization, residues, and corrosive products.
Japan	Malfunction should not affect a safety system.
Germany	No specific requirement.
USSR	Direction is provided to install drains or collection containers for fire water for not less that 15 minutes of activation. Rooms equipped with automating fire extinguishing systems should not have systems above control panels unless the panels are waterproof.
U.K.	No specific requirements - reference to IAEA Guidance.

VENTILATION

U.S.	Separate smoke and heat vents should be provided for areas where there is a potential for heavy smoke.
IAEA	Fire compartments containing redundant trains should preferably have an independent and fully separated ventilation system. For common systems access needed for smoke venting requirements including use of fire dampers and smoke prevention flaps.
Canada	Means for heat and smoke venting to the outside shall be provided for all indoor areas continuing a high fire load (Allows "equivalent protective measures" where venting cannot be provided.)
Japan	Information not received.
Germany	Special smoke and heat removal equipment shall be provided if necessary.
USSR	Direction is given for providing pressurized ventilation for stairwell and control rooms. Also direction is provided for exhaust units for rooms possessing a fire hazard.
U.K.	No specific criteria.

EMERGENCY LIGHTING

U.S.	Minimum 8-hour self contained battery packs required in all areas that must be manned for safe shutdown and access and egress routes.
IAEA	"reliable lighting system backed-up with an emergency lighting system" for permanent escape routes and access routes for fire-fighting teams
Canada	Emergency lighting provided with uninterruptible power supply shall be installed in all fire-fighting access routes and fire exits.
Japan	Not specified in guideline.
Germany	Escape routes shall be sufficiently lit.
USSR	No specific requirements.
U.K.	No specific requirements - reference to IAEA Guidance.

FIRE BRIGADE REQUIREMENTS

U.S.	5 man brigade per shift with quarterly training and drills
IAEA	"if required by the national authorities". "Some members of each shift crew should be trained in fire protection"
Canada	Requirement for shift fire bridgade with fire captain and sufficient members to carry out fire action plans. Regular training and shifts are required.
Japan	Not specified; function performed by security force.
Germany	An in-plant fire squad shall be set up from among the operating personnel. The local fire department shall also be familiarized with the plant.
USSR	Full time para-military fire departments are provided.
U.K.	No specific requirements. The local authorities have the fire fighting responsibilities. They may delegate it to the plant.

SURVEILLANCE REQUIREMENTS

U.S.	Direction to have surveillance program in place. Reference to NFPA codes which have test frequencies.
IAEA	Ensure that all fire protection systems are inspected in conformance with the technical specifications.
Canada	Direction tc inspect equipment in accordance with applicable ULC, NFPA or other Standard.
Japan	Test and surveillance programto be developed by utility.
Germany	Fire protection equipment shall be subjected to periodic recurrent tests. Testing intervals shall be laid down by the authorized inspection agency.
USSR	No specific guidance.
U.K.	Reference to IAEA Guidance.

(3)

FIRE PRA METHODOLOGY

PRESENTATION TO ACRS
SUBCOMMITTEE ON AUXILIARY AND SECONDARY SYSTEMS

JANUARY 17, 1991

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STEPS IN A FIRE ANALYSIS

1. SCREENING OUT OF NON-SIGNIFICANT FIRE ZONES AND DETERMINATION OF FIRE INITIATING EVENT FREQUENCY IN EACH ZONE.

2. QUANTIFICATION OF SEQUENCES FROM FIRES IN UNSCREENED ZONES

   A. DETERMINE PROBABILITY OF DAMAGE TO TARGETS BY FIRE

   B. DETERMINE PROBABILITY OF RANDOM EVENTS

   C. ASSESS RECOVERY ACTIONS, ADD TO CUT SETS AND QUANTIFY

   D. PERFORM UNCERTAINTY ANALYSIS

SEE: PROCEDURES FOR THE EXTERNAL EVENT CORE DAMAGE FREQUENCY ANALYSES FOR NUREG-1150, NUREG/CR-4840.

SCREENING ANALYSIS AND DETERMINATION OF FIRE INITIATOR FREQUENCIES

1. IDENTIFICATION OF RELEVANT FIRE ZONES

   --ZONES CONTAINING SAFETY-RELATED EQUIPMENT WHICH CAN MITIGATE TRANSIENTS/LOCAS

2. CRITICAL AREA ANALYSIS

   A. (NUREG-1150) USE SETS WITH LOCATION IDENTIFIERS ATTACHED TO EACH BASIC EVENT. DETERMINE WHICH ZONE COMBINATIONS, AND WHICH ZONE COMBINATIONS COMBINED WITH RANDOM FAILURES, LEAD TO CORE DAMAGE:

      Z1 + Z2*Z3 + Z4*Z5*R1 + ...

      TRUNCATE IF 3 OR MORE FIRE ZONES INVOLVED OR IF RANDOM FAILURES ARE <1E-4.

   B. (BRUNSWICK) STEPS 1 AND 2 ARE COMBINED. LESS RELIANCE ON COMPUTER CODES, MORE ON JUDGEMENT.

SCREENING AND FIRE INITIATOR FREQUENCIES (CONTINUED)

3. FIRE INITIATING EVENT FREQUENCY

   A. (NUREG-1150) FOR CERTAIN AREAS, DATA DIRECTLY APPLICABLE (E.G., SWITCHGEAR ROOMS). FOR OTHER AREAS PARTITIONING IS REQUIRED. DATA FOR, SAY, THE AUXILIARY BUILDING IS USED IN CONJUNCTION WITH AN AREA FRACTION, OR OTHER MEANS OF PARTITIONING, SUCH AS COMBUSTIBLE LOADING FRACTION, WHEN APPLICABLE.

   B. (NUREG-1150) FOR THE AREAS WHERE DATA IS APPLICABLE (E.G. SWITCHGEAR ROOMS, AUX BLDG) A PROCEDURE EQUIVALENT TO A TWO STAGE BAYESIAN UPDATING IS USED. (FORMULATION DUE TO IMAN.)

   C. (BRUNSWICK) USE PLANT-SPECIFIC FREQUENCIES FOR "IGNITION"--E.G., IN A MOTOR CONTROL CENTER. COMBINE THIS WITH:

      --COMBUSTIBLE EXPOSURE (TIME AND SPACE)
      --IGNITABLE CONFIGURATION PROBABILITY

4. FURTHER SCREENING ON FIRE INITIATOR FREQUENCY (NUREG-1150 METHOD)

QUANTIFICATION OF SEQUENCES

1. DETERMINE PROBABILITY OF DAMAGE TO TARGETS BY FIRE.

NUREG-1150

USE A CODE (COMPBRN-III, MODIFIED) WHICH DETERMINES TARGET TEMPERATURE AS A FUNCTION OF TIME.

INITIATING FIRE IS EITHER A LARGE POOL FIRE (WEIGHTING 30%) OR A SMALL POOL FIRE (WEIGHTING 70%). IN SMALL CLOSED ROOMS HOT GAS LAYER CAN BE IMPORTANT AND SMALL FIRES CAN CAUSE DAMAGE.

TIME TO DAMAGE (TGROWTH) DETERMINED BY TIME AT WHICH TARGET DAMAGE TEMPERATURE IS REACHED

FOR PEACH BOTTOM NUREG-1150 ANALYSIS, SWITCHGEAR FIRE RESULTING IN OPEN FLAMES ABOVE CABINET MODELLED BY OIL POOL FIRE

FAILURE OF AUTOMATIC SUPPRESSION:

WATER: .04
HALON: .06
CO_2: .04

FOR MANUAL SUPPRESSION, THE TIME TO SUPPRESSION IS ESTIMATED FROM GENERIC DATA, AND TARGET DAMAGE OCCURS IF THIS TIME EXCEEDS TGROWTH

DETERMINE PROBABILITY OF DAMAGE TO TARGETS (CONTINUED)

BRUNSWICK PRA

DAMAGE POTENTIAL DETERMINED FROM AN EQUATION (TIME-INDEPENDENT) IN APPENDIX D OF THE BSEP FIRE PRA. UNCLEAR HOW EQUATION WAS OBTAINED. NO REFERENCES, NO DERIVATION.

IF TARGET TEMPERATURE EXCEEDS 700° F DAMAGE POTENTIAL SET TO 1.0; OTHERWISE TO .05.

THE BSEP FIRE PRA NOTES: FOR PROPAGATION OF CABLE FIRES, DAMAGE POTENTIAL SET TO .05 BECAUSE FIRE RETARDANT CABLE INSULATION MATERIALS CURRENTLY IN USE AT BSEP HAVE BEEN SHOWN TO BURN VERY SLOWLY. (P. 2-7 OF THE BSEP FIRE PRA.)

IN BRUNSWICK FIRE PRA, AUTOMATIC SPRINKLER SYSTEM IS GIVEN A FAILURE PROBABILITY OF .025

MANUAL SUPPRESSION FAILURE PROBABILITY DEPENDS ON TYPE OF COMBUSTIBLE: .75 OR .95, DEPENDING ON LOCATION, FOR FUEL OIL OR LUBE OIL; .25 FOR CABLE.

QUANTIFICATION OF SEQUENCES, CONTINUED

2. FOR SINGLE ZONE FIRES, COMBINE ABOVE CONDITIONAL PROBABILITY OF FIRE CAUSING DAMAGE TO THE TARGETS WITH PROBABILITY OF RANDOM FAILURES AND INITIATING FIRE FREQUENCY

3. MULTIPLE ZONE ANALYSIS

   NUREG-1150 USED DATA BASE OF BARRIER FAILURES

   ESTIMATED NUMBER OF BARRIERS OF EACH TYPE IN PLANT POPULATION TO OBTAIN A BARRIER FAILURE RATE

   BRUNSWICK FIRE PRA USED A PRODUCT OF TWO NUMBERS:

   BARRIER FAILURE PROBABILITY

   BARRIER PROPAGATION PROBABILITY (FOR DOORS, DAMPERS, THIS PROB. =1.0 FOR CABLE FIRES, LUBE OIL FIRES, BUT .05 FOR SWITCHGEAR FIRES.)

4. RECOVERY OF RANDOM FAILURES FOR CUTSETS NOT SCREENED OUT IS APPLIED.

COMPBRN-III CODE

REFERENCE: NUREG/CR-4566

COMPBRN CODE IS A ZONE CODE, WITH 2 ZONES:

HOT LAYER
AMBIENT LAYER

USES MASS AND ENERGY CONSERVATION FOR EACH ZONE

USES CYLINDRICAL FLAME MODEL FOR RADIATIVE TRANSFER

BURNING RATE NOT WELL MODELLED--PYROLYSIS RATE DEPENDS ON THERMAL FEEDBACK FROM FLAME, HOT GAS LAYER, ETC. SIMPLIFICATION MADE.

A VARIETY OF ERRORS WERE FOUND BY SANDIA IN FIRE RISK SCOPING STUDY (NUREG/CR-5088). THESE WERE CORRECTED BY SNL BEFORE USE IN THE NUREG-1150 STUDIES. MODIFIED CODE IS UNDOCUMENTED.

ERRORS FOUND BY SANDIA IN COMPBRN-III

(SEE FIRE RISK SCOPING STUDY, NUREG/CR-5088, P. 72)

1. ERROR IN THE FORCED VENTILATION HOT GAS LAYER MODEL. PREDICTED HOT GAS LAYER TEMPERATURE 20°C BELOW INITIAL AMBIENT ROOM TEMPERATURE.

2. NO RADIATIVE HEAT TRANSFER DIRECTLY ABOVE FLAME. CABLE TRAYS DIRECTLY OVERHEAD COOLER THAN TRAYS OFF TO ONE SIDE.

3. CALCULATION OF VIEWFACTORS WERE INCORRECT.

4. OBJECTS IN THE FLAMES RECEIVED ONLY CONVECTIVE HEAT TRANSFER. BUT DOMINANT MODE OF HEAT TRANSFER IS BY RADIATION.

5. CONDUCTION ALGORITHM UNSTABLE.

6. CALCULATION OF RADIATIVE HEAT TRANSFER FROM A FLAME TO AN ADJACENT TARGET IS INCORRECT, AND LEADS TO SUBSTANTIAL OVERPREDICTION OF RADIATIVE HEAT TRANSFER TO ADJACENT TARGETS FROM A FLAME.

7. EFFECT OF EXTERNAL HEAT FLUX (E.G., FLAME FEEDBACK) ON THE MASS BURNING RATE OF A BURNING TARGET NOT INCLUDED. MASS BURNING RATE UNDERPREDICTED.

RESULTS OF THE BRUNSWICK FIRE PRA

	CORE DAMAGE FREQUENCY (PER YEAR)	
	UNIT 1	UNIT 2
BEFORE APPENDIX R MODIFICATIONS	3.4E-4	5.8E-4
AFTER APPENDIX R MODIFICATIONS	5.5E-5	6.8E-5
AFTER ADDITIONAL RISK REDUCTION MEASURES	1.8E-5	2.1E-5

BRUNSWICK UNIT 2 CONTROL ROOM SCENARIO QUANTIFICATION

COMPARISON OF BRUNSWICK PRA METHODOLOGY TO NUREG-1150

	BRUNSWICK PRA METHODOLOGY	NUREG-1150 METHODOLOGY
FIRE FREQ	.4/YR	2E-3/YR
PROB. FIRE FORCES ABANDONMENT OF CONTROL ROOM	6.7E-4	.1
POST APPENDIX R COND. PROB. OF CORE DAMAGE, GIVEN ABANDONMENT OF CONTROL ROOM	.1	.1
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CORE DAMAGE FREQUENCY	3E-5/YR	2E-5/YR

NOTE: THE PROBABILITY OF CORE DAMAGE, GIVEN ABANDONMENT OF THE CONTROL ROOM, IS DOMINATED BY MAINTENANCE OUTAGES OF THE B TRAIN RHR HEAT EXCHANGER AND THE NUCLEAR SERVICE WATER PUMP 2B.

FIRE RISK SCOPING STUDY ISSUES

1. CONTROL ROOM PANEL/REMOTE SHUTDOWN PANEL INTERACTIONS (GI-147, TO BE PRIORITIZED)
2. MANUAL FIRE FIGHTING EFFECTIVENESS (INCLUDING SMOKE CONTROL) (GI-148, TO BE PRIORITIZED)
3. TOTAL ENVIRONMENT EQUIPMENT SURVIVAL (INCLUDING SPURIOUS OPERATION OF SUPPRESSION SYSTEMS) (GI-57)
4. ADEQUACY OF FIRE BARRIERS (GI-149, TO BE PRIORITIZED)
5. SEISMIC/FIRE INTERACTIONS (WILL BE ADDRESSED IN IPEEE)
6. ADEQUACY OF ANALYTICAL TOOLS FOR FIRE

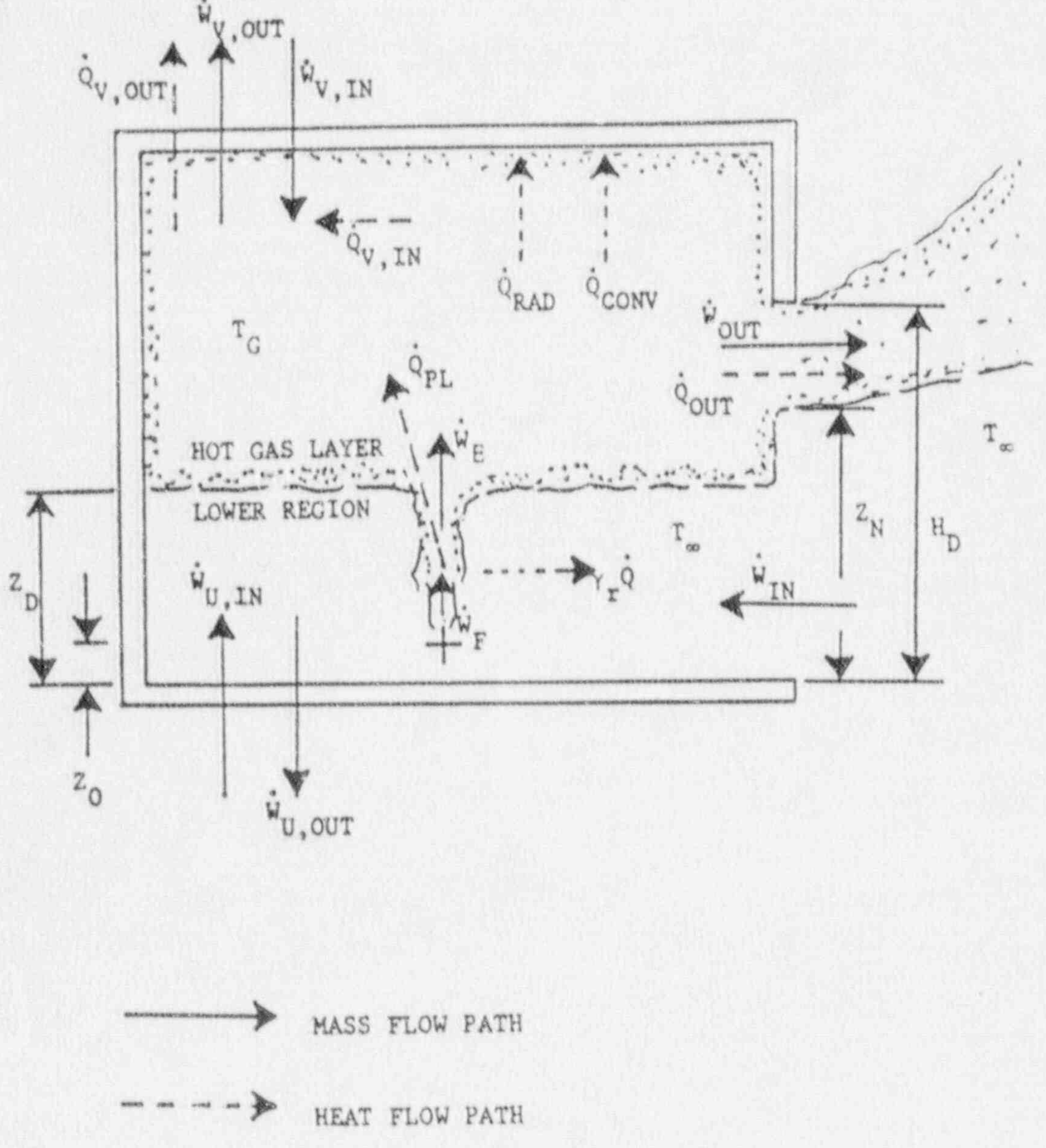

Figure 3: Features of Room Fire in COMPBRN III HGLM