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NUCLEAR REGULATORY COMMISSION

BEFORE THE ATOMIC SAFETY AND LICENSING BOARD

DKT/CASE NO. 50-537

TITLE UNITED STATES DEPARTMENT OF ENERGY PROJECT MANAGEMENT CORPORATION - TENNESSEE VALLEY AUTHORITY (Clinch River Breeder Reactor)

PLACE Oak Ridge, Tennessee

DATE December 14, 1982

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UNITED STATES OF AMERICA

NUCLEAR REGULATORY COMMISSION

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ATOMIC SAFETY AND LICENSING BOARD

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In the Matter of x

UNITED STATES DEPARTMENT OF ENERGY x

PROJECT MANAGEMENT CORPORATION x

x Docket No. 50-537

TENNESSEE VALLEY AUTHORITY x

(Clinch River Breeder Reactor Plant) x

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Hemlock Room

Executive Seminar Center Building

301 Broadway

Oak Ridge, Tennessee

Tuesday, December 14, 1982

The hearing in the above-entitled matter was convened pursuant to adjournment, at 8:30 a.m.

BEFORE:

MARSHALL E. MILLER, Chairman

GUSTAVE E. LINENBERGER, JR., Member

CADET HAND, Member

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-and-

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U. S. Nuclear Regulatory Commission

Washington, D. C. 20555

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I N D E X

E X H I B I T S

NUMBER	IDENTIFIED	RECEIVED
Applicants':		
No. 46	--	5374
No. 47 (Accompanying Glossary)	--	5374
Staff's:		
No. 17	5442	--
No. 18	5653	5682
No. 19	5324	5324
Intervenors':		
No. 15	5461	--
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No. 19	5492	--
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P R O C E E D I N G S

8:30 a.m.

JUDGE MILLER: Good morning. We're ready to resume, I take it.

Who's examining whom?

MR. EDGAR: The Staff was examining.

JUDGE MILLER: That's right. Mr. Swanson, you may proceed.

Whereupon,

GEORGE H. CLARE,

LEE F. STRAWBRIDGE,

LAWRENCE W. DEITRICH

and

H. WAYNE HIBBITTS

the witnesses on the stand at the time of the evening adjournment, resumed the stand and, having been previously duly sworn, were examined and testified as follows:

CROSS-EXAMINATION

BY MR. SWANSON:

Q. When we left off yesterday, Mr. Clare was describing, I believe, two areas besides the reactor cavity where there might be redundant primary heat transport system piping or cabling in the same area; and you mentioned cable spreading rooms and the control room. Is that correct, Mr. Clare?

BY WITNESS CLARE:

A. That's correct.

Q. Is there any sodium running through those areas, such as could cause a sodium fire that would affect both of those systems?

BY WITNESS CLARE:

A. No. The only things present in the cable spreading rooms are the cables themselves and the fire protection system equipment. And in the control room, other than the control equipment, which is electrical and electronic equipment, the cabling between the cabinets is the only thing present.

Q. And what components comprise that fire protection system you're describing -- or you've mentioned?

BY WITNESS CLARE:

A. I don't know all the details of the fire protection system. In the control room, for example, there is what's referred to, I believe, as a halon fire suppression system, which is typically used where one would like to be able to extinguish fires and maintain habitability of the area.

In the cable spreading room, there would be some automatic system to suppress the fires. Whether that would be a water system, a halon system or other system, at this point I don't have the details.

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Q I was wondering if you could describe in a general fashion the capability of the sodium leak detection system, which surrounds the piping -- sodium piping. Can you describe its function?

BY WITNESS CLARE:

A. There is a leak detection system which applies to the sodium piping, and special emphasis is put on the primary coolant system piping.

That system is both redundant and diverse, and perhaps its most outstanding characteristic is it's extremely sensitive.

The requirements that we've placed on that system are that it be able to detect a 100-gram per hour leak, which is a leak barely weeping sodium out of the hole.

In tests we've demonstrated that it not only meets that particular requirements, but, in fact, can detect leaks an order of magnitude or two less than that.

I believe that system is discussed, at least briefly, in Section 3.3 of Applicants' Exhibit 1 on which we gave testimony in August.

Q Given --

BY WITNESS CLARE:

A. On Page 41 of that document.

Q Given its capability to detect very small

1-4

leaks, what kind of conclusions can one draw about the likelihood of that system detecting a small leak before it has a chance to propagate into a larger leak that could then cause problems for the capability of the coolant system?

BY WITNESS CLARE:

A. Our understanding of the situation is that there would be a very high likelihood that a leak would be detected, either by these systems I've identified. And then there are yet, in addition to the systems I described before, other measures -- other detection measures -- for example, radiation detectors, in the cells which would be able to pick up the leak and allow us to shut down the reactor and go in and repair it before any larger leak would occur.

This is described fairly fully, along with some of the fracture mechanics type considerations that you mentioned yesterday, in our Exhibit 1 testimony, Pages 41 and 42.

Q. You again discuss, in more of a general fashion, at Pages 13 and 14 the decay heat removal systems. And again on Page 17 you reference the steam generator system in connection with the intermediate heat transport system.

I'm interested in -- again along the same area

1-5

of leak detection, of finding out what general characteristics or systems are in place to detect or deal with steam generator leaks.

BY WITNESS CLARE:

A. Well, we have three levels of systems that provide protection against sodium/water reactions in the steam generator that could result in steam generator tube leaks.

The first is, in fact, a leak detection system. This system takes a small fraction of the flow of the intermediate heat transport system, processes it through instrumentation, which would detect the presence of either hydrogen or oxygen which would be some of the reaction products of a sodium/water reaction.

And upon the detection of oxygen or hydrogen, the sodium would alarm to the operator; and you would have procedures to shut down the plant at that point.

That system is extremely sensitive. It will detect leaks on the order of 10^{-4} to 10^{-5} pounds of water per second into the sodium.

It's an extremely sensitive system.

That system has been tested in prototypic steam generator configurations at the Energy Technology Engineering Center.

The second level of protection we have is

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comprised of a pressure relief system, which is primarily a rupture disk, that interfaces with the cover gas system of the intermediate heat transport system.

If a leak should go undetected long enough so that the hydrogen and oxygen in the intermediate sodium pressurize that system to a level of approximately 50 psi greater than its normal operating pressure, this pressure relief system would relieve the excess pressure, would lead to shutdown of the plant and alert the operator to the situation so that he could isolate the leaking steam generator.

And if those actions were taken promptly enough, even though there was a leak in the steam generator, one might be able to continue moving decay heat by using that particular loop.

In that case the sodium/water reaction would not result in a loss of that particular decay heat removal path.

Now, the third level of protection against sodium/water reactions is a series of larger rupture disks that are located very close to the steam generator on the sodium system itself.

Those rupture disks would be activated if there were a large sodium/water reaction, a very vigorous one, one that might result from a complete severance of one or even more tubes, allowing a very large flow rate of water into the sodium, large generation of hydrogen and oxygen creating fairly high pressures -- 200, 300, 400 psig, over the normal operating pressure.

These rupture disks would burst the reaction products, and the surrounding sodium would flow into what's called the reaction products separator tank. The gases would be relieved harmlessly up a vent stack to the atmosphere.

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BY WITNESS CLARE: (continuing)

A. I would note that neither the water in the steam generator system, nor the sodium in the intermediate heat transport system is radioactive. So there is no hazard associated with venting those reaction products out of the building.

Q. How many simultaneous steam generator leaks would have to occur before you'd lose the primary heat transport system capability? Are we talking about one or two, or are we talking about many more?

BY WITNESS CLARE:

A. I don't have -- We haven't performed analyses that would give an exact number, to answer your question. We believe, based on testing and experience in other LMFBR plants, that it would be unlikely that one would get more than a small fraction of a tube rupturing at -- you know -- within the same instant of concern.

We have taken, as a design basis, an increase of what we consider to be the maximum from experience and tests, by -- on the order of -- an order of magnitude. And what we impose in the time frame of interest, which is a second or two, is the complete double-ended rupture of three steam generator tubes over a period of three seconds.

Q. And that's within one steam generator?

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BY WITNESS CLARE:

A. That's correct.

Q. How many would be required to lose capability of all the steam generator?

BY WITNESS CLARE:

A. Well, there are nine units in the plant, nine steam generator units in the plant, three on each of the loops -- intermediate heat transport system loops. One could accommodate anywhere between three and nine different leak events involving up to -- well, it's difficult to answer your question.

But one would have to have leaks that would affect all nine units in order to completely negate the shutdown heat removal through those particular paths.

And in any event, one would have the fourth heat decay removal path always available in spite of however many sodium/water reaction events occurred in the steam generator.

Q. Can you describe that remaining heat removal path, should the steam generators all fail?

BY WITNESS CLARE:

A. The fourth path to remove decay heat is what we refer to as the direct heat removal service. It is described in some detail in Section 3.3 of Applicants' Exhibit 1.

1-10

It consists of a sodium loop that takes sodium from the reactor vessel, using electromagnetic pumps to pump it through what's referred to as an overflow heat exchanger.

The sodium is cooled there and pumped back to the reactor vessel. From the overflow heat exchanger, heat is carried through a knack, a sodium/potassium system, again pumped with electromagnetic pumps through what we call airblast heat exchangers where the heat is pumped to the environment.

Q. Thank you.

And does that part of the system have any steam generators?

BY WITNESS CLARE:

A. No. As I noted earlier, no sodium/water reaction would be -- would have any effect on the ability of that system to remove decay heat.

Q. Thank you.

Now, you, in response to Question 21, describe the use in Clinch River of the same design concepts: redundancy, diversity and independence, as are used at LWR plants supporting the judgment -- the likelihood of failure of the SHRS would be no greater than that of similar LWR systems.

Are you referring there to a range of

1-11

reliabilities of various LWR plants that you have compared Clinch River with?

BY WITNESS CLARE:

A. We're comparing here the fundamental design concepts that are used in Clinch River, and those that are used in a light water plant -- as noted here, the redundancy, diversity and independence.

And upon reviewing that and understanding the application of the similar design concepts, concluding that one -- without additional information can conclude that the likelihood of failure of Clinch River would not be significantly worse than that of an LWR.

Q. Did you compare Clinch River design with any other specific LWR in performing this -- reaching this conclusion?

BY WITNESS CLARE:

A. We are aware that we have used some designs for some systems in this plan -- designs very similar to some light water reactor plants. And, for example, the auxiliary feedwater system that we use on this plant is consistent with the most up-to-date state of the art auxiliary feedwater systems that are used in pressurized water reactors.

It is, in fact, significantly different from the auxiliary feedwater systems that may have been used

1-12

in earlier light water reactor plants.

Q. And this auxiliary feed system is being designed to meet the TMI action plan requirements; is that correct?

BY WITNESS CLARE:

A. The auxiliary feedwater system is being designed -- and perhaps the word I would choose is "evaluated" -- in accordance with the requirements imposed post-TMI, which include evaluations on the process capability, the flow rates and pressures that must be met, the requirements that must be met by the auxiliary feedwater system, as well as the reliability of the system being evaluated per the TMI guidelines.

Q. Thank you.

And continuing on with the SHRS, the shutdown heat removal system? I don't have my glossary in front --

BY WITNESS CLARE:

A. That's correct.

Q. In Answer 13, you mention that this system includes -- That's Answer 13 on Page 13 -- includes redundancy, diversity and independence to provide protection against random and common cause failures.

I was wondering if you could describe for us, please, the specific design measures or analyses you've performed to guard against common cause failure for this

1-13

system.

BY WITNESS CLARE:

A. Common cause failures can result in a number of levels within the design construction and operation of the system. We've attempted to guard against common cause failures in each of those levels.

For example, one typical offender in the area of common cause failures is providing redundant systems which are dependent on the same power supply. In the case of this plant we have established very firm ground rules about the separation of our power supplies, and, in fact, performed extra reviews -- supplementary reviews to assure that our power supply separation requirements are met and that our redundant decay heat removal loops do not depend on a common power supply.

Similar evaluations are being done to assure that control systems are not common. There will be detailed, rigorous quality assurance activities during construction and operation to assure that common cause failures during those phases will not affect the redundant shutdown heat removal system path.

Q. Thank you.

MR. SWANSON: That's all the questions that I have on the accident contention.

As I mentioned yesterday, Mr. Mizuno would have a few questions on the 5(b) contention.

JUDGE MILLER: Very well.

CROSS-EXAMINATION

BY MR. MIZUNO:

Q Mr. Hibbitts, on Page 3 of your testimony -- Do you have that before you right now?

BY WITNESS HIBBITTS:

A Yes.

Q You discuss the Y-12 plant. Does the Y-12 plant play any role in producing energy or fuel for any energy generation mode?

BY WITNESS HIBBITTS:

A No. They have no role in national energy.

Q So their only role is in national security?

BY WITNESS HIBBITTS:

A Yes, that's correct.

Q Turning to Page 4 of your testimony, you discuss the Oak Ridge National Laboratory. Did you do an evaluation of whether shutdown of the Oak Ridge National Laboratory could affect national energy supply or national security?

BY WITNESS HIBBITTS:

A Yes, this was evaluated. And our answer is basically that it has no significant role in regard to national energy supply.

Q Is that because that Oak Ridge National Laboratory does not produce any type of fuel for any energy generation mode?

MS. FINAMORE: Objection. Leading the witness.

JUDGE MILLER: Excuse me. What was the question?

MR. MIZUNO: I withdraw the question now and would like to rephrase it.

BY MR. MIZUNO:

Q Could you provide the basis for your statement that --

BY WITNESS HIBBITTS:

A ORNL is a research and development facility. It is not a production facility, with the exception of isotopes for medical use -- for example -- research use.

While one could conceive of a long-term relationship between research and development and national energy supply, we feel that -- you know, long-term shutdown of the plant would have minimal effect because the research can be conducted elsewhere.

ORNL is not a unique facility, such that there would really be a significant relationship between long-term energy supply and shutdown of Oak Ridge National Laboratory.

1-16

Q. Okay. When you said -- Do you recall in your testimony yesterday that you said that you had not evaluated the effects of closure of ORNL on nation l security and national energy supply?

BY WITNESS HIBBITTS:

A. Yes. My answer to that question was related to my personal evaluation. DOE has evaluated the risk to national security as a result of a long-term shutdown of Y-12, in relationship to a CRBR accident.

In essence, they must have evaluated the impact as well. While the impact of a long-term shutdown is certainly undesirable -- or highly undesirable or unacceptable, depending on how one wants to phrase it, the risk has been deemed accpetable by DOE.

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2-1

Q Thank you.

Going on with your oral testimony, I believe you discussed depleting the plume when calculating deposition.

Would you explain the effect of depleting the plume, whether it's conservative or not?

BY WITNESS HIBBITTS:

A. It is conservative.

In other words, what I was saying was, that what will actually happen in the case of a plume as it is moving across the land, is part of the nuclides will fall out and become -- simply lay on the ground.

This is where deposition comes from.

In our calculation, we did not take into consideration or take credit for the fact that the plume concentration was actually being reduced as it was transported toward K-25 and Y-12.

We assumed that all the radionuclides were still there and that the deposition occurred at the specific rate as indicated.

Q Thank you.

Do you recall your discussion regarding the EPA protective action guidelines, also known as PAGS?

BY WITNESS HIBBITTS:

A. Yes, I believe so.

2-2

Q Could you briefly summarize the role of PAGS in determining whether to undertake protective actions.

BY WITNESS HIBBITTS:

A. Protective action guides are provided, basically, to States by the EPA as guidance to allow them to be consistent from one state to the other, as to when to take protective measures for the public.

For example, one could recommend sheltering versus evacuation versus not doing anything.

The protective action guide for a whole body dose, for example, is 1 to 5 rem. The 1 rem is usually considered to be more or less a threshhold for sheltering. Asking people to stay indoors with windows closed and so forth.

Evacuation may be an option, depending on the circumstances.

When one gets up to the upper end of the protective action guide, however, say, for example, 5 rem in the case of whole body dose, EPA does recommend evacuation except in extenuating circumstances.

Q Okay.

Would you have to wait until the doses reach the level of the protective action guideline levels, 1 to 5 rem, before you start taking protective actions?

BY WITNESS HIBBITTS:

A. No. On the contrary. It's just the opposite.

These guides are not total dose guides, in the sense that the protective action is to prevent those doses from occurring. So if you already have received 5 rem, for example, and are projected to receive no more, there's no reason to evacuate.

The idea is to prevent the 5 rem exposure.

Q. So you would undertake protective actions before you actually reached those doses?

BY WITNESS HIBBITTS:

A. Yes, absolutely.

In fact, you are taking protective action to prevent those doses.

Q. Okay.

When you -- in making your calculation in your testimony for your various tables, I wonder if you could explain the assumptions that you made regarding the person who is receiving the dose at various locations?

BY WITNESS HIBBITTS:

A. We didn't really make any assumptions regarding the person. We made the calculations based on the location.

Well, I think I get your point.

So one would have to assume that the person

2-4

was at the location full time, twenty-four hours a day, continuously throughout the duration of the release, the duration of exposure.

Q Did you assume he was inside a building or outside?

BY WITNESS HIBBITTS:

A Outside.

JUDGE MILLER: What was the answer?

WITNESS HIBBITTS: Outside.

MR. MIZUNO: The Staff has no further questions on this Contention.

JUDGE MILLER: Thank you.

Redirect.

REDIRECT EXAMINATION

BY MR. EDGAR:

Q Yesterday, Mr. Strawbridge, you were asked about, and I believe Mr. Clare, were asked about natural circulation tests on FFTF and the fact that FFTF doesn't have certain systems and components that are in CRBR.

What is your opinion concerning the applicability and the utility of FFTF data for CRBR?

BY WITNESS CLARE:

A The FFTF data, which included tests of their entire system, from the reactor vessel out through what they call dump heat exchangers, which are at the same

2-5

place in their system as our steam generators would be located, is fully applicable to CRBRP.

The piping is approximately the same size. The components have approximately the same types of pressure drop relationships. Flow paths are arranged quite similarly.

Beyond the dump heat exchangers, of course, FFTF does not have equipment comparable to CRBRP.

However, the equipment on CRBRP from the steam generator outwards to the protected air-cooled condenser -- and I might note I'm referring to Figure 3 on Page 18 of Applicants Exhibit 46 -- is fairly conventional waterside -- excuse me, steam water system equipment.

The functioning of natural circulation in such equipment has been well-established for at least decades in other nuclear power plants, lightwater power plants, in fossil fired power plants and those characteristics are well-known and applicable to CRBRP.

Q Mr. Strawbridge, you were asked a sequence of questions yesterday about the possibility of pipe break coupled with failure of the pumps to trip.

What is your opinion on the likelihood of this sequence?

BY WITNESS STRAWBRIDGE:

A. The likelihood of a large pipe leak, in itself, is very, very low. In the postulate that was made, it is combined with the likelihood of a failure of the plant protection system, where one of the features of that plant protection system is to trip the pumps.

So, your combined failure, then, plant protection system, which also is of very little likelihood so, the combined likelihood of that postulated sequence of occurrences would be very remote, squared, I would say.

/ / /

9:00 A.M.

BY MR. EDGAR:

Q Mr. Hibbitts, you were asked questions yesterday about --

JUDGE MILLER: What is very remote, squared?

(Laughter.)

BY MR. EDGAR:

Q -- about the effect of sodium or the difference that the presence of sodium would make in regard to deposition, in your calculations.

Could you explain what difference it does if any?

BY WITNESS HIBBITTS:

A. What I was referring to was, if sodium is present, we would have iodines in a particular form, as opposed to an elemental form; therefore, the deposition rates would differ by a factor of approximately 20.

With sodium present and there hence the particular form being present, the deposition would be decreased by a factor of approximately 20.

BY WITNESS STRAWBRIDGE:

A. Could I add one other aspect that would be different, if you have sodium.

And that is that the amount of materials being released from the reactor containment building, would be

2
3-8

reduced because of the aerosol effects from that sodium.

This was discussed in the earlier testimony in Applicants Exhibit 1 on Page 49, which shows that the actual releases from the containment would be lower, if sodium were included in the site suitability source term.

So, this would be a second difference.

Q. Mr. Strawbridge, you were asked about the fact that you did not use ICRP-30 models for your calculations on Page 34 of Exhibit 46, for organs other than bone.

Have you done any analysis of this issue and, if so, what are your conclusions?

BY WITNESS STRAWBRIDGE:

A. Yes. We have performed a separate analyses not reported in the testimony, which did apply dose commitment factors from NUREG-CR-0150 for all organs and the whole body as giving representative type numbers of ICRP-30 methodology.

What we found from that, compared to the use of NUREG-0172 commitment factors, which were used and reported in the table on Page 34, when applied to Case 2 of those four cases, we found that the thyroid dose decreased, the 30-day dose decreased by about 20 percent.

The liver dose increased by a factor of 2.3.

The lung dose increased by a factor of about

2-9

1.9

The whole body dose showed no significant change, in applying the ICRP-30 type methodology.

Based on this comparison and those changes, there would be no changes to the conclusions that we've drawn in any of our testimony.

Q Yesterday there was discussion of Table J.4 in Appendix J and perhaps some confusion.

What does the data on Table J.4 represent?

BY WITNESS STRAWBRIDGE:

A The data in Table J.4 is simply the inventories of the various nuclides in the various nuclide groups.

It does not represent releases of material but simply the nuclides that are present and also the half-lives of those nuclides, the total core inventories of those nuclides.

Q Mr. Hibbitts, in your discussion yesterday, you talked about the use of actual sector versus worst sector meteorological data.

What was your rationale for using the actual sector data?

BY WITNESS HIBBITTS:

A My evaluations were for two specific locations. Therefore, we had the ability to use the data specifically

2-10

for the sectors in which those locations were included.

Q Mr. Clare, you were asked questions about sodium water reaction in the steam generator in the Phenix Reactor in France.

You indicated that there was no sodium fire.

Could you explain what particular events occurred in regard to that incident and in regard to sodium water reactions?

BY WITNESS CLARE:

A. Yes.

There was a leak in one of the steam generators in the Phenix Reactor. The leak was detected. The reactor was shutdown by the plant operators.

The water side and the sodium side of that particular loop was drained and a safe, stable shutdown heat removal situation was established in the plant.

During the process of repair, after the sodium water reaction accident was terminated, a valve was inadvertently left in the wrong position while the sodium system was being filled.

As a consequence of that, approximately one gallon of sodium did leak into an air environment. The fire was extinguished. The repair continued. The plant is back on line.

2-11

JUDGE MILLER: Mr. Clare, what is the approximate size of the Phenix? That's the original Phenix and not the super-Phenix which is under construction, I assume.

WITNESS CLARE: That's correct.

JUDGE MILLER: Do you know how the size compares with Clinch River?

WITNESS CLARE: The Phenix Reactor is slightly smaller than CRBRP. Larger than FFTF.

JUDGE MILLER: Thank you.

BY MR. EDGAR:

Q. Mr. Strawbridge, there was discussion yesterday of the transuranic elements that were considered in the analysis relative to Contention 5(b).

What specific transuranic elements did you include in your inputs to Mr. Hibbitts' calculations?

BY WITNESS STRAWBRIDGE:

A. We included the transuranic elements that included isotopes of neptunium, americium, curium and californium in the inputs that we provided to Mr. Hibbitts.

Q. Mr. Hibbitts, in your deposition calculations did you include the effects of the transuranic elements listed by Mr. Strawbridge?

2-12

BY WITNESS HIBBITTS:

A. Prior to making these deposition calculations, I had screened out those transuranic elements that would have minimal impact on the dose in deposition calculations.

As a result, I ended up with a total of ten transuranics, radionuclides.

I have gone back and checked to see the relationship between plutonium, as listed in the tables, and the curium 242, which was pointed out as another likely large source of deposition.

In the case of the SSST, the curium 242 was roughly three-quarters as large as plutonium 241, the other large radionuclide.

In the case of the HCDA, the curium 242 was only one-fifteenth as large as the plutonium 241.

These were by far the largest contributors to the deposition.

Q. Mr. Clare, you were asked a question about AWF systems and indicated that AFW systems in Clinch River are significantly different from those in earlier LWR systems.

What are the major differences?

BY WITNESS CLARE:

A. Some of the major differences between the current state of the art, auxiliary feedwater systems, such as those at Clinch River and the earlier ones, are that the present systems are generally automatically initiated.

That is, when there's a need for auxiliary feedwater, there are automatic systems that turn pumps on, open valves and provided for that flow, rather than there being manual initiation required, which would be the case in earlier systems.

Also, the number of pumps and the number of headers which are used to get the flow from whatever the source of water is to the steam generators being supplied, differs. The current designs typically include multiple diverse pumps with separate headers, as opposed to some of the earlier systems that used a fewer number of pumps and generally a single header.

Beyond that, there is the general question of safety classification. The current systems are generally safety classification, which leads to a greater -- a more -- what's the word I'm looking for -- a better quality assurance program being applied to the particular system in question, compared to the non-safety related systems in the earlier plants.

/ / /

MR. EDGAR: We have no further redirect.

JUDGE MILLER: Any recross?

MS. FINAMORE: Yes.

RECROSS-EXAMINATION

BY MS. FINAMORE:

Q. Mr. Clare, you stated yesterday that you had performed some systems interactions studies. Did those include any fault tree/event tree analysis?

BY WITNESS CLARE:

A. Yes.

Q. And where are those documented?

BY WITNESS CLARE:

A. They are documented in a number of different documents. Immediately coming to mind are documents in CRBRP-1, the CRBRP safety study, the key system review documents, and the reliability program documents.

Q. Where are these reliability program documents?

MR. EDGAR: Objection. Now we are going well beyond the scope of 1(a) and we are just getting into discovery.

MS. FINAMORE: Well, the witnesses said yesterday that they had performed these studies, and I'm just trying to get it clear for the record which studies he's referring to.

I'm not asking for discovery. I'm not asking

3-2

questions on those studies, just trying to get it clear which ones he's referring to.

JUDGE MILLER: Well, if the witness said it yesterday, why are you doing it now in recross?

MS. FINAMORE: He just referred to it in a general manner, systems interaction studies, and I'm asking him where in the PSAR, for example, those studies are located.

JUDGE MILLER: He's told you where they are.

WITNESS CLARE: They are not located in the PSAR.

BY MS. FINAMORE:

Q Are they referenced in the PSAR?

JUDGE MILLER: This does seem to be getting into elements of discovery above and beyond the redirect testimony, which is the limiting factor of recross.

MS. FINAMORE: This is just a purpose of clarification as to which studies he referred to. He said "reliability studies." It's not clear from that which ones he's referring to.

JUDGE MILLER: Well, maybe I'm missing something.

What was the redirect testimony that you are now seeking to clarify?

MS. FINAMORE: That was the first question

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asked of Mr. Clare.

He was asked if he performed any systems interaction studies in his key system review, and I'm merely asking him where are those referenced in the PSAR.

JUDGE MILLER: He said they are not.

MS. FINAMORE: No, he didn't answer that question.

MR. EDGAR: I would like to add that --

MS. FINAMORE: That's my only question on this issue.

MR. EDGAR: -- on redirect we didn't ask anything about systems interaction studies. My memory is only --

MS. FINAMORE: The Staff did.

MR. EDGAR: -- about ten minutes --

JUDGE MILLER: Wait a minute. It may have been Staff. What did you ask, Mr. Swanson?

MR. SWANSON: I asked the question about systems interaction. I asked for a description, a little more detail about the systems interaction review that was performed.

JUDGE MILLER: All right. You represent you have just one question?

MS. FINAMORE: Yes.

JUDGE MILLER: All right. Ask the one question then. Let's move on.

BY MR. FINAMORE:

Q Are these documents referenced in the PSAR, and if so, where?

BY WITNESS CLARE:

A. One or two of the documents, certainly not all the documents I mentioned, are referred to in Appendix C of the PSAR.

Q Did you rely upon those documents in any way for your testimony in Exhibit 46?

BY WITNESS CLARE:

A. No.

Q Did you rely upon any of your systems interaction studies for your conclusions in Exhibit 46?

BY WITNESS CLARE:

A. No.

Q Mr. Clare, you discussed yesterday certain areas in the plant in which cables from several different loops came together, and particularly, the reactor cavity, the cable spreading room, and the control room.

You also mentioned certain fire protection systems in each of those areas; is that correct?

BY WITNESS CLARE:

A. No. Let me explain.

In the reactor cavity, the thing that comes together is piping, not cabling.

Q. Okay. You did refer to fire protection systems in each of those three areas, did you not?

BY WITNESS CLARE:

A. No.

Q. Did you refer to fire protection systems in any of those areas?

BY WITNESS CLARE:

A. Yes, the cable spreading room and the control room.

Q. And isn't that because there is a potential for fire in both of those areas?

BY WITNESS CLARE:

A. The reason that one provides fire protection systems is to minimize the effects of a postulated fire in those areas.

Q. Assuming as a hypothetical that for some reason those fire protection systems in the cable spreading room did not work as designed, isn't it possible that one could have a fire spreading to more than one of the systems served by those cables?

BY WITNESS CLARE:

A. There are cables for more than one system in at least one of the cable spreading rooms.

There is separation provided between the cabling o. the different loops, different decay heat removal paths,

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for example, within the cable spreading room.

The intent of that separation being that a fire or some other problem with one set of cabling would not affect the other cabling.

Q. What does the separation consist of?

BY WITNESS CLARE:

A. It consists of a combination of physical spacing and protective barriers, such as steel or concrete barriers.

Q. It is possible, is it not, that despite those separation factors, a fire could affect cables from more than one loop in the cable spreading room?

MR. EDGAR: Objection. Asked and answered.

JUDGE MILLER: Sustained. It has been covered.

BY MR. FINAMORE:

Q. Does the cable spreading room contain cables from all of the three shutdown heat removal paths?

BY WITNESS CLARE:

A. Could you repeat the question, please?

Q. Does the cable spreading room contain cables from all three shutdown heat removal paths?

BY WITNESS CLARE:

A. There are two separate cable spreading rooms, and between the two cables -- in the combination of the two cable spreading rooms, all of the cabling to the control

-7

room is contained.

Q. But does either one of the cable spreading rooms contain cabling from all three of the shutdown heat removal systems?

BY WITNESS CLARE:

A. I don't know.

Q. Does anyone else know?

BY WITNESS STRAWBRIDGE:

A. No, I don't know.

Q. You are not that familiar with the functions of the cable spreading room, are you?

BY WITNESS CLARE:

A. I am familiar that the function of the cable spreading room is to allow for appropriate routing and separation of the cabling to and from the control room.

That is the function of the cable spreading rooms.

Q. You described earlier today the capability of the sodium leak detection system.

Do you know the failure rate of that detection system?

BY WITNESS CLARE:

A. No.

Q. You discussed the leak detection system for steam generator leaks. Do you know the failure rate of

-8

that leak detection system?

BY WITNESS CLARE:

A. No.

Q. You said that you attempted to guard against common caused failures in your Answer 13 relating to the shutdown heat removal systems.

Did you perform a fault tree/event tree analysis to determine what other methods of common caused failure there might be, other than common power source?

MR. EDGAR: Objection. Relevance. The Board deferred Contention 3(a) in these proceedings, which deals with fault tree/event tree and probabilistic risk assessment.

I fail to see the relevance.

MS. FINAMORE: Well, that is true --

JUDGE MILLER: We think that is correct. We think, also, it's beyond the scope of the redirect.

The testimony was on redirect in response to your cross. Now you are getting back to where you were to which response was being made.

So we think you are beyond now the scope.

MS. FINAMORE: I'm just -- He said that he has taken common caused failures into account, and I'm trying to determine how he did take that into account.

JUDGE MILLER: No, he was asked that because

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you were asking questions which produced that redirect inquiry. You had your opportunity.

BY MS. FINAMORE:

Q Mr. Hibbitts, you stated that your assumptions regarding plume depletion were conservative. Can you tell me how conservative those assumptions are?

BY WITNESS HIBBITTS:

A. Without performing the calculations, I really can't say.

Q Do you have any idea of how much deposition would occur before the -- I withdraw the question.

Mr. Hibbitts, do you know whether EPA has a protective action guide for bone dose?

BY WITNESS HIBBITTS:

A. They do not.

Q Isn't it true that the bone dose is controlling for plutonium deposition?

MR. EDGAR: May I have a clarification? Under what circumstances?

JUDGE MILLER: Let's see if the witness needs clarification.

Do you understand the question?

WITNESS HIBBITTS: I have to think about it a little bit.

JUDGE MILLER: You are entitled to do that. We

3-10

encourage it, in fact.

If there is any clarification you need now to address the thrust of the question, we would ask Counsel to supply it.

I don't know whether you need it or not. Is there anything that you want rephrased?

MS. FINAMORE: If I may rephrase the question.

JUDGE MILLER: All right.

BY MS. FINAMORE:

Q Isn't it true that bone dose is controlling for plutonium?

BY WITNESS HIBBITTS:

A. I'm a little mixed up. We start out with PAG's and then deposition and now plutonium. So it's a little bit confusing.

I believe you are correct, though, that plutonium, for comparison with standards, normal, for example, occupational radiation standards, the bone dose would be controlling.

Q Mr. Hibbitts, you stated that for the SSST, the Curium-242 release is only three-quarters as large as the PU-241; is that correct?

BY WITNESS HIBBITTS:

A. Yeah, I believe I said approximately.

Q Approximately, and that in the HCDA analysis,

3-11

the Curium-242 is one-fifteenth as large as the PU-241; is that correct?

BY WITNESS HIBBITTS:

A. Yes, again approximately.

Q. How do you account for this difference?

BY WITNESS HIBBITTS:

A. I really don't account for it. This information is what was calculated for the source term.

Q. Did you calculate the source term to arrive at these figures?

BY WITNESS HIBBITTS:

A. No, I didn't.

Q. You were given these numbers?

BY WITNESS HIBBITTS:

A. Yes.

Q. By whom?

BY WITNESS HIBBITTS:

A. By Westinghouse.

Q. Mr. Strawbridge, can you account for the difference?

BY WITNESS STRAWBRIDGE:

A. No, I've never made that comparison before, so I --

Q. So you don't know why there's discrepancy between the two types of accidents?

3-12

BY WITNESS STRAWBRIDGE:

A No, other than I do know that there are different types of plutonium being assumed in the two cases that he has used, as I think we explained yesterday.

MS. FINAMORE: I have no further questions.

JUDGE MILLER: Thank you.

Staff?

MR. SWANSON: No.

JUDGE MILLER: Judge Hand?

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JUDGE HAND: Yes, just a couple.

BOARD EXAMINATION

BY JUDGE HAND:

Q Mr. Clare, you a little earlier this morning said there were nine steam generators, as the plant is being designed?

BY WITNESS CLARE:

A. Yes. On each one of our heat transport system paths from the reactor out to a steam generator, we have three units we refer to sometimes as steam generator modules, that work together to extract the heat from the intermediate sodium and provide steam to the turbine.

Q These are nine physically discrete generators; they are not three inside of one sleeve or something?

BY WITNESS CLARE:

A. That's correct, three discrete pieces of equipment.

Q Why isn't there just a single large generator for each one?

BY WITNESS CLARE:

A. There was an evaluation of the kind of steam generator that should be provided on the plant, and the conclusion was that this was the appropriate steam generator configuration.

The three units perform two different types of service. Two of the units perform as what we call evaporators, and after the water that's fed into those units is heated, it becomes a mixture of steam and water, but the steam is saturated.

The third unit on each loop serves as a super heater. The steam there can be super-heated and sent to the turbine.

It's a matter of the engineering of the system, understanding the types of functions that one wants to perform, that led to the choice of the three module approach.

Q. And does it make a difference in heat removal, depending on which of those three units fails, if there was a failure?

BY WITNESS CLARE:

A. Let me give you two answers to the question.

The first is that during plant operation, each unit removes approximately the same number of megawatts from the intermediate heat transport system sodium.

In terms of a failure, i.e., sodium/water reaction from a tube failure, if the failure were to occur in an evaporator, it would be operationally simpler to isolate that evaporator from the water side, which could then allow you to continue removing heat with the remaining evaporator and the super-heater of that loop.

It would be somewhat more operationally

4-3

difficult to do that if it were the super-heater that had failed.

This is not a result of any fundamental physical characteristic, but rather, the arrangement of valves, et cetera, surrounding each of the units.

Q. The two evaporators are both feeding to the one super-heater; is that the configuration?

BY WITNESS CLARE:

A. That's correct.

Q. Having nine pieces of equipment rather than three -- maybe three isn't reasonable, but it seems that you might have just one large steam generator on each loop.

Does this, therefore, make it more likely that something is going to go wrong?

BY WITNESS CLARE:

A. We think it's quite to the contrary. These units being somewhat smaller and more manageable make it easier, for example, to do the fabrication, transportation, installation.

We are less likely to have difficulties in those kinds of operations that would somehow impact the reliability of the units.

Also, being smaller, it makes it, again, less operationally complicated to replace one of those units should something occur and it needs to be replaced for plant operation or shutdown heat removal to continue through that loop.

Q Can you help me just a little more?

How big is one of these things?

BY WITNESS CLARE:

A. One steam generator module is approximately four feet in diameter and approximately sixty feet long.

Q Okay. thank you.

Mr. Hibbitts, you gave us some information about the impact that CRBR might have on the gaseous diffusion plant or Y-12 and some of the things that flow from that.

Is there any reasonable possibility that something going on at the gaseous diffusion plant or at Y-12 could have an impact on CRBR? Could we go the other way on that streak?

BY WITNESS HIBBITTS:

A. If you like, we can discuss it.

Q I'm just curious about it?

BY WITNESS HIBBITTS:

A. Yes. Y-12's operations -- well, for one thing, Y-12 is roughly nine to eleven miles away.

They don't have large quantities of toxic materials on hand. Uranium is their business. The large majority of their work is with metals.

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The worst thing that could probably happen at Y-12 would be a criticality, which is a very localized event.

In the case of K-25, they are from roughly two-and-a-half to three-and-a-half miles away.

They do have large quantities of UF-6 on hand. At present they have large quantities of anhydrous hydrogen flouride, but within the next year they are getting rid of the anhydrous hydrogen flouride.

Presently they are big tanks, and they are just doing away with the tanks.

As they need flourine, they will bring in very small cylinder size quantities.

The UF-6, which again is -- the business they are in is enriching uranium, of course, in the form of UF-6.

UF-6 is a solid at standard temperature and pressure. They have very, very large quantities of it sitting around being stored.

Again, this is a solid so it doesn't represent a hazard.

Material in the cascade likewise presents a minimal hazard because, for one thing, it's under negative pressure, and for another -- well, back off. It is under negative pressure.

There have been safety analyses performed that show that the hazard at distances if minimal.

So to answer your question, no, we see no impact from either plant on CRBR operation.

Q Is there anything else at Oak Ridge, any of the small reactors that exist, and so forth, any of those that conceivably threaten CRBR in any way?

BY WITNESS HIBBITTS:

A There have been safety analyses done for various facilities at ORNL. The two large reactors are the HFIR, the H-F-I-R, reactor, which is a hundred megawatt thermal, and the ORO, which is thirty megawatt thermal.

If one assumes absolutely worst case conditions, if all the iodine, or essentially all the iodine released, and the noble gases and so forth, one can get up into the low rem range dose at approximately the CRBR distance.

The actual impact of such an event on CRBR would be minimal insofar as operations are concerned.

Q It would not cause evacuation of CRBR?

BY WITNESS HIBBITTS:

A Certainly not the control room. I mean, if -- you know, again, this is a super-conservative type of estimate, so in reality one wouldn't expect this type of situation to exist.

This is straight line meteorology, worst,

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absolutely worst meteorological conditions at that distance. So it's a very unrealistic evaluation.

Even if it were to occur, though, one would probably -- for these low rem doses, one would probably evacuate non-essential personnel; but there's no reason at all to evacuate personnel important to the operation of the plant.

Q Does the control room at CRBR, or will the control room at CRBR have some special protection against itself in case of an accident? Is there some --

BY WITNESS HIBBITTS:

A Oh, yes. Yes, it has air cleaning systems and isolation systems.

JUDGE HAND: Thank you.

JUDGE MILLER: Judge Linenberger?

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BOARD EXAMINATION

BY JUDGE LINENBERGER:

Q Gentlemen, you've made numerous references yesterday and today to Applicants' Exhibit 1, which is a document that's now several months old, and I wonder if there's anything that has happened in the intervening period of time since Applicants' Exhibit 1 was written that would cause you to want to modify in any way anything that's contained in that document?

I care not who answers.

BY WITNESS STRAWBRIDGE:

A The only thing of significance, I think, is the two tables that relate to doses and releases that we have repeated the analyses for those equivalent conditions in our latest testimony and they show up on Pages 34 and 35 of Applicants' Exhibit 46.

We believe that these are more realistic assessments of the conditions that what were presented in equivalent tables of Exhibit 1.

That's the only newer or more up-to-date information that I have.

BY WITNESS CLARE:

A I would make no changes to Exhibit 1, other than what Mr. Strawbridge has said.

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BY WITNESS DEITRICH:

A I would just point out to make sure it's clear that in the hypothetical accident analysis area there is an ongoing dialogue with the Staff and its consultants, and we have done additional calculations in the course of this dialogue.

The results of those calculations have not produced anything which would cause us to change the conclusions which are in Exhibit 1.

Q All right. Thank you, gentlemen.

Also, there's been a number of references to information flowing out of FFTF of interest and benefit to the system under consideration here.

With respect to the original time track or course of events that this project was on, it looked superficially, to me at least, as though FFTF would tend to parallel in time more than I would have thought desirable the evolution of the Clinch River design.

Now, for better or for worse, the course of events has gone a little differently, and FFTF operationally is certainly leading Clinch River.

I would like to have just a little better understanding, not in great detail, but just a brief summary, as you gentlemen see it, and whoever wishes to be spokesman, it's fine by me.

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What do you see now as the role of FFTF insofar as the kind of information that Clinch River Project is profiting from or benefiting from?

BY WITNESS STRAWBRIDGE:

A I'll start the answer. If others on the panel want to supplement it, then fine.

Q Fine.

BY WITNESS STRAWBRIDGE:

A FFTF has now reached its point where it has completed its first operating cycle, and I believe they are in the process of going through the refueling and so on that's planned at the end of that first cycle.

So we are certainly starting to get some real operating on-line type experience from the FFTF facility.

In terms of the role that it plays, it still will be a facility that will lead the Clinch River facility in terms of gaining experience in terms of fuel performance, showing that certain burnups can be achieved and so on, well in advance of when similar but somewhat different fuel assemblies are placed in the Clinch River Plant.

So from that standpoint there will be in many areas confirmatory information coming out of FFTF which will feed into our Clinch River final design and experience as we get ready to start up and operate the Clinch River Plant.

4-11

In a broader sense, throughout the construction and the startup and this initial operation of FFTF, we have had a very fruitful exchange or feedback of information from FFTF to the Clinch River Project, and we have a formal program to make sure we are aware of and utilizing the FFTF experience in the Clinch River Plant.

We have a process whereby that information is sent from people at FFTF who are there specifically to gather information that could be useful to Clinch River, send it to the Clinch River Project, and then make sure it gets disseminated to those component and systems engineers where that information would have some bearing.

Q What other areas than fuel design and performance is Clinch River Project extracting information from FFTF?

BY WITNESS STRAWBRIDGE:

A It's really across the whole board. For example, experience in handling inerted cells and achieving leak rates in the cells.

They, of course, tested their containment to the same leak rate that the Clinch River containment is being designed to.

So we have that kind of background, and where they do run into problems and need to fix things because of those problems they discover, that's the type information

4-12

that I'm indicating is being fed back to the systems engineers on the Clinch River Project to make sure we take advantage of it.

BY WITNESS CLARE:

A. I think the only thing that I would add, in addition to what Mr. Strawbridge has said, is that I think on the original schedule for both projects, FFTF would have led Clinch River by a significant time period, and the present situation is not significantly different than what was envisioned in the first place.

There have been various adjustments in the schedules of both plants as time has gone on.

Q. Well, for instance, your testimony today and earlier has alluded to concepts such as structural and thermal margins beyond design basis -- bases.

Are there things about the design and function of FFTF that lend support to those concepts in Clinch River?

BY WITNESS STRAWBRIDGE:

A. There have been some features added on to FFTF, such as a capability to vent the containment through a cleanup system that is similar to those kinds of features that we have in the Clinch River design.

So, certainly, from the standpoint of somebody having designed the system and hooked it up, we do have that additional experience.

4-13

Obviously, those features have not had a need to function and perform their function, but tests are performed and so on to show that the features would indeed function if required.

So from that standpoint, Clinch River has certainly some similarities and is making use of the FFTF information.

In the structural margin beyond the design base area, FFTF took a fairly similar approach to the approach Clinch River is taking, and that is that they are providing margins for a hypothetical core disruptive accident that could be energetic.

In fact, they performed a series of scale model dynamic tests similar to what were described yesterday, some of the tests that we have done on the Clinch River Plant as well.

Quite a few years earlier, FFTF had performed similar experiments there, and have applied that to their assessments of their structural margins beyond the design base.

Q All right. Thanks.

Heat exchangers have come in, and particularly steam generators, which I sort of classify as a heat exchanger, have come in for considerable discussion, and in the lightwater side of the industry have come in for a

4-14

considerable notoriety, if I read the newspapers correctly.

To what extent, and I'm getting into things better left to the construction permit phase, and I don't want to go into details now; but has there been a conscious effort, let me ask, to try to profit from the problems that the lightwater industry has experienced with steam generators?

BY WITNESS CLARE:

A Yes. We have carefully watched what's going on in the lightwater reactor side of the business and have attempted to apply those lessons.

I think there is one fundamental difference between the particular steam generators that we have designed for this plant that alleviate many of the difficulties they've had in the lightwater reactor area.

That pertains to the use of water only on the tube side of the heat exchanger, and the configuration of the heat exchanger such that there is virtually no possibility whatsoever of a buildup of crud or debris or corrosion products in any cracks, crevices, plates, gaps, anything, where the water is located.

The water comes in with a clean shot at the tube sheet, goes straight up the tube. It does take a 90-degree bend, but goes straight out the other side.

There are no support plates, baffles or anything

4-15

else for any products, any deposits to be left that could subsequently result in physical degradation of the boundary between the sodium and the water.

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BY JUDGE LINENBERGER:

Q It sounds as though you might be able to make your fortune working on a light water team.

BY WITNESS CLARE:

A Well, they have the disadvantage that they have to use water on both sides -- the tube side and the shell side. We have the advantage of using sodium, which is far more benign from a materials standpoint.

Q Let's talk about the benignness of sodium for just a moment. You were discussing leaks earlier and their ability to detect water migrating into the sodium side. It wasn't clear to me, although you used impressive numbers, such as 10^{-4}, 10^{-5} pounds per second of water to the sodium.

I don't have a practical feeling for the significance of that in the following sense, that it seems to me that as soon as a little bit of water sees some sodium, there may be sodium hydroxide production.

And I have the impression that sodium hydroxide might not be so benign with respect to erosion processes. So this high sensitivity that you talked about for detecting water, is that adequate to assure that the sodium hydroxide problem doesn't arise?

BY WITNESS CLARE:

A Well, there's a fair amount of distance

5-2

between the 10^{-5} sort of leak and the onset of a sodium hydroxide problem. The reason for that is that although you're absolutely correct, sodium hydroxide will be formed in the reaction, the amount of sodium hydroxide is extremely small compared to the over a million pounds of sodium in the intermediate heat transport system.

The sodium hydroxide would be diluted to the extent that it would have virtually no effect on the materials, up to and including fairly large leaks. This has been tested and found to be the case in even much smaller systems where the dilution would not be as great, where we have done tests of sodium/water reactions.

On the other hand, your concern over the longer term is one we're concerned about. We have measures, such as the reaction products separator tank that I mentioned earlier this morning, which are intended to minimize the amount of contact there would be between the reaction products and the materials, should there be any significant large quantity of those reaction products.

Q Sodium hydroxide -- under the state points of the operation of these heat exchangers is in what physical state? Solid? Liquid? Vapor?

I ask because I'm curious about this dilution that you discuss.

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BY WITNESS CLARE:

A. I believe it's a liquid at the temperature we're talking about, which is up around -- oh, between ... oh, say, 800 degrees average temperature.

Q. Yesterday I believe Intervenors asked a question that involved hypothesizing that the sodium recirculation pump would fail to operate, and simultaneous with that, the reactor would fail to scram.

One of you indicated that this kind of event had been looked at under something which you gave a name to -- I don't remember that name -- but it wasn't clear to me whether that's a -- represents a back-to-the-drawing-board kind of situation, or is the system somehow going to have some capability to recover?

And if it is, can you discuss that just a bit, please.

BY WITNESS STRAWBRIDGE:

A. Yes. I indicated that that sequence that was asked about is what we have typically called the loss of flow HCDA initiating sequence. So that particular sequence would lead to a hypothetical core disruptive accident; and that is the sequence that has been analyzed for the last dozen years or so for the Clinch River plant and has formed a part of the basis for our structural margin and thermal margin beyond the design base features.

So we have features in the plant specifically to mitigate that and some other sequences. It is not something new; it is something that we've been looking at right along as beyond the design base.

Q Say just a little bit about the features that might mitigate that.

BY WITNESS STRAWBRIDGE:

A Okay. That sequence can lead you into core melting. And so the features that we have in there to mitigate the consequences of a core melt accident are what we call our thermal margin beyond the design base features that include things such as capability to vent the reactor cavity to the containment to avoid repressurizing of the reactor cavity, capability to be able to vent the containment through a cleanup system if the need arises to avoid any overpressure type conditions that could arise in the containment, capability to purge the containment to avoid excessive hydrogen buildup in the containment following a core melt event, and an annulus cooling system to maintain -- which circulates air between the steel containment shell and the concrete confinement structure to maintain temperatures satisfactory in those areas and remove heat from that -- from the containment shell for that process.

5-5

All of those features are specifically in the plant design to mitigate actions that are beyond the design base. And one of the principal ones of those accidents is the sequence that you're asking about.

Q Speaking of core melt, the light water industry has been labeled with a geographically inaccurate term called "China Syndrome." I would infer from the thrust of your testimony here that you don't consider it as plausible or probable -- and I'll ask you which later -- that a molten core will, in essence, breach any final barriers that protect the public from substantive radioactivity releases.

Now, is that a proper inference that I make from your testimony, that this won't happen? Or can it? And if it can, is it improbable or what? Please speak to that subject.

BY WITNESS STRAWBRIDGE:

A All right. I think your inference overall is generally correct. But let me address is a little more specifically.

We have discussed the consequences of the sequence you're talking about in our Exhibit 1 testimony, specifically Pages 65 and 66, in a section that's called "Accommodation of Whole Core Melting."

We go through a sequence there which is what

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we predict would be the consequences. And, basically, our expectation is that if you had whole core melting, the material would finally penetrate partway into the concrete that is down below the reactor vessel -- in the base mat -- penetrate partway through that.

Or the best expectation is that it would not penetrate all the way through the concrete. We have, however -- And it would solidify in place there eventually after some number of months of time.

However, we have made some assumptions that you could have cracking of the concrete sufficient to let the radioactive products through the bottom of the base mat and then have done groundwater studies to assess what would be the consequences in the case that somehow it did get through.

Those assessments have been reported in CRBRP-3, Volume 2, and show that, in fact, taking into account the amount of time that would be required for the material to find its way from the location under the containment to the location of the river, for example, that the materials would have decayed to the point where the final concentrations of materials in the groundwater would be such that they would even be below the 10 CFR 20 guideline values.

Q Well, implicit in what you have said is that you have ruled out -- by this base mat cracking -- ruled out any path of concern to the -- directly to the atmosphere then; is that correct?

BY WITNESS STRAWBRIDGE:

A. The path to the atmosphere is, in fact, addressed through the features that we have on the containment to prevent failure of the containment. And the path to the atmosphere would be through our vent system, which is into our reactor containment cleanup system before any material would come out of that system to the atmosphere, if it were necessary to vent the containment.

So there's no direct path to the atmosphere. It would be through the cleanup system to the atmosphere.

Q. But this crack in the base mat allows things to eventually get -- find access to the groundwater. Why doesn't it allow things to sort of diffuse through dirt-fill around the foundation mat and come to the atmosphere?

BY WITNESS STRAWBRIDGE:

A. There -- Any of the gases -- volatile materials and so on would have long since been released through this cleanup system, so that there would not be a source of pressure or anything of that sort in this longer time frame when the materials would be down in the base mat area, so you could have some local diffusion into ground materials. But we do not see them as being a

5-8

significant source of release to the atmosphere.

JUDGE MILLER: Let's take a ten-minute recess, please.

(A short recess was taken.)

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JUDGE MILLER: Are we ready to resume, please?

I see we have been handed an errata sheet containing corrections to NUREG-0139, Supplement No. 1; is that correct?

Who is responsible?

MR. MIZUNO: This is the Staff's errata sheet. This is an update errata sheet to the errata sheet which was dated November 15th, 1982 and was distributed at the last hearing session.

JUDGE MILLER: Okay.

I hate to quibble but supercede is spelled with two S's up there. So, correct the errata, would you, please?

(Laughter.)

MR. EDGAR: Is that an errata squared?

(Laughter.)

JUDGE MILLER: I don't get into squared. I'm always too nervous to ask them what they mean, to tell you the truth.

All right, we will have the record reflect the errata corrections, as the first supplement to the previously filed. Was that in November, Mr. --

MR. MIZUNO: November 15th, 1982.

JUDGE MILLER: Judge Linenberger,I believe you have some questions.

MR. SWANSON: Maybe we should assign an exhibit number --

JUDGE MILLER: Yes.

MR. SWANSON: The confusion is that we have already, to help matters, given the Reporter copies of the next two pieces of Staff testimony and numbered them, so this would be Staff Exhibit 19.

JUDGE MILLER: All right.

We will show that Staff Exhibit 19 is the sheet designated as errata corrections to NUREG-0139, et cetera, and are there any objections to this exhibit?

MR. EDGAR: No objection.

JUDGE MILLER: Very well.

MS. FINAMORE: We're still reviewing it. Just a moment.

JUDGE MILLER: All right. Subject to your bringing something to the Board's attention, we will admit Staff Exhibit 19 as containing corrections.

(Staff Exhibit No. 19 was marked for identification and received in evidence.)

JUDGE MILLER: If you have any objections or additional matters, you may bring them up subsequently.

Let me say while Judge Linenberger is getting his examination assembled here, that the Staff will be

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requested to put on the two panels. We think you get a little too cumbersome.

Our experience has been that it gets very confusing when you put on too many witnesses on a panel, so we'll ask that you put them on as you have indicated in your sheet, rather than attempting to combine and I think that the 5(b) testimony is reasonably separable, we understand, the basis for some of it may be contained in the testimony of the first and larger panel but the cross-examiners will be asked to have that in mind.

Secondly, we think that in the future, on witnesses of the Applicants, at any rate, that we will ask the Staff to cross-examine first, because it's too difficult to try to recall what is the scope of recross and redirect examination, when we have them more than that way.

So, if the Staff will take the first cross-examination of the Applicants witnesses, then the Intervenors, then the redirect and recross, I think we can keep the scope orderly and find it more convenient.

I don't think it will matter to Counsel, particularly.

MS. FINAMORE: Excuse me, Judge Miller. Does that also apply to the Staff panel which --

JUDGE MILLER: I don't know. We didn't make

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any ruling on that.

MS. FINAMORE: Because there are no more Applicant panels. It's just a Staff panel remaining.

JUDGE MILLER: I thought I saw Applicants there on 12-15.

MS. FINAMORE: Oh. Excuse me. You're right.

JUDGE MILLER: Well, we might think about it. We haven't had the problem arise with reference to the Staff's panels.

BY JUDGE LINENBERGER:

Q Yesterday morning one of you gentlemen indicated that the -- in the evolution of the Clinch River design, there had been a change in the safe shutdown earthquake ground acceleration from .18g, to, I believe, .25g and I wonder if you could tell me, first, approximately when that change was adopted and very briefly, what was the motivation for it?

BY WITNESS CLARE:

A The change was adopted in approximately 1976. The motivation for the change was an interpretation of the available data on seismic motion in this general region, by the NRC Staff technical reviewers, which differed from that of the engineers who had originally established the 0.18g for this project.

That difference in interpretation is one that arose subsequent to the licensing of other nuclear reactors in this area.

The .18g that we had originally chosen as a safe shutdown earthquake for this plant was consistent with the safe shutdown earthquake that had been chosen for other TVA lightwater reactors in the region.

It was, however, upgraded to the higher number.

Q Do I infer correctly, then, that this represented a change in interpretation rather than new input respecting seismology of the area?

BY WITNESS CLARE:

A To the best of my knowledge, that's correct.

Q Does anybody have anything different to offer?

(No response.)

Mr. Hibbitts, at one point yesterday, you, in answer to one of Intervenor's questions, used the term deposition philosophy, or at least I think you did. If not, correct me, but, indeed you did use that term, I should like to understand what it means.

Deposition rate means something to me but depostion philosophy doesn't.

BY WITNESS HIBBITTS:

A It is essentially a rate. It's the rate -- an easy way of picturing it would be the rate at which a particle is falling.

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It's largely related to just gravitational --

Q I see.

BY WITNESS HIBBITTS:

A --- it's a centimeters per second unit, as a matter of fact.

Q All right.

In your Table 1 on Page 8 of Applicants Exhibit 47, you have given a value for ground contamination and parenthetically, a total deposition value, and my memory is faulty here -- did you say that 54 microcuries per square meter largely was attributable to iodine?

BY WITNESS HIBBITTS:

A Yes,sir.

In fact, on the next page at the top, it specifically says:

"The short half lived Item 131
and neptunium 239."

Q Right.

Now, realistically, is this true because there is iodine transport associated with sodium or is iodine looked at independently of any sodium release?

BY WITNESS HIBBITTS:

A The SST, which is what this is referring to, does not assume a sodium release. So this was elemental

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iodine.

Q All right.

Now, if my memory serves me correctly, over the last perhaps two or three years, there has been a , at least amongst lightwater types who worry about these things, a growing awareness that maybe iodine is not released in the event of an accident in nearly as large amounts as had previously been thought and, indeed, I think there may be some information coming out of TMI-II, that indicated the amount of iodine that got into the atmosphere there was considerably smaller than what might have been anticipated.

Now, when you arrive at a number such as you have in your Table 1 here, does that or does it not take into account more recent experience that would tend to indicate that maybe the iodine is not getting out to the extent that people had first thought?

BY WITNESS STRAWBRIDGE:

A. I would like to answer that, since that depends on source terms that we supplied to Mr. Hibbitts.

The iodine source term in the site suitability source term, was defined to be 50 percent release, of which half of that is released to the atmosphere of the containment and half plated out.

It is identical to the site suitability

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source terms that are used for lightwater reactors and have been used right along for lightwater reactors.

It does not reflect the more recent information, which I agree with you, does in fact, imply that the releases could be considerably less than people had previously thought they might be.

That newer information has not yet been factored into the regulations and because of that, we continue to use for site suitability source term, the values that were previously defined there.

So, it is conservative from that standpoint. That element of conservatism has not been removed.

Q Fine.

Now, I believe there was another element of conservatism, if I understood correctly, that involved the fact that this discussion in your testimony, Mr. Hibbitts, is focused on other nearby facilities, rather than on population considerations and, if I remember correctly, I think you said that wet deposition was excluded and I simple-mindedly look on this as saying; "Well, the plume is moving along. We won't take credit for any rain washing things out and it will go unrained upon to a gaseous diffusion plant or whatever."

Is that, in essence, what you said and do you consider that an ingredient of conservatism?

6-9

BY WITNESS HIBBITTS:

A. No. The fact that we did not include wet deposition, really wasn't in order to improve conservatism.

In some ways it would not be conservative.

What I was referring to specifically yesterday was that the way we -- if we calculated wet deposition as we did dry deposition, it would be highly conservative because we would be assuming essentially a cloud sitting over Y-12 and everything that comes by, you know, gets rained on by that cloud.

The problem with wet deposition is that, especially during the short release is, that it can distort your results dramatically and you have very little basis upon which to make assumptions.

You know, if you have one-day release, is it going to rain or is it not going to rain? If you're talking about a yearly average, for example, routine releases, you can use annual average data and come up with something halfway meaningful.

For short-term releases, three, four days, a week releases for example, the results that you get could be greatly distorted and very difficult to relate to reality.

That's really the basic reason for not doing a wet deposition calculation.

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BY JUDGE LINENBERGER:

Q Well, I hear your words, but what's bothering me is that, presuming no rainfall doesn't comport with reality either. So I am left with --

BY WITNESS HIBBITTS:

A I guess maybe a better way of doing it might have been to have looked at, say, two extremes: no rain and continuous rain, for example. This could have been done. I'm not aware of this type of procedure normally being done.

Quite often rainfall is not considered in this type of evaluation. It's the rule, rather than the exception.

It is very difficult, though, to relate to -- because, for example, assuming it is raining, you're going to get a much larger deposition rate. At the same time you're going to get a much larger deposition runoff. It's going -- A very large percentage is going to end up in a river.

Again, the assumptions are very tricky. There are so many -- It's such a complicated thing to model that it's very difficult to come up with meaningful results.

So most people don't try it, for a short term at least, such as the ...

Q Okay. I guess we live with what we have here, but it's certainly not the best of all possible worlds. So be it.

Just quickly, Table J.4 of Staff's Exhibit 9 has been adverted to a number of times. On the page preceding that table, there is the explanation that this inventory corresponds to shutdown.

Now, does shutdown there mean end of life of the facility? Does it mean shutdown after some equilibrium fuel cycle, and to what extent are these numbers burnup-dependent?

I've asked, I guess, three questions there. We can take them one at a time. What does shutdown mean in that --

BY WITNESS STRAWBRIDGE:

A It's my understanding that -- These are, of course, Staff numbers. But my understanding of the numbers are that it would represent the numbers after a complete cycle operation and then shutdown for a refueling, which would maximize the fission products and the transuranic elements and that sort of thing.

So the shutdown refers to shutdown for a refueling after a normal refueling cycle at the end of an operating cycle or a refueling cycle.

Q So, as you understand it, then this inventory represents the inventory in a -- let's say, a fuel bundle that has received the highest burnup it's going to receive?

BY WITNESS STRAWBRIDGE:

A. It would represent the average of all fuel assemblies at that point in time.

Q. All right.

BY WITNESS STRAWBRIDGE:

A. These are cumulative. The actual total -- if you want to look at it that way. It's not a single fuel assembly. It's total for the whole core.

Q. Okay. Yes. That's right. It would not be the maximum for all --

BY WITNESS STRAWBRIDGE:

A. That's right.

Q. In discussion of natural circulation capability, your testimony, Applicants Exhibit 46, at Page 18, portrays what is called a prtected air cooled condenser.

I've asked this question before, but I'll ask it again. What does the word "protected" refer to?

BY WITNESS CLARE:

A. "Protected" refers to the fact that it is protected from phenomena -- external phenomena which might otherwise impact its operability. It is seismically qualified to the safe shutdown earthquake.

It is protected from both the pressures and potential missiles that could result from a tornado.

Q So, in essence, it is the equivalent of Safety Category 1?

BY WITNESS CLARE:

A It is Seismic Category 1. It is a Safety Class piece of equipment.

Q With some trepidation I come back to shock waves again, or the absence of same. At the top of Page 27 of Applicants Exhibit 46, there is a statement that energy of expansion will be transmitted through the primary coolant system as pressure waves traveling at sonic, not shock wave, velocity.

Sonic velocity is not a shock wave. It's not entirely clear to me what kind of analysis you did to satisfy yourself that that is indeed the case. Can you discuss this just briefly, please?

BY WITNESS STRAWBRIDGE:

A Yes. The analyses that we've performed to analyze the characteristics of energetic hypothetical core disruptive accidents included doing, first of all, calculations using computer codes, such as the SAS computer code and VENUS computer code, which is what determines the actual fuel motions, clad motions, sodium motions throughout the course of the event, including the potential for configurations that may end up being more active partway through the sequence and give you a power burst as a result of that.

That information being fed into a -- what's called a hydrodynamic disassembly code to look at the expansion then of the materials, and the movement of materials which would then give you negative feedbacks that end up shutting down the reactor.

That overall expansion process defines a pressure volume type relationship that then represents the energetics of this sequence.

Q Isn't time also part of that relationship, or shouldn't it be, or why not?

BY WITNESS STRAWBRIDGE:

A Time, you can pick out as -- pressure time and volume versus time, which you can then eliminate time and get a pressure volume type characteristic from -- if you wish.

That pressure volume type information is then fed into a computer code, such as the one from Argonne National Laboratory called REXCC, which then looks at the expansion of those materials and what kinds of pressure as a function of time is exerted on things like the core barrel, the actual reactor vessel, the head, the core

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structure and the pressure versus time that would exist at the inlet nozzle and the outlet nozzle to the reactor vessel.

Those pressure versus time histories at those nozzle locations is then fed into a separate calculation which can track the pressure pulses then going down the piping and around the system, coming from both ends and end up going around the system through the pump, the IA checks, check valve and the piping, of course.

Those computer codes are then used to predict pressure versus time in those various components which we then feed back into our design process in what's called structural margin beyond the design base, to be sure that our components can accommodate the resultant kinds of dynamic loads you get from that calculational sequence.

Q What would we do without computers? The morning paper reported that an unauthorized computer code had been run by the White House staff, and it predicted John Glenn in 1984.

(Laughter.)

Q The comment was that the White House was not going to run that code again.

What kinds of things have you under your belt that give you confidence that you haven't got a John Glenn code in there somewhere that you shouldn't have?

7-7

JUDGE MILLER: Leave politics out of it.

WITNESS STRAWBRIDGE: The various computer codes that I've just mentioned, which are a sequence of computer codes, have individually been checked against the experimental data in parts in some cases, in the whole in some other cases, to provide a reasonable degree of assurance that, in fact, what they are predicting has some relationship to reality, as opposed to being fiction.

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WITNESS STRAWBRIDGE (continuing): Those predictions and verifications of the various codes are reported in documents that we have referenced in our CRBRP-3, Volumes 1 and 2.

Different kinds of experiments were used to validate the different codes. But for an example, there have been -- and we referred to these yesterday to some degree -- some scale model experiments where these modified explosive type charges were put off to simulate the pressure volume characteristics within the reactor vessel, and where you have actual measured data then on what the pressure time characteristics are at different locations, such as the vessel head and so on, you then apply the analytical model to that same experiment and predict the results and, in fact, when doing that would come up with what we consider to be quite reasonable agreement in that kind of calculation.

We have also done some similar predictions of experiments using the computer code that was used to predict the pressure pulse transmission around the piping and the rest of the primary system, and again have obtained satisfactory agreement using those codes checked against experimental results.

So those are the kinds of things -- without trying to go into the details on each one -- that we have, in fact, done in this area.

WITNESS DEITRICH: I should mention, as a point of clarification, that the code that's used to calculate the material motion in the bubble expansion phase that Mr. Strawbridge mentioned -- that's when we're doing the calculation that leads to the pressure time histories, and, consequently, the loadings on the various components is a well-documented, well-verified code that has been used for a number of years.

That code does have the capability for dealing with shock waves, because in the early days of its development, it was validated against explosive experiments using conventional explosives which did generate shock waves.

So that that possibility has not been ignored in the analysis.

BY JUDGE LINENBERGER:

Q Hasn't the -- You're saying the code doesn't fall aprt if it has to deal with anything like near discontinuity associated with a shock wave. It doesn't avoid this automatically, so that it always gives you a non-shock wave analysis?

BY WITNESS DEITRICH:

A That's correct.

Q Okay. These concepts of thermal and structural

7-10

margins beyond the design basis is bothering me a bit in the sense that I tend to think of them in terms of reflecting conservatisms that the designer might build in when he specifies a particular alloy for a certain type of duty or something.

But the way you gentlemen discuss them, they seem to take on a rather different connotation. You speak in terms of being able to perform testing and maintenance with respect to these features that conceptually I don't think I fully appreciate.

Can you address for me what -- as you talk about on the top of Page 31 of Applicants Exhibit 46 -- with respect to the thermal margin, testing and maintenance.

What exactly does this mean? It sounds like -- if you find after the fact there was thermal margin -- is not as large as you would like to have it, other than moving out something and replacing it with something with a better thermal margin, what's the practical significance of testing and maintenance here?

BY WITNESS STRAWBRIDGE:

A. Okay. Let me try to explain. We're talking here about specific features and systems that had been added. Those are called thermal margin beyond the design base features here in the statement at the top of Page 31.

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A system -- Let me use one system as an example. The annulus cooling system, which is there simply to help mitigate the consequences of a core melt accident, is the system that would blow air between the steel containment sheel and the concrete confinement building and remove heat by the process of moving air through that annulus space and out, and taking heat along with it.

The testing and inspection that can be done on that kind of a system is, for example -- the principal feature of that system are a number of fans that blow the air.

One can periodically inspect the fans and, in fact, test the fans, turn them on and see that the fan does, in fact, blow air at the rate that it should blow air.

That kind of a test certainly can be done periodically.

We're talking here in Item B about testing and inspection after installation and periodically meaning before the occurrence of an event where you need to bring the feature into service in Item B.

Now, similar other systems and features, such as our cleanup system, can likewise be inspected and tested periodically after installation of the equipment.

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BY WITNESS CLARE:

A. If I could add a note to that, to perhaps clarify some of the confusion on a different level. Any of the plant capabilities that we include in these categories beyond the design -- margin beyond the design base are not only margins in existing plant equipment, but as in the case of this system Mr. Strawbridge was just talking about, it's a new capability, a new system, a new feature that has been added to the plant which gives the overall plant an additional margin.

It's not just margin in a particular piece of equipment that was there in any case.

Q. That helps. Thank you.

And, finally, at Page 38 of Applicants Exhibit 46, there is a discussion of relative risk from CDA classes in Table J.2. And in the text there is a reference to Table J.2 of a draft supplement of the FES.

Recognizing now that there is a Final Supplement, are there any differences between the Draft and Final Supplement that would change the results you have?

BY WITNESS CLARE:

A. There are no differences. The copy that I have in front of me has a handmarked change from "Draft" to "Final" in it. I thought the copies that we passed out

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at the beginning of yesterday, that those marks --

Q That could well be, because I have already marked up my prefiled testimony. I was reluctant to use the handout of yesterday --

BY WITNESS STRAWBRIDGE:

A But there were no changes to that statement.

Q All right.

DR. COCHRAN: Excuse me. There is a minor change in the footnote that was dropped from Table 2, but I don't think it's significant to their testimony.

WITNESS STRAWBRIDGE: I believe there was a footnote added. I think it did not impact the numbers in the table, nor did it impact how I used the numbers in the table to arrive at my table on Page 38.

DR. COCHRAN: I just wanted to correct that.

JUDGE LINENBERGER: Thank you, gentlemen. I believe that's all I have, Chairman Miller.

JUDGE MILLER: Very well. Is there any reason why this panel may not be excused?

(No response.)

JUDGE MILLER: Thank you, gentlemen. You are excused.

(Witnesses excused.)

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JUDGE MILLER: Move in the Staff --

MR. EDGAR: Your Honor, I would like to make an offer of exhibits, Applicants' Exhibits 46 and 47 into evidence.

JUDGE MILLER: Is there any objection to Exhibit 46?

MR. SWANSON: No objection.

MS. FINAMORE: We have a continuing objection regarding the use of design details in this exhibit, which the Board has already ruled on regarding an earlier exhibit.

We would like to have the record reflect that.

JUDGE MILLER: What is your objection?

MS. FINAMORE: As we stated in regard to Applicants' Exhibit 1, a lot of the information deals with details of the CRBR design, which was ruled beyond the scope of this proceeding by the Board in April.

JUDGE MILLER: Yes. What we ruled was that the use of some details did not render inappropriate this consideration of an LWA-1; but if there were significant differences to a reactor of this size, type, character and the like, you were free to go into them, which you have, I think, to a limited extent.

Is there anything beyond that that you seek to do?

MS. FINAMORE: Well, our objections to this testimony are the same as the objections to the earlier testimony.

JUDGE MILLER: Well, what are those? We are making a record as we go along.

If you have objections, state them, and we'll consider them.

MS. FINAMORE: Just one minute.

JUDGE MILLER: Yes.

MR. EDGAR: While that is pending, I wonder if we could get a response to Applicants' Exhibit 47 and get that out of the way.

JUDGE MILLER: We are likely to have the same response, I would think.

Are there any objections to Applicants' Exhibit 47, which is the 5(b) testimony?

MR. SWANSON: No objection.

JUDGE MILLER: You might in the meantime be assembling your first panel up here.

MR. SWANSON: Yes.

Were any of your witnesses previously sworn, Mr. Swanson?

MR. SWANSON: I believe all but Mr. Thadani have been sworn.

JUDGE MILLER: That's correct.

All right. All witnesses who have been previously sworn remain under oath.

Those that have not been sworn please stand.

Whereupon,

BILL M. MORRIS

JERRY J. SWIFT

JOHN K. LONG

EDMUND T. RUMBLE, III

LEWIS G. HULMAN

were called as witnesses by and on behalf of the Staff and, having been previously sworn, were examined and testified as follows:

Whereupon,

MOHAN C. THADANI

was called as a witness by and on behalf of the Staff and, having been first duly sworn, was examined and testified as follows:

JUDGE MILLER: We are giving an opportunity to consider their stated position on Applicants' Exhibits for identification 46 and 47. We'll pause a moment on that.

(Pause.)

MS. FINAMORE: My first objection is to Question and Answer 37 on Page 33 of Applicants' Exhibit 46.

JUDGE MILLER: Page 37?

MS. FINAMORE: It's Answer 37 on Pages 33

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through and including 35.

JUDGE MILLER: What's the basis of your objection?

MS. FINAMORE: This answer and question deal with a so-called "more realistic calculation of the effects of CRBR release impact -- releases.

These calculations, as the witnesses have indicated, were performed after the Exhibit 1 was filed just a few months ago.

They were first revealed to Intervenors on November 1st of 1982 when this prefiled testimony was submitted.

That was after the close of the discovery period, except for new information appearing in the Environmental Impact Statement for the first time.

Therefore, the Intervenors were unable to find out the background information for these new calculations.

When we questioned the witnesses on the stand regarding the background for these calculations, they indicated that regarding the more realistic calculation of gas sparging, the information was not yet published anywhere in the PSAR or in other documents such as CRBRP-3.

Therefore, we have been unable to get the background information for these documents.

The Applicants admitted that this calculation did involve design details of the plant itself, which go into the calculation of the realistic temperature for the pool and the dilution of the plutonium oxide.

This calculation is very important because I believe it resulted in an increase in -- because it resulted in a decrease in the originally calculated bone surface dose by 100 rems.

We think this information is precisely the type of information which the Board had ruled in April was beyond the scope of this proceeding; and more importantly, we were unable to get discovery on the background of these calculations, and we are still unable to get it because of the time situation and the fact that the information is not available.

So, therefore, we believe this information should be stricken from the record as beyond the scope.

JUDGE MILLER: Applicants?

MR. EDGAR: First of all, the basic point of reference here is that these calculations are nothing more than a repeat of the calculations that were done in Exhibit 1 and which appear in tables at Pages 71 through 72 of Applicants' Exhibit 1.

The same objection was raised in connection with Applicants' Exhibit 1, and the Board found that the objection had no merit.

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For the same reasons today that the Board held previously, the objection should be overruled.

As to the second point, that is, NRDC's purported inability to get discovery, the statements in Exhibit 46 are rather explicit.

The methods of analysis have been well known. The approach to the analysis has been well known since the first days of the hearings.

The Board did reopen discovery on all matters. If there was a problem after the close of discovery for the particular assumptions here, I must say that NRDC never even asked for information.

It seems to me that this is a question where very little prejudice, if any -- and in my judgment, no prejudice can be claimed as a matter of factual circumstances.

We submit that the information is relevant, it's probative, and it should be admitted.

JUDGE MILLER: Staff?

MR. SWANSON: I think the argument, lack of discovery, cannot be a prevailing argument in this situation.

I think we are all on the same footing in that regard. There's plenty of information that we saw for the first time in Intervenor's proposed testimony that we didn't have an opportunity to discover on, either.

I think we are basically all on the same footing when we realize what the discovery rules were.

It sounds as though the specific paragraph we are talking about is a re-analysis of what was presented before so that the general topic, the analysis, the scope, procedures used, et cetera, was subject to prior discovery, and they certainly had an opportunity to examine today to find out if the procedures were any different.

I think under the circumstances the objection is without merit.

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JUDGE MILLER: What about the scope of the proceedings argument?

MR. SWANSON: In terms of the level of detail permitted?

JUDGE MILLER: In terms of the objection made.

There were two prongs, as I understand the objection. One was the discovery, lack of ability to get information and so forth.

The other is based upon the initially continuing objection, the scope of discovery in regard to Clinch River Project details.

MR. SWANSON: Well, I think the Board properly articulated the standard in its order of last April when it in more detail set forth the regulatory standard as to the level of inquiry required in an LWA-1 stage.

The Board correctly pointed out that the level of inquiry that is required at the CP stage in terms of detail, safety reviews, is just not required.

It's a state of the review as it exists now, and we think the Board correctly applied that standard.

It is unfortunately not a clear line delineation as to what level of detail is acceptable and what isn't. It's a matter of judgment, and I think in this situation it's a matter which was discussed before without objection.

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There doesn't appear to be any more level of detail now than there was the first time this analysis was presented, and we think the ruling of the Board should remain that this is permissible discussion at this phase of the hearing.

MS. FINAMORE: May I respond to --

MR. EDGAR: Your Honor, may I make one reference to the transcript of yesterday to correct a mischaracterization by Counsel.

Counsel argued that the analysis in question did involve design details.

Let me refer the Board to Transcript 5172, and Witness Strawbridge's answer to the question: "Wouldn't the calculation of realistic pool temperature depend on specific details of the CRBR design?

"Answer: "No. Once you have a meltdown, you don't care much about what the details were before you got to that point. You've lost the detail by the time you've got to this stage of the accident."

MS. FINAMORE: May I respond?

JUDGE MILLER: Yes.

MS. FINAMORE: To correct a mischaracterization by Applicants that said discovery was reopened for all purposes on November 1st, I think the Board's order will show that it was opened only for the limited purposes of

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new information in the Environmental Impact Statement, and not for discovery on the testimony of the Applicants.

Secondly, in terms of prejudice to Intervenors, we feel that the prejudice involves the new information, rather than the information in Exhibit 1, in particular, the reduction in the bone surface dose which is admittedly controlling for plutonium by 100 rems.

The Applicants stated that the methods were well known. These methods, as Applicants stated, were first discussed with the Staff only recently.

I don't think the characterization of them as well known is appropriate.

The Staff mentioned that new information by Intervenors was included in its testimony. I would just like to point out that Intervenors attempted to include all the background for all their calculations, such that they would be able to be reproduced.

This is not the case in this situation. If you look at Answer 37, you'll notice that the Applicants mentioned four or five different factors that had changed, and gave no reasons or factor changes for each of those until we were on the stand today.

Therefore, it was unable for us to reproduce the impact of each of these factor changes on the dose calculations on Pages 34 and 35.

8-11

In particular, we were unable to calculate the impact of gas sparging without the gas sparging formulas, which have not yet been available.

In terms of design details, I don't have the transcript in front of me, but although the witness may have provided the answer cited by Applicants, it's my recollection that when asked about specific design details, the Applicants did admit that those would be important or useful in the calculation of the gas sparging effects.

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MR. EDGAR: Just as a final note, the argument made assumes that what we are here for is a trial, and if there's something wrong with the calculations, with a reasonable amount of skill those difficulties can be brought out.

There is no perfect system for discovery. This information has gone in before. It should go in again.

JUDGE MILLER: Let me inquire what testimony or what computations do you contend that you saw or were confronted with for the first time in trial, rather than previously filed in the prepared direct written testimony?

(Pause.)

JUDGE MILLER: Have you found what you were referring to?

MS. FINAMORE: Again, I don't have the transcript in front of me, but --

JUDGE MILLER: Here's a transcript, if you need that.

MS. FINAMORE: Okay.

JUDGE MILLER: My question, however, is what is the testimony, written or oral, but I presume it goes back to the prefiled written, that you contend you did not see or have the benefit of seeing prior to this phase of the hearing?

I'm trying to find out the date, essentially.

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MR. EDGAR: Our position, Your Honor, on that is that it's well disclosed in the testimony. There's been ample opportunity to prepare.

JUDGE MILLER: I'm trying to find out if that's in November 1 prefiled testimony, or if there have been some changes or additions that present any aspects of unfairness.

Let me ask you, Mr. Edgar. You and your staff are pretty conversant with the facts, and I see from the press that you bring in your bookcases and appropriate paraphernalia.

Can you tell us was there any testimony, written or oral, that confronted the Intervenors or anyone else with either surprise or with information or data which was not available, say, by November 1, which is the date, I believe, of the filing of the prefiled testimony?

MR. EDGAR: The answer is no, and it's clear on the face of the testimony. In A-37 we describe with references to materials that are available --

JUDGE MILLER: Yes, I see that.

MR. EDGAR: -- the PSAR amendments, ICRP-30 --

JUDGE MILLER: I've seen that.

MR. EDGAR: -- and there's just not --

JUDGE MILLER: Is there anything beyond that, more recent?

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MR. EDGAR: Not to my knowledge.

JUDGE MILLER: Staff? Well, maybe you've found it by now. What is it?

MS. FINAMORE: The main new piece of information is what the Staff calls a more realistic calculation of gas sparging.

JUDGE MILLER: Where does that appear?

MS. FINAMORE: In the written testimony, it's the second-to-last line on Page 33.

JUDGE MILLER: That's the November 1 filing?

MS. FINAMORE: Yes. In the written -- in the oral --

JUDGE MILLER: Well, if it was in the November 1 filing, you had the opportunity to read it and to do something about it.

I just wanted to be sure you weren't taken by surprise with some new computations.

MS. FINAMORE: Yes. I'm getting to that. That's in the oral testimony yesterday.

JUDGE MILLER: Well, I know, but the oral testimony was a product of your own cross-examination, wasn't it, because the only oral testimony that came followed in a temporal way the prefiled testimony that was filed November 1, 1982.

The oral testimony came later and was brought

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into play as a result of your cross-examination.

MS. FINAMORE: If I may get a clarification of your question.

Are you asking whether there was new written information subsequent to November 1st?

JUDGE MILLER: Yes.

MS. FINAMORE: Yes, apparently there was. I don't know if it was written or not.

The Applicants said that they have met with the Staff recently --

JUDGE MILLER: No, no. What I'm talking about is the direct testimony.

MS. FINAMORE: Are you asking if there was any --

JUDGE MILLER: If there was any direct testimony subsequent to November 1 to which you did not have access until recently, a week, or....

MS. FINAMORE: No. The deadline for the prefiled testimony was November 1st, except for information relating to new information in the Final FES Supplement, which was --

JUDGE MILLER: Yes, triggered by the Final Supplement to the FES.

MS. FINAMORE: That was filed November 12th --

JUDGE MILLER: And the parties were directed themselves to work out a short discovery period.

MS. FINAMORE: -- by Intervenors.

Yes. The deadline for that was November 12th.

JUDGE MILLER: Yes.

MS. FINAMORE: The Intervenors filed updated testimony on November 12th.

However, the discovery period was closed, I believe it was the middle of October. So this testimony was filed after the close of the discovery period.

So although --

JUDGE MILLER: You mean the original discovery period; is that what you mean?

MS. FINAMORE: Any discovery on any matters, other than those specifically raised for the first time --

JUDGE MILLER: Other than those triggered by -- were the terms the Board used -- those that were triggered by the Final Supplement to the FES.

MS. FINAMORE: Yes. The information in Answer 37 was not triggered by information contained for the first time in the Final Environmental Impact Statement Supplement; therefore, it was not open to discovery by Intervenors.

JUDGE MILLER: Wait a minute.

Before we get into the "Who struck Johns," I'm trying to establish clearly once and for all, is there anything subsequent to November 1?

I'll address November 1 and the filings then, but I want to be sure that -- in your presentation you spoke as though you had just been suddenly confronted with a lot of computations and footnotes and whatever.

I want to know whether or not the matters that you are complaining of, without going into the details at the moment, are contained in the November 1, 1982, filing by the Applicants which has now been marked for identification Applicants' Exhibit 46?

MS. FINAMORE: The one matter that was added was the statements by the Applicants --

JUDGE MILLER: Now wait a minute.

Before the one that was added, let's find out what was contained in the November 1. Does it include everything you are complaining of with one exception you are about to tell us about?

MS. FINAMORE: That's right. Nothing was filed by Applicants subsequent to this November 1st testimony. That was the deadline.

JUDGE MILLER: It was everybody's deadline, wasn't it?

MS. FINAMORE: Yes.

JUDGE MILLER: All right. It's been filed. You read it and you saw those matters on Page 33, a more

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realistic calculation and so forth.

You read it and knew about it November 1 on, correct?

MS. FINAMORE: We read it. We were unable to get discovery on it.

JUDGE MILLER: What effort did you make to get discovery?

Answer, none, n-o-n-e, right?

MS. FINAMORE: Yes, because the Board's order closed discovery --

JUDGE MILLER: Of course, we always close discovery, but we also have always said and it's part of our practice that if you can show good cause, if you can show good cause and bear the heavy burden that's implicit there, you can at least make an attempt to reopen discovery for discrete specified issues or matters.

Secondly, we have a standing order here, picking up the Comanche Peak procedure whereby we have instructed all of you before you make that or any other motion confer among yourselves, because many of these things can be handled by negotiations.

Then when you make such a motion, as would be contemplated by a motion to reopen discovery for a specific purpose, you would in that motion tell us what efforts have been made and results, and the Board would then rule.

You didn't do any of those things, I don't believe, did you?

MS. FINAMORE: Well --

JUDGE MILLER: First of all, did you or did you not?

MS. FINAMORE: No, we believed that discovery was closed. In addition --

JUDGE MILLER: You are a lawyer. You know what the purpose of motions is. We've explained it before.

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MS. FINAMORE: In addition, we felt that the timing was such that we were going to hearing in a matter of days --

JUDGE MILLER: You gambled and lost. Let's put it in a nutshell. You could and should have made efforts. If you were concerned and felt that you would be prejudiced, you could and should have done as a lawyer a number of things.

You did none of them. Now, while we are in the midst of trial, we are therefore going to adhere to our previous rulings, and on the basis of the objections that you have made, we will overrule the objections, and we will admit into evidence Exhibits 46 and 47.

I will further point out that the spirit of our rulings is for the parties, first of all, before you complain to the Board, is to talk to each other.

Back in Washington we say pick up a phone and try to get what you say you need, and then tell us what efforts you've made in the motion that you then file to trigger the Board's exercise of discretion.

Now, you are going to be engaged here Thursday and probably half of Friday in closing arguments. You have until then, (a), to do what you should have done months ago under the Comanche Peak procedure, talk to these people, request what it is you claim you need, and then tell us in closing arguments what the result is.

MS. FINAMORE: Okay.

JUDGE MILLER: That's all you have to do.

MS. FINAMORE: I'd like to point out two more things. First of all --

JUDGE MILLER: You have pointed out about as much as we are ready to listen to now. We don't want to prolong this.

MS. FINAMORE: We had two bases for the objection. Second --

JUDGE MILLER: What's that? Go ahead. What is the basis that you haven't yet addressed.

MS. FINAMORE: That the information in this answer is beyond the scope of the proceeding.

JUDGE MILLER: Overruled. We have previously discussed that. I think you all know the basis for that.

MS. FINAMORE: We have two other portions of the testimony --

JUDGE MILLER: Okay, what are they?

MS. FINAMORE: -- that we believe are beyond the scope of the proceeding, as involving design details.

JUDGE MILLER: Well, if it's involving design details, we'll adhere to our ruling, but you may want to make your record by pointing out the pages and the answers that you wish to object to.

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MS. FINAMORE: The first is on Page 8, the final paragraph, the final sentence, starting with, "Figure 1 shows the approximate response of reactor power to a step change in reactivity not close to $1, not considering any reactivity feedback (the conservatively estimated maximum design basis step reactivity insertion is 60 cents)."

JUDGE MILLER: Now there you claim what, you've been given too much information instead of too little?

MS. FINAMORE: No, that this information is beyond the scope of the proceeding, and that under the Board's order of April we were precluded from going into discovery on detailed design considerations.

JUDGE MILLER: That was as to detailed design considerations. It was not as to matters which you might regard as detail which have a bearing to this or any other plant of a similar type or purpose.

What would you have gone into there that you didn't on cross-examination or otherwise?

MS. FINAMORE: The question is whether or not that is the maximum design basis step reactivity insertion rate that should be assigned to this reactor, based on seismic or other events.

(Bench conference.)

MR. EDGAR: I'd like to point out for the record that the information which appears at the bottom of Page 8 there, if you'll look at the top sentence on the page, the whole discussion is centered around the general reactivity principles for an LMFBR; but in addition, the Applicants' Exhibit 1 at Pages 20 through 23 discusses design basis requirements for reactivity in the shutdown system.

That's previously been admitted, and if anything, this subject here and the form of the discussion is in much less detail than the prior admitted testimony.

MS. FINAMORE: If I may respond.

JUDGE MILLER: Yes.

MS. FINAMORE: The Applicants, to my recollection, did refer to specific design details when questioned on this subject.

JUDGE MILLER: Wait a minute. I'm not following you. What happened?

In the first place, address, if you will, the fact that at the top of Page 8 it does say typical values are about so-and-so for LWR's and about half that value for a reactor of the general size and type of Clinch River.

It does appear that that page is consistent with our previous rulings, namely that the information as admitted for the purpose of dealing with reactors of the general size and type as Clinch River, and in fact it's even specifically stated up at the top.

So I still don't know why in context you are contending that it is not within that ambit.

MS. FINAMORE: I've been informed that the sentence on the top of Page 8 is referring to a different subject, namely the beta values, whereas the final sentence on Page 8 refers to the rho values for LMFBR's.

JUDGE MILLER: Well, it may well be, but once again, it shows the theory upon which the testimony is proffered.

Now, you can object to that. You could cross-examine if you wanted to. I don't recall now whether you did or not. You may have.

MS. FINAMORE: I believe the Applicants relied upon specific design details in order to get their 60-cent figure.

Those are the types of design details that we were unable to counter, since discovery was closed to us on those types of matters as far back as April.

JUDGE MILLER: Well, discovery was closed as to the specific design details of Clinch River as such.

MS. FINAMORE: Yes, and that's --

JUDGE MILLER: The Board taking the position that you would be able to do so when you got to the construction permit stage, but that insofar as consideration of reactors of the general size and type, the fact that there are some details proffered I suppose are necessary unless you are going to look at the whole thing in a vacuum.

I should think that you are getting more information by having it done that way than by having it done more generally.

MS. FINAMORE: We were given information regarding the specifics of the CRBR design that Applicants relied upon to get this 60-cent figure.

What we were unable to do is to get discovery on information regarding specifics of the CRBR design that we could use to counter the information given by Applicants.

JUDGE MILLER: What information, what details, then, would you have asked for either on cross-examination or what you are calling discovery of the last sentence of Page 8, having in mind now that it's cast in the general framework, whether it's another issue or not, at the top of reactors of the general size and type as Clinch River?

MR. EDGAR: I'd like to add something for the record.

The statement was made that the top of the page talks about rho and the bottom of the page talks about beta; but for this purpose, if you look at the middle of the page, rho is assumed to be equal to beta.

So I think we've got a little question of mathematics and logic here on the table.

JUDGE MILLER: I thought it said rho equals beta, but I wasn't sure whether it was Greek or what, and I hesitated to get involved in it, but I did see it.

MR. EDGAR: The other thing is that the sense of this testimony on this page is as long as you are not close to $1, the specific value doesn't make any difference here in the parenthetical. It could be 60 or 80 or whatever.

That's there for information, and it's almost preposterous to suggest that if NRDC had discovery, that they could have gone into and disproved 60 cents.

Now that's just not a logical proposition. If you look at the context and this Board has the expertise to do that, there is no question that this objection is totally without merit.

MS. FINAMORE: If I may respond.

The purpose for which we would want discovery is to get information that might enable us to challenge the 60-cent figure.

I appreciate Mr. Edgar's testimony on whether or not we would be able to succeed. However --

JUDGE MILLER: Why would you want to? That's my question. Why would you want to?

I'm going to materiality.

MS. FINAMORE: Okay. The Applicants testified

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yesterday and in their testimony that the control rod response requirements of LMFBR's and LWR's are similar for reactivities not close to a dollar.

I assume the one inference they would wish to make from that statement is that probabilities of failure of these control rods are also similar to LWR's and LMFBR's.

That's an inference that we would dispute.

They also, to my recollection, relied on information regarding seismic qualifications for their discussion of the 60-cent figure.

It was based on their estimates of earthquake impacts and responses to them.

If we were able, as we had originally wished, to get discovery on design details and were able to use that information to challenge this 60-cent figure such that it would be close to a dollar, the whole hall of cards would break down.

The similarity between LMFBR's and LWR's control rod requirements might be brought into question; and, therefore, the use of probabilities in LWR control rods in their analysis of CRBR probabilities would also be called into question.

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JUDGE MILLER: NOw, with all that in mind, on November 1, why didn't you do something about it?

MS. FINAMORE: We felt --

JUDGE MILLER: No, don't feel.

Address somebody, either the Board or the parties, if you really believe that it has the significance than you are now arguing.

My question is, why, November 1, didn't you make an appropriate,first,request of the parties, and, secondly, that being unsuccessful, address a motion to to the Board?

Why did you wait until now?

MS. FINAMORE: We addressed a motion to the Board twice regarding the scope of discovery and the scope of this proceeding.

JUDGE MILLER: Now, wait a minute. Wait a minute.

Where did you address the Board? Just show me the motion where you went into the matters which are set forth on Page 8 of the pre-filed testimony, which is Applicants Exhibit 46?

MS. FINAMORE: We felt we were bound by the Board's ruling.

JUDGE MILLER: Now, you're arguing.

When I ask you something, I want a direct, non-evasive response.

Show me the written motion to the Board where you discussed or requested discovery or anything else pertaining to the matters set forth on Page 8, whose significance you have just now described in the record.

MS. FINAMORE: We have no such written motion. We were bound by the Board's ruling in April and August regarding the scope of this proceeding.

JUDGE MILLER: In August, we had no indication about your rho/beta argument. We didn't have it until a while ago, as a matter of fact, or this week at the earliest . Now, it's the first time you've brought this matter to the Board's attention. Now, there is no sense in giving us general arguments and general motions about scope.

If you can't show us where you specifically addressed the problem that you described and its implications to you that you've just now described and I'm referring to the rho/beta, Page 8, matter. If you've got nothing else than what you've just told us, you've, on this record, made no effort prior to this week, at any rate and probably prior to today, to bring it to the Board's attention, by motion or otherwise, let alone the preceding matters that you've been instructed to take up with opposing Counsel.

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Now, having failed to do so, we're not going to take more time now to go into matters that you could and should have raised earlier and failed to do.

We pointed out, however, that you still have a more limited opportunity to do that which you should have done seasonably, prior to the closing arguments we're going to hear from you on Thursday and Friday.

Now, we'll let the matter rest there and we overrule your objection.

Exhibit 46 and 47 are admitted and we overrule the objection that you stated for the record.

(Applicant Exhibit Nos. 46 and 47, respectively, were admitted into evidence and inserted into the record immediately following, along with glossary of terms relating to Exhibits 46 and 47.)

GLOSSARY
(Contentions 1, 2, 3, and 5b)

ABHX - Air Blast Heat Exchanger

AFWS - Auxiliary Feedwater System

ANL - Argonne National Laboratory

BOC - Beginning of Cycle

BWR - Boiling Water Reactor

CDA - Core Disruptive Accident

CRBR - Clinch River Breeder Reactor

CRDM - Control Rod Drive Mechanism

Cs - Cesium

DBA - Design Basis Accident

DHRS - Direct Heat Removal Service

DOE - Department of Energy

ECCS - Emergency Core Cooling System

EOC - End of Cycle

FFTF - Fast Flux Test Facility

FSFES - Final Supplement to the Final Environmental Statement

GCEP - Gas Centrifuge Enrichment Plant

HCDA - Hypothetical Core Disruptive Accident

HTS - Heat Transport System

IHTS - Intermediate Heat Transport System

IHX - Intermediate Heat Exchanger

LMFBR - Liquid Metal Fast Breeder Reactor

LOF - Loss of Flow

LOHS - Loss of Heat Sink

LWA - Limited Work Authorization

LWR - Light Water Reactor

MW hr - Megawatt hour

NSSS - Nuclear Steam Supply System

OHX - Overflow Heat Exchanger

ORGDP - Oak Ridge Gaseous Diffusion Plant

ORNL - Oak Ridge National Laboratory

PACC - Protected Air Cooled Condenser

PHTS - Primary Heat Transport System

PSAR	-	Preliminary Safety Analysis Report
PWR	-	Pressurized Water Reactor
Rb	-	Rubidium
RSS	-	Reactor Shutdown Systems
SCRDM	-	Secondary Control Rod Drive Mechanism
SEFOR	-	Southwest Experimental Fast Oxide Reactor
SGAHRS	-	Steam Generator Auxiliary Heat Removal System
SG	-	Steam Generator
SHRS	-	Shutdown Heat Removal Systems
SMBDB	-	Structural Margin Beyond the Design Base
SSST	-	Site Suitability Source Term
TDAFWP	-	Turbine - Drive Auxiliary Feedwater Pump
T-G	-	Turbine - Generator
TMBDB	-	Thermal Margin Beyond the Design Base
TOP	-	Transient Overpower

A. Ex. 46

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UNITED STATES OF AMERICA

NUCLEAR REGULATORY COMMISSION

In the Matter of	)	
UNITED STATES DEPARTMENT OF ENERGY	)	
PROJECT MANAGEMENT CORPORATION	)	Docket No. 50-537
TENNESSEE VALLEY AUTHORITY	)	
(Clinch River Breeder Reactor Plant)	)	

APPLICANTS' TESTIMONY

CONCERNING NRDC

CONTENTIONS 2d), 2f), 2g), 2h), 3c) and 3d) (Environmental Effects) and 5b)

Dated: November 1, 1982

Q.1. Please state your names and affiliations.

A.1. George H. Clare, Manager, Licensing, Westinghouse Advanced Reactors Division. Lee E. Strawbridge, Manager, Nuclear Safety and Licensing, Westinghouse Advanced Reactors Division. L. Walter Deitrich, Associate Director, Reactor Analysis and Safety Division, Argonne National Laboratory.

Q.2. Have you prepared statements of your professional qualifications?

A.2. Yes. Copies are attached to this testimony.

Q.3. What subject matter does your testimony address?

A.3. This testimony addresses the environmental effects of CRBRP accident analyses. This issue is defined in NRDC Contentions 2d), 2f), 2g), 2h), 3c) and 3d) (Environmental Effects) and 5b).[1] Specifically, NRDC alleges that

> 2. The analyses of CDAs and their consequences by Applicants and Staff are inadequate for purposes of licensing the CRBR, performing the NEPA cost/benefit analysis, or demonstrating that the radiological source term for CRBRP would result in potential hazards not exceeded by those from any accident considered credible, as required by 10 CFR 100.1(a), fn. 1.
>
> d) Neither Applicants nor Staff have demonstrated that the design of the containment is adequate to reduce calculated offsite doses to an acceptable level.

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[1] This testimony addresses the basis for the selection of the core accident cases that are assessed in separate testimony addressing Contention 5b). See Q/A 40.

f) Applicants have not established that the computer models (including computer codes) referenced in Applicants' CDA safety analysis reports, including the PSAR, and referenced in the Staff CDA safety analyses are valid. The models and computer codes used in the PSAR and the Staff safety analyses of CDAs and their consequences have not been adequately documented, verified or validated by comparison with applicable experimental data. Applicants' and Staff's safety analyses do not establish that the models accurately represent the physical phenomena and principles which control the response of CRBR to CDAs.

g) Neither Applicants nor Staff have established that the input data and assumptions for the computer models and codes are adequately documented or verified.

h) Since neither Applicants nor Staff have established that the models, computer codes, input data and assumptions are adequately documented, verified and validated, they have also been unable to establish the energetics of a CDA and thus have also not established the adequacy of the containment of the source term for post accident radiological analysis.

3. Neither Applicants nor Staff have given sufficient attention to CRBR accidents other than the DBAs for the following reasons:

c) Accidents associated with core meltthrough following loss of core geometry and sodium-concrete interactions have not been adequately analyzed.

d) Neither Applicants nor Staff have adequately identified and analyzed the ways in which human error can initiate, exacerbate, or interfere with the mitigation of CRBR accidents.

5. Neither Applicants nor Staff have established that the site selected for the CRBR provides adequate protection for public health and safety, the environment, national security, and national energy supplies; and an alternative site would be preferable for the following reasons:

b) Since the gaseous diffusion plant, other proposed energy fuel cycle facilities, the Y-12 plant and the Oak Ridge National Laboratory are in close proximity to the site an accident at the CRBR could result in the long term evacuation of those facilities. Long term evacuation of those facilities would result in unacceptable risks to the national security and the national energy supply.

Q.4. What fundamental core conditions are most important in considering the environmental effects of accidents?

A.4. In the Applicants' Testimony on Contentions 1, 2 and 3 (Exhibit 1), it was shown that reactor accidents involve either:

- o Excessive heat generation, or
- o Reduced heat removal.

Q.5. What design features are important to prevention of these two core conditions?

A.5. A discussion of design features which can prevent progression of these two conditions beyond the design base and preclude initiation of a hypothetical core disruptive accident (HCDA) in a reactor of the general size and type of the CRBRP was presented in Applicants' Exhibit 1. These features include:

- o Redundant, diverse reactor shutdown systems (RSS).
- o Redundant, diverse shutdown heat removal systems (SHRS).

- o Means to prevent inlet pipe rupture.
- o Means to maintain a balance between individual subassembly heat generation and heat removal.

Q.6. Which of these features are of primary interest in the NRC Staff's estimates of the environmental effects of accidents in Appendix J of the ~~Draft~~ Final Supplement to the Final Environmental Statement ~~(DSFES)~~ (FSFES)?

A.6. The RSS and the SHRS are of primary interest. The Appendix J analysis makes estimates of the risks associated with HCDAs. The two systems which have the greatest influence on the Staff's Appendix J estimates of the frequency of progression to HCDA conditions are the RSS and the SHRS.

Q.7. What physical characteristics of LMFBRs are of primary importance in assessing the capability of the RSS to prevent excessive heat generation and progression to HCDA conditions?

A.7. The principal means of preventing HCDAs due to excessive heat generation is the RSS. The RSS must be able to provide a timely response to prevent excessive heat generation resulting from any credible reactivity insertion. The time response characteristics required of the RSS are strongly influenced by the kinetics of the reactor, i.e., its response to reactivity insertions.

Q.8. What a: the reactor kinetics characteristics of an LMFBR and how do they compare to those of an LWR?

A.8. Heat generation in a reactor is determined by the mass of fissile material present, the fission cross-section, and the neutron flux. For a reactor of the general size and type of CRBRP, control of the reactor power is accomplished by control of the neutron flux. The fundamental neutron balance states that:

[Rate of change of neutron density] =
[Net rate of neutron production in fission reactions]
-[Rate of neutron loss by leakage and non-fission absorption]

For a critical reactor, the rate of change of neutron density is zero. Neutron production balances losses. Withdrawal of a control rod from the reactor core will reduce neutron losses by non-fission absorption, so the neutron density (and reactor power) will increase, and vice versa. The rate at which changes in reactor power occur is determined by the rate and magnitude of change in non-fission absorption and by the kinetics parameters of the reactor under consideration.

A change in the balance between neutron production, losses, and absorption is manifest in a change in the effective multiplication factor, i.e., the ratio of the neutron density in one generation to that of the preceding generation. The reactivity, rho, is defined in terms of the effective multiplication factor, k_{eff}, as

$$rho = (k_{eff} - 1)/k_{eff}$$

For a critical reactor, k_{eff} is one and reactivity is zero. Most neutrons are produced essentially instantaneously in the fission process. These neutrons are called "prompt neutrons." Prompt neutrons slow down from the energy at which they were produced to the energy at which they cause new fissions. This slowing down, along with diffusion to a fissile nucleus, takes a short time called the prompt neutron lifetime. Typical prompt neutron lifetimes are the order of 10^{-5} seconds for LWRs and 10^{-7} seconds for LMFBRs.

However a small, but important, fraction of the total number of neutrons resulting from fission appears as the result of radioactive decay of certain fission products, with half-lives ranging from a few tenths of a second to tens of seconds. These half-lives for "delayed neutrons" are nearly the same for LWRs and LMFBRs. It is these delayed neutrons which determine the reactor kinetics behavior under all credible operating and accident conditions. The effective fraction of total neutrons which appear as delayed neutrons depends on the material in which fissions occur (primarily ^{235}U in an LWR, ^{239}Pu and ^{238}U in an LMFBR), and to a minor extent on the reactor design.

Typical values are about 0.0065 for LWRs and about half that value for a reactor of the general size and type of CRBRP.

A critical reactor depends on both prompt and delayed neutrons to sustain the chain reaction. Thus, it is said to be "delayed critical." Should the reactivity become high enough that the reactor is critical on prompt neutrons alone, it is said to be "prompt critical." The latter condition is defined as

rho = beta

where beta is the effective delayed neutron fraction. It is convenient to normalize reactivity to the delayed neutron fraction, thereby introducing the "dollar" of reactivity, such that 1$ of reactivity represents prompt criticality. One cent of reactivity is 0.01 dollar.

The equations relating reactivity and reactor power are well known. Figure 1 shows the approximate response of reactor power to a step change in reactivity not close to 1$, not considering any reactivity feedback (the conservatively estimated maximum design basis step reactivity insertion is 60¢).

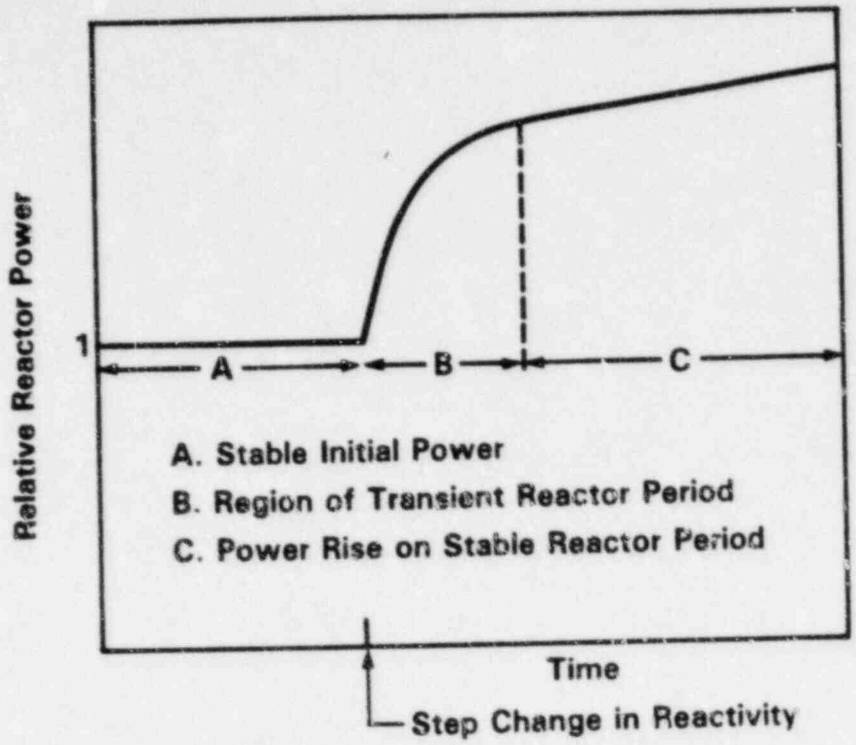

Figure 1.

It is seen that there is an initial rapid power increase which quickly slows to a power rise on a stable reactor period. (The reactor period is the time for power to increase by a factor of "e".) The transient reactor power and its rate of change are determined principally by reactivity and delayed neutron lifetime, and only in a secondary way by prompt neutron lifetime. The stable period and magnitude of power rise are essentially the same for LWRs and LMFBRs for reactivities not close to 1$. Thus, the LMFBR, even with its shorter prompt neutron lifetime compared to the LWR, is not appreciably different in its control characteristics from an LWR.

Q.9. How do reactivity feedbacks affect LMFBR reactor kinetics?

A.9. The preceding discussion of reactor kinetics did not include any consideration of reactivity feedbacks associated with change in reactor temperatures. In practice, such feedbacks are important in reactor control.

In a fast reactor, the most important of these feedback mechanisms in controlling the power rise associated with reactivity transients is the Doppler coefficient. The Doppler coefficient reflects a net increase in the proportion of neutrons absorbed without causing fission to those causing fission as the temperature increases. The decrease in reactivity due to Doppler feedback is a prompt effect; that is, no time delays associated with heat transfer or material motion are involved. Thus, Doppler feedback is effective in attenuating power transients associated with large reactivity insertions, even including prompt critical conditions. The effectiveness of the Doppler coefficient in a fast reactor was demonstrated by experiments in the SEFOR reactor.

Another important prompt feedback mechanism is fuel expansion. Fuel expansion decreases the fuel density which is reflected as a decrease in the fission cross-section and, consequently, a decrease in reactivity.

Other reactivity feedback mechanisms, such as coolant density changes, can influence the reactor heat generation. However, these effects are not prompt in time, since a heat transfer delay is involved. Thus, such feedbacks are not of primary importance in determining the speed of response requirements for the RSS.

Q.10. What conclusions do you draw concerning the feasibility of designing the CRBRP RSS to prevent excessive heat generation?

A.10. Although an LMFBR of the general size and type of CRBRP will have a shorter prompt neutron lifetime and smaller delayed neutron fraction than would a typical LWR, the control response requirements of the two reactor types are similar. This conclusion follows because the reactor kinetics for the range of reactivity insertions encountered in Design Basis Accidents are principally dependent on delayed neutron lifetimes and reactivity (normalized to the delayed neutron fraction). Thus, no extraordinary shutdown system response characteristics are required, and LWR technology is applicable. Furthermore, prompt reactivity feedbacks from the Doppler effect and fuel expansion mitigate power transients associated with reactivity insertions. Thus, the short prompt neutron lifetime is of no practical significance in reactor control. As was demonstrated in Section 3.3 of Exhibit 1, it is feasible to provide shutdown systems, based on LWR technology, which assure a high likelihood of reactor shutdown. Such systems with adequate time response characteristics are clearly within the state of technology.

Q.11. What conclusions have you drawn concerning the NRC Staff's estimates of the frequency of progression to HCDA conditions as a result of failure of the RSS on demand?

A.11. The NRC Staff's estimates of the frequency of failure of the RSS on demand and the resultant progression to HCDA conditions are based upon experience with LWR systems. The Staff recognized that CRBRP has two shutdown systems, but gave only limited credit for the presence of the second system.

Based on the similarity of the shutdown system requirements, the CRBRP RSS can use technology similar to that used in LWRs, and the likelihood of failure of a single shutdown system in CRBRP should be similar to that in an LWR. However, since two redundant, diverse, independent fast acting shutdown systems have been provided in CRBRP, rather than one such system as in an LWR, the likelihood of failure of the RSS should be substantially less in CRBRP than in an LWR. On this basis, the Staff's Appendix J estimates of shutdown system failure frequency and the resulting likelihood of HCDA conditions are conservative.

Q.12. What design features are of primary importance to prevention of reduced heat removal and progression to HCDA conditions?

A.12. The Reactor Shutdown Systems are designed to automatically shut down the reactor if reduced heat removal occurs while the reactor is at power (Exhibit 1, Section 3.3). The Shutdown Heat Removal Systems (SHRS) are designed to remove reactor decay heat and reestablish the balance between heat generation and heat removal (Exhibit 1, Section 3.3).

Q.13. What SHRS general design characteristics and available experience support the NRC Staff's Appendix J estimates of the frequency of SHRS failure?

A.13. The SHRS includes redundancy, diversity and independence to provide protection against random and common-cause failures. This is consistent with the approach used in the design of systems used to remove reactor decay heat in Light Water Reactor (LWR) plants. This supports the judgment by the NRC Staff that failure of the CRBRP SHRS would result in core degradation at a frequency similar to that estimated for Pressurized Water Reactor (PWR) plant systems (~~D~~FSFES, Appendix J, Page J-~~2~~4).

Q.14. Are there additional characteristics which can enhance the capability of LMFBR SHRSs relative to LWRs?

A.14. Y s. There are several characteristics of sodium coolant that enhance the capability of LMFBRs for decay heat removal. Sodium has a high boiling temperature (1600^{o}F) compared to the normal operating temperatures (1000^{o}F hot leg temperature). The large margin to boiling assures that (1) the primary coolant system will not be pressurized by sodium vapor, and (2) a large temperature increase can be accommodated in the primary coolant without boiling in the core which could degrade heat transfer. Sodium has a high thermal conductivity: approximately 30 Btu/hr-ft-^{o}F vs 0.3 Btu/hr-ft-^{o}F for water. The high thermal conductivity assures effective heat transfer even at low sodium flow rates. Although the specific heat of sodium is less than that of water (0.3 Btu/lb-^{o}F vs 1 Btu/lb-^{o}F for water), the large sodium inventory of the primary and intermediate heat transport systems (approximately 3 million pounds) provides a large heat capacity (approximately 1 million Btu/^{o}F). These thermal properties combine to enhance SHRS capability in three ways: (1) the high boiling temperature allows operation at atmospheric pressure and thus passive mitigation of primary coolant leaks; (2) the sodium coolant and systems characteristics facilitate shutdown heat removal using only the thermal driving head to circulate coolant, i.e., natural circulation; and (3) the large system heat capacity and large margin to boiling provide a long time after reactor shutdown before shutdown heat removal is necessary.

Q.15. How does the boiling temperature of sodium enable passive maintenance of primary coolant inventory?

A.15. The large margin to boiling assures that the primary coolant system will not be pressurized by sodium vapor as a result of normal plant operation or a DBA. The only pressure sources in the primary coolant system are the static head and pump head. The primary coolant pump main motors are tripped when the Reactor Shutdown Systems (RSS) are tripped assuring that the normal pump head (approximately 150 psig) is relieved when the reactor is shut down. The only pressure sources during SHRS operation are the static head and the head from the primary coolant pumps operating on pony motors (approximately 5 feet maximum).

This low pressure allows the use of a totally passive approach to maintaining primary coolant inventory. Guard vessels are provided around the primary coolant system components and elevated piping is used between the components. The upper lips of the guard vessels are high enough and the volume between each component and its guard vessel is small enough so that no leak from the primary coolant boundary could result in loss of so much sodium that the core or the reactor vessel outlet nozzles would be uncovered. Thus, no active components (such as pumps or valves) are required to function to maintain primary coolant inventory. The guard vessel-elevated piping concept is illustrated in Figure 2.

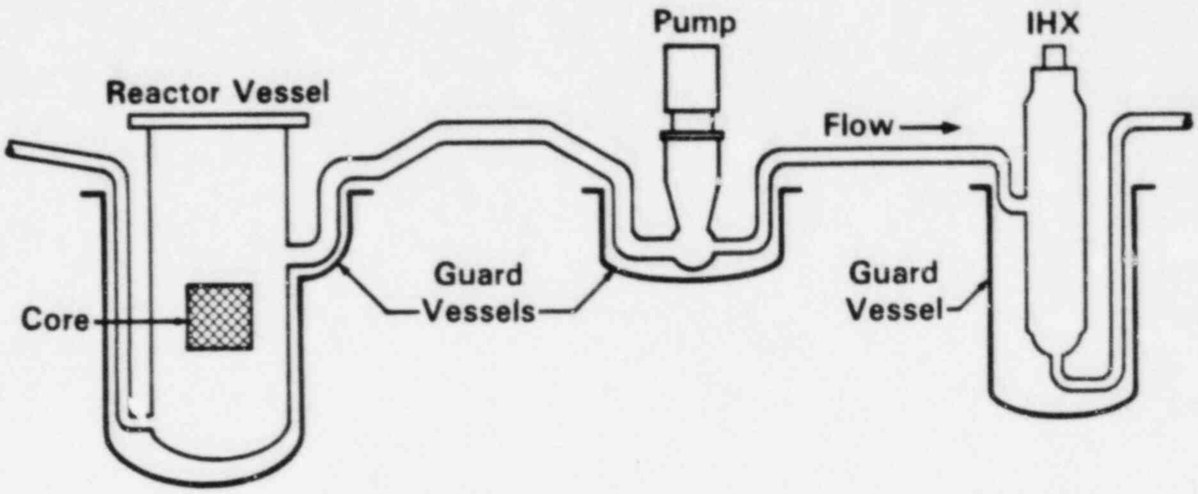

Figure 2. Guard Vessels and Elevated Piping Assure Primary Coolant Inventory is Maintained.

Q.16. How does this approach to maintaining reactor coolant inventory enhance SHRS capability relative to LWRs?

A.16. This passive approach to maintaining reactor coolant inventory in the event of a primary coolant leak can be functionally compared to the active Emergency Core Cooling Systems (ECCS) used in LWR plants. These passive features, which take advantage of the physical characteristics of sodium, provide an inherently reliable means of enhancing the capability of the SHRS.

Q.17. How do the thermal characteristics of the sodium coolant and systems characteristics enable natural circulation?

A.17. The high thermal conductivity of sodium and the large margin to boiling are desirable thermal characteristics that allow the use of low flow rates (as low as 3 percent of normal full flow) to remove decay heat from the core following coastdown of the primary coolant pumps. When heated in the core, sodium expands, becoming less dense; when cooled in an Intermediate Heat Exchanger (IHX), sodium contracts, becoming more dense. By locating the IHXs higher than the core, this expansion and contraction can be used to establish a natural thermal driving head which would circulate sodium through the core and primary coolant system, i.e., natural circulation. Natural circulation can remove all decay heat from the core even if all three primary pony motors fail to operate for decay heat removal. Similarly, arrangement of the plant so that the steam generators are higher than the IHXs can provide sodium natural circulation in the Intermediate Heat Transport System (IHTS) to remove the decay heat from the primary sodium coolant.

The same principle can be used to take advantage of the fact that heating water yields steam which will rise from the steam generator forcing natural circulation between the steam generators and the steam drums. Similarly, rising steam and falling condensate will transport heat to the

Protected Air Cooled Condenser (PACCs) where heated air will rise to naturally cool the PACCs.

As shown in Figure 3, the components in CRBRP are arranged to provide natural circulation all the way from the core to the PACCs.

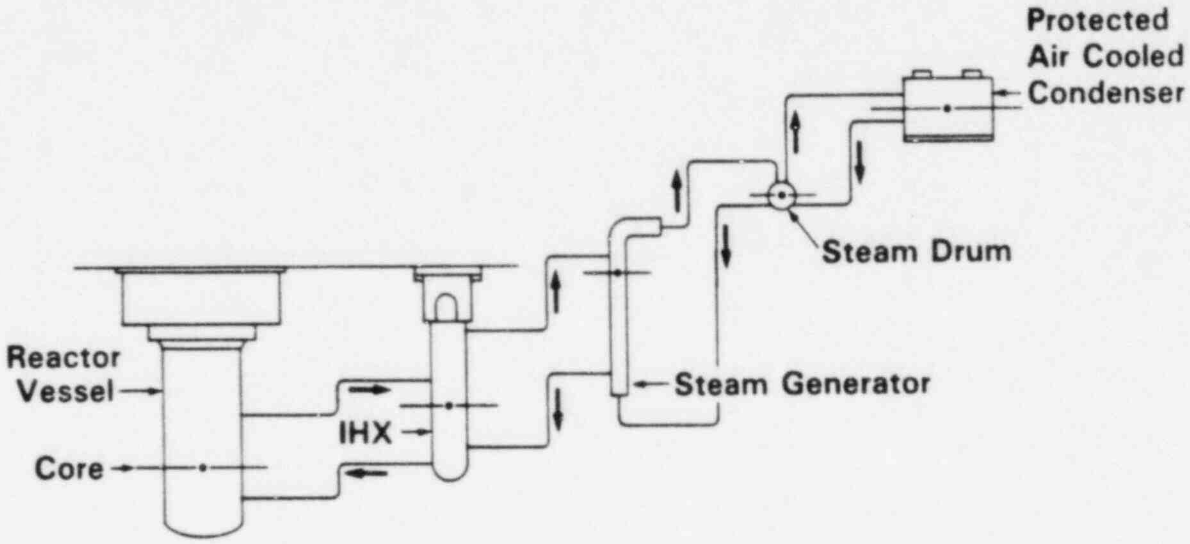

Figure 3. Elevation Differences in Major Components Provide a Natural Circulation Capability.

The capability to remove heat by natural circulation to the PACCs supplements heat removal using power relief valves and a turbine-driven auxiliary feedwater pump (TDAFWP) which are also included in CRBRP.

Q.18. How does natural circulation enhance SHRS capability relative to LWRs?

A.18. Arrangement of the plant to take advantage of the desirable inherent heat removal characteristics of sodium provides for SHRS functioning with loss of offsite power concurrent with failure of all of the emergency diesel generators. Further, the natural cooling capability of the PACCs provides the SHRS function even if the TDAFWP were to fail one hour after reactor shutdown. This gives CRBRP protection against SHRS failure due to loss of all electric power and loss of the TDAFWP. SHRS failure due to loss of all electric power and loss of the TDAFWP is a principal failure mode considered by the NRC Staff in judging the reliability of SHRS based upon LWR experience (~~D~~FSFES, Appendix J, Page J-4). Thus, natural circulation provides a passive, inherently reliable means for protection against SHRS failure and an enhanced SHRS capability relative to LWRs.

Q.19. How does the large system heat capacity enable maintenance of a large margin to sodium boiling?

A.19. The sodium coolant in the primary and intermediate heat transport systems has sufficient heat capacity to store 100 MW hr of heat while increasing the bulk sodium temperature by only 300° F. Increasing the sodium temperature 300° F from its normal bulk temperature (approximately 850° F) would not result in sodium boiling and would not result in inadequate core cooling or failure of the primary coolant boundary. As a result, a large amount of reactor decay heat can be stored in the sodium coolant itself. Even if one assumes a complete loss of heat sink (LOHS), all of the decay heat produced in the first 5 hours after reactor shutdown (about 100 MW hr) could be stored this way. If the reactor has been shutdown for a day, all the decay heat produced in the next 4 days could be stored.

Q.20. How does the large system heat capacity enhance SHRS capability relative to LWRs?

A.20. Because heat can be stored in the primary and intermediate sodium, the assumed failure of the SHRS to transport heat to an ultimate heat sink (called Loss of Heat Sink - LOHS) would not result in rapid progression to HCDA conditions. Plant operators would have a considerable period of time (at least several hours) to take corrective actions to establish or reestablish the SHRS function. In contrast, the NRC Staff's Appendix J analysis assumed that LOHS would always result in an HCDA (~~D~~FSFES, Appendix J, Page J-3), without regard for the inherent margin provided by the heat transport system heat capacity. Consequently, this design characteristic provides enhanced SHRS capability which would make the Staff's estimate on the frequency of HCDAs due to LOHS conservative.

Q.21. What conclusion have you drawn concerning the NRC Staff's estimates of the frequency of progression to HCDA conditions as a result of failure of the SHRS on demand?

A.21 The CRBRP SHRS uses the same design concepts--redundancy, diversity and independence--as are used in LWR plants. This supports the NRC Staff judgment (~~P~~FSFES, Appendix J) that the likelihood of failure of the SHRS would be no greater than that of similar LWR systems. However, there are three particular characteristics that enhance the capability of the SHRS: passive maintenance of primary coolant inventory, natural circulation, and large system heat capacity. The enhanced capability provided by these characteristics supports a conclusion that the NRC Staff's estimate of the frequency of HCDA initiation due to failure of the SHRS is conservative.

Q.22. Under Design Basis Accident conditions, how do the containment design characteristics limit the consequences and risks of accidents?

A.22. As shown in Applicants' Exhibit 1, Section 4, the Site Suitability Source Term (SSST) release envelops the consequences of the spectrum of Design Basis Accidents and includes the effects of fission products, core materials and sodium under Design Basis Accidents conditions. The limiting Design Basis Accident results in a slow pressurization of containment to maximum pressures of less than 2 psig, as compared with a design pressure of 10 psig.

Even if the design pressure (10 psig) of containment is assumed throughout the release period, the containment can be designed to limit the radiological releases for the SSST (hence, for all Design Basis Accidents) well below the dose guideline values.

Q.23. Under conditions beyond the design base, how do the containment design characteristics limit the consequences and risks of HCDAs?

A.23. Applicants' Exhibit 1, Section 3.3 showed that CRBRP can be designed so that HCDAs are beyond the design basis. Nevertheless, Applicants have included features in the design to provide additional margin for mitigation of these hypothetical accidents. As discussed in Exhibit 1, Section 5.2, these features are designed to meet the Structural Margin Beyond the Design Base (SMBDB) requirements in "Hypothetical Core Disruptive Accident Consideration in CRBRP" (CRBRP-3), Volume 1, Section 5.2 and the Thermal Margin Beyond the Design Base (TMBDB) requirements in CRBRP-3, Volume 2, Section 2.1. These features are designed to accommodate both the mechanical and thermal challenges resulting from HCDAs. As illustrated in Figure 4 below, the SMBDB requirements provide design capability to withstand an early mechanical challenge to the integrity of the reactor coolant boundary. These requirements, in turn, are designed to prevent releases of radioactivity through the primary system, including the reactor closure head, to the containment and an early (time periods on the order of seconds or minutes after initiation of an HCDA) challenge to the integrity of the Reactor Containment Building. The TMBDB requirements protect against both short term and longer term challenges to the integrity of the Reactor Containment Building resulting from the effects of whole core melting.

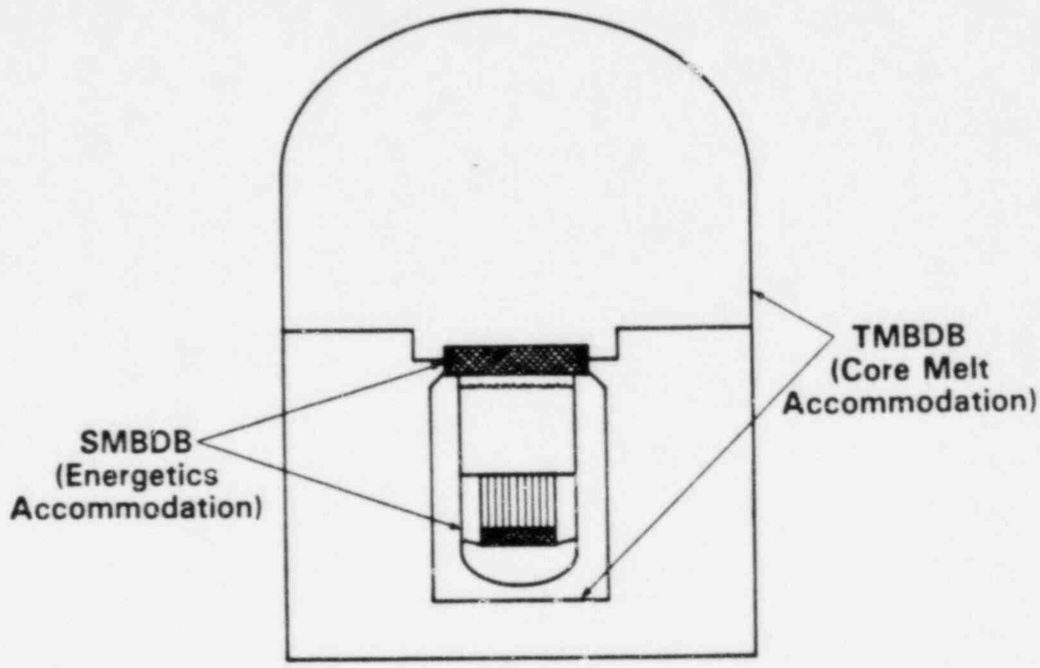

Figure 4.

Q.24. What is the significance of energetics to the risks and consequences of HCDAs?

A.24. Section 5 of Exhibit 1 showed that it is feasible to design CRBRP so that a realistic assessment of HCDA sequences, including best estimate analysis and a consideration of uncertainties, predicts a non-energetic outcome (no significant early mechanical challenge to the primary system integrity). Section 5 of Exhibit 1 also showed that pessimistic assumptions, well beyond those appropriate for a realistic assessment, must be invoked to predict an energetic outcome. Finally, Section 5 of Exhibit 1 showed that CRBRP can be designed to provide a structural margin which will accommodate the energetics predicted even in these pessimistic analyses. Significantly, substantial releases through the reactor closure head and an early challenge to containment integrity would not be predicted for any of these cases.

Q.25. What is your opinion concerning the Staff's Appendix J estimates and assumptions regarding head releases?

A.25. In Appendix J of the F~~D~~SFES, the assignment of relative probabilities and the selection of head release source terms for the primary coolant system response are judged to be conservative. The NRC estimates assume head release source terms that imply that all HCDAs would be energetic. In fact, the likelihood of an energetic outcome is very low. In Table J.2, "CDA Class 1, 2, 3 and 4", consequences have been based on a source term corresponding to either Category III or IV for the primary coolant system response. Both Categories III and IV imply an energetic HCDA (see p. J-5) and substantial head releases due to mechanical challenges. This, in turn, has biased the analyses to overestimate the source terms released to containment and the consequences of HCDAs.

Q.26. Is an energetic HCDA a nuclear explosion?

A.26. No. Even for those HCDA energetics analyses in which pessimistic assumptions have been made and an "energetic" outcome is predicted, the "energetic" result does not imply conditions at all similar to those resulting from either conventional (e.g., TNT) or nuclear explosives. A "nuclear explosion" is physically impossible in an LMFBR, just as it is physically impossible in an LWR. This can be shown by comparing the basic physical characteristics of nuclear explosives, conventional explosives and HCDAs.

Q.27. What are the basic physical characteristics of nuclear explosives?

A.27. Nuclear explosives must be designed to minimize negative reactivity feedbacks while material motions are induced to provide a super-prompt-critical condition at reactivity insertion rates greater than a million dollars per second. In that case, much of the energy release occurs in nano-seconds (billionths of a second) and results in peak pressures in the range of 5000 kilobars. Under such conditions, much of the energy can be released in the form of shock waves[2] that can produce damaging impulse loadings on surrounding structures.

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[2]Shock waves are compression waves having a discontinuity at the wave front; they are formed, for example, when the speed of a body relative to a medium exceeds that at which the medium can transmit sound.

Q.28. What are the basic physical characteristics of conventional explosives?

A.28. Conventional explosives typically have initial pressures in the range of 300 kilobars. Much of the energy release occurs in micro-seconds (millionths of a second). Again, much of the energy can be released in the form of shock waves that can produce damaging impulse loadings on surrounding structures.

Q.29. What are the basic physical characteristics of HCDAs?

A.29. An LMFBR, such as CRBRP, includes inherent prompt negative reactivity feedbacks that tend to limit any power excursions. As discussed in Q/A 9 above, the most important negative feedback mechanism is the Doppler coefficient which provides a negative feedback whenever the fuel is heated.

Although most HCDA sequences are predicted to terminate in a non-energetic manner (i.e., there is no significant early mechanical challenge to primary system integrity), for some pessimistic assumptions an energetic outcome could be predicted. In such energetic HCDAs, the reactivity insertion rates at prompt critical are typically in the range of tens of dollars per second. The energy release is limited by the inherent negative reactivity feedbacks and the movement of the fuel to regions of lower reactivity worth as a result of local pressurization. The peak pressures reached are typically less than 0.5 kilobars (approximately 7000 psi). The energy of expansion of the pressurized materials is transmitted through the primary coolant system as pressure waves traveling at sonic velocity, not as shock waves.

Q.30. How do the physical characteristics of nuclear explosions, conventional explosions and energetic HCDAs compare?

A.30. Table 1 provides representative values for characteristics of nuclear explosives, conventional explosives and energetic HCDAs. Figure 5 illustrates the most important differences in regard to pressure and energy release. Based on these comparisons, it is evident that the conditions associated with an HCDA are completely different from those associated with either conventional explosives

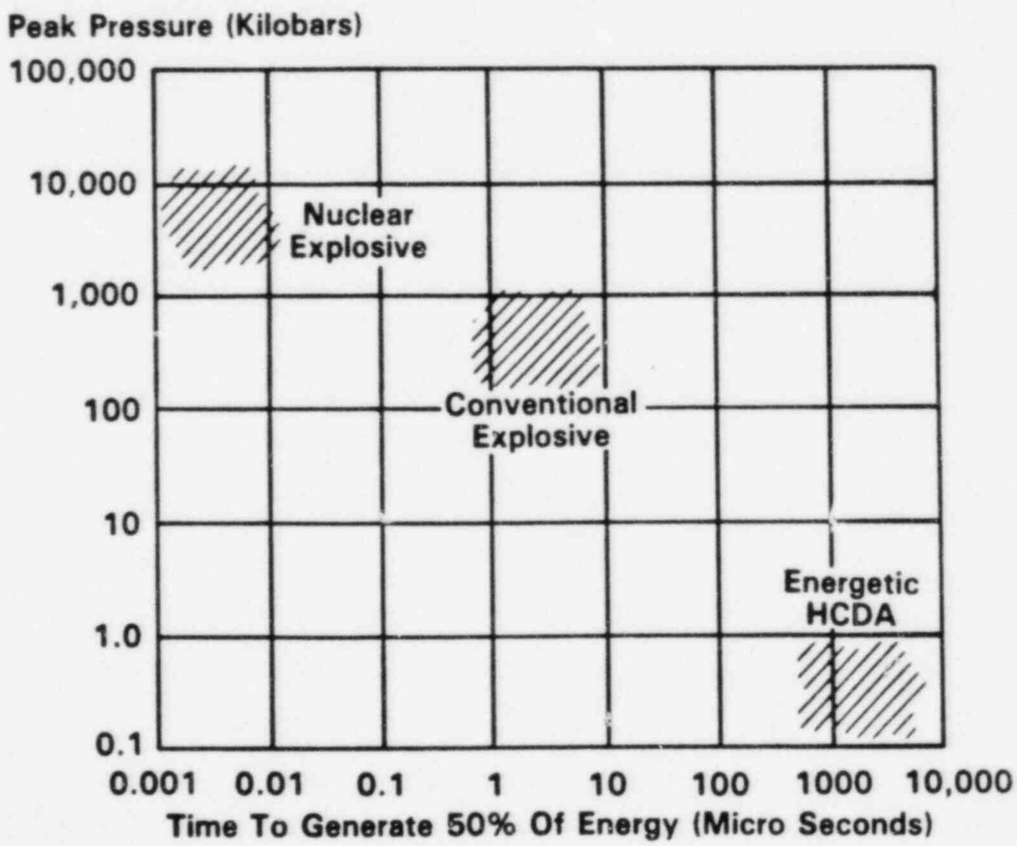

Figure 5. Nuclear and Conventional Explosive Comparison with Energetic HCDA.

	NUCLEAR EXPLOSIVE	CONVENTIONAL EXPLOSIVE	ENERGETIC HCDA
REACTIVITY INSERTION RATE ($ / Sec)	GREATER THAN 1,000,000	------------	LESS THAN 100
MAXIMUM REACTIVITY $	100 - 200	------------	Approx. 1
TERMINATION MECHANISM	EXPANSION OF MATERIAL WITH SHOCK WAVE	DEPLETION OF REACTANT	EXPANSION OF SOME FUEL WITHOUT SHOCK WAVE
TIME TO GENERATE 50% OF ENERGY (10^{-6}S)	LESS THAN 0.010	3	> 1000
TEMPERATURE (^{o}K)	50,000,000	5000	5000
PEAK PRESSURE (Kilobars)*	5,000	300	0.5
EXPANSION	MUCH GREATER THAN SONIC WITH FORMATION OF SHOCK WAVE.	GREATER THAN SONIC WITH FORMATION OF SHOCK WAVE	SONIC WITH NO SHOCK WAVE
DAMAGE MECHANISM	SHOCK WAVE LOADING	SHOCK WAVE LOADING	PRESSURE LOADING

*One Kilobar is approximately 15,000 psi.

TABLE 1 Nuclear and Conventional Explosive Comparison with Energetic HCDA or nuclear explosives and the use of the terms "nuclear explosion" or even "explosion" in relation to HCDA phenomena is simply incorrect.

Q.31. Do LMFBR accidents involve a risk associated with nuclear explosion?

A.31. No.

Q.32. How can the risk associated with whole core melting be accommodated?

A.32. As shown in Exhibit 1, Section 5.3, whole core melting is a predicted outcome of some HCDA sequences. The effects of whole core melting on containment are characterized by a slow progression and there is considerable time (on the order of a day) before operation of the plant features provided to mitigate the consequences of such accidents is required. Three types of TMBDB features are provided. Instrumentation is provided to monitor the course of the accident and to assess the degree to which the containment is challenged (by measuring temperatures, pressure and hydrogen concentration). To avoid unacceptable challenges to the containment, systems are provided to cool the containment, and to vent and purge containment to control hydrogen. In the event of the need to vent and purge, releases would be directed through a cleanup system that would remove a large fraction of the non-gaseous materials. Since the accident sequence would proceed slowly and since these TMBDB features would be operator controlled, flexibility exists to effectively manage the accident so as to minimize the accident consequences. Extensive sensitivity studies, which were summarized in Exhibit 1, Section 5.3, show that the TMBDB features can be designed for effective operation over a wide range of conditions, including much more extensive sodium-concrete reactions than have been observed experimentally, variations in material properties, and variations in accident progression paths, while ensuring that radiological consequences are acceptably low.

Q.33. What is your opinion concerning the NRC Staff's Appendix J estimates and assumptions regarding containment failure under HCDA conditions involving whole core melting?

A.33. In Appendix J of the F~~D~~SFES the NRC Staff estimated that the probability of containment failure as a result of the failure of containment mitigating systems (TMBDB features) could be as high as 10^{-2} per demand. This is judged to be conservative. The criteria for and characteristics of these features are such that the Staff's analysis overestimates the likelihood of failure. In particular:

A. The TMBDB features are being designed to the specifications and requirements associated with Safety Class 3 components and systems (CRBRP-3, Volume 2, Section 2.1.1). Redundancy is being provided for the active components. Class 1E power is being provided to these features.

B. The TMBDB features are being designed so that appropriate testing and inspection can be performed after installation and periodically (CRBRP-3, Volume 2, Section 2.1.1).

C. The active TMBDB components are located outside the Reactor Containment Building and as noted above the accident sequence is characterized by slow progression. This provides access and time for corrective actions, ensuring availability of TMBDB features when required. Maintenance could also be performed if needed after the features are brought into service.

Q.34. What is your opinion concerning the NRC Staff's Appendix J estimates and assumptions regarding releases from containment in the event of containment failure?

A.34. The predicted release of radioactive material in Appendix J of the ~~D~~FSFES is judged to be conservative for the following reasons:

A. The overpressure failure of containment was assumed to occur at a pressure of about 20 psig. This is considerably below the structural capability which can be provided. CRBRP-3, Volume 2, Table 3-10 shows representative analyses with failure pressures in the range of 35 to 45 ~~to 55~~ psig.

B. If containment failed by overpressure, it would likely be at a time in excess of the 24 hours assumed by the NRC Staff. CRBRP-3, Volume 2, Section 3 shows representative analyses with times at which venting would be required of approximately 36 hours. If actions were not taken to vent, containment failure would occur at some time in excess of 36 hours.

Q.35. What conclusions have you drawn relative to the Staff's estimates of containment failure likelihood and releases from containment?

A.35. The Staff's estimates of release from containment are based on conservative estimates of the frequency of head releases. These estimates are conservative because they are based on assumptions which imply that all HCDAs are energetic. By contrast, an energetic HCDA is judged to be of low likelihood. In addition, the Staff has made a conservative estimate of the likelihood of containment failure by overpressure. Thus, the Staff's estimated frequencies of head releases and releases due to overpressure failure are conservative.

Q.36. What conclusion have you drawn concerning the consequences of beyond design basis events in CRBRP?

A.36. As indicated in Section 5.3 of Applicants' Exhibit 1, atmospheric releases from HCDAs are characterized by radiological dose consequences that are acceptably low. Moreover, these consequences are relatively insensitive to a range of initial releases of material through the reactor vessel closure head seals and because of the effectiveness of the cleanup system, these consequences are insensitive to containment vent times over a range of times between about 10 and 36 hours. Furthermore, the analyses in Section 5.3 of Applicants' Exhibit 1 show that CRBRP can be designed so that the conservatively analyzed radioactivity releases compare favorably to WASH-1400 values for similar beyond the design base events in LWRs.

Q.37. How does a more realistic calculation of the effects of CRBRP releases impact the resultant doses and the comparison of the CRBRP releases with LWR releases under similar beyond design basis conditions?

A.37. Repeating the calculations in Section 5.3 of Exhibit 1, but using meteorological data from PSAR Section 2.3 (Amendment 65), the current (heterogeneous) core design (PSAR Amendment 51), ICRP-30 models for bone surface (Endosteal cells) and red bone marrow (NUREG/CR-0150, Vol. 3), and a more realistic calculation of gas sparging (carryout of fuel along with the gas that bubbles through the pool)[3],

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3This considered a) a more realistic temperature for the pool; 4500° F rather than 5000°F, and b) dilution of the PuO_2 by the molten concrete.

the radiological consequences can be compared in the following tables:

DOSE SUMMARY FOR HYPOTHETICAL ACCIDENT SCENARIOS CONSIDERED (Rem)

	Organ	Case 1	Case 2	Case 3	Case 4
Exclusion Boundary (2 Hour)	Bone Surface	0.027	0.19	6.47	27.0
	Red Bone Marrow	0.026	0.040	0.56	2.18
	Liver	0.052	0.060	0.44	1.21
	Lung	0.021	0.032	0.72	1.77
	Thyroid	0.014	0.020	23.4	19.6
	W. Body	0.81	0.82	1.09	1.21

	Organ	Case 1	Case 2	Case 3	Case 4
Low Population Zone (30 day)	Bone Surface	0.92	0.95	2.45	6.07
	Red Bone Marrow	0.19	0.19	0.27	0.56
	Liver	0.36	0.36	0.18	0.32
	Lung	1.54	1.55	0.82	1.00
	Thyroid	85.3	85.4	8.13	5.43
	W. Body	2.10	2.09	1.73	1.65

COMPARISON OF RADIONUCLIDE RELEASES TO ATMOSPHERE FOR CRBRP WITH LWRs FOR A COMPARABLE MELTDOWN SCENARIO

Radioactivity Released (curies)

Element	CRBRP	PWR (3)	BWR (3)
Xe-Kr	3.6×10^{7}	1.0×10^{8}	2.1×10^{8}
I	2.1×10^{5}	2.0×10^{6}	1.1×10^{6}
Cs, Rb	5.2×10^{1}	1.2×10^{4}	7.6×10^{4}
Te, Sb	4.8×10^{4}	2.2×10^{5}	8.6×10^{5}
Ba, Sr	7.5×10^{2}	3.3×10^{4}	2.2×10^{5}
Ru(1)	2.8×10^{3}	3.9×10^{4}	3.3×10^{5}
La(2)	4.1×10^{3}	2.9×10^{4}	2.9×10^{5}

(1) Includes: Ru, Rh, Co, Mo, Tc

(2) Includes: U, La, Zr, Nb, Ce, Pr, Nd, Np, Pu, Am, Cm

(3) From WASH-1400, Appendix VI, Calculation of Reactor Accident Consequences, October 1975. The LWR scenarios used for comparison here are PWR-6 and BWR-4 described in Section 2 of WASH-1400, Appendix VI.

Q.38. What conclusions have you drawn concerning the risks associated with beyond design basis events in CRBRP?

A.38. It is feasible to design CRBRP so that the risks of beyond design basis events are similar to those for LWRs.

Q.39. What conclusions have you drawn concerning the NRC Staff's analysis in Appendix J?

A.39. The Staff's analysis presented in Appendix J is conservative in three ways: First, the frequency of failure of both the RSS and SHRS are overestimated. Thus, the frequency of initiation of an HCDA is also overestimated. Second, the radiological source associated with each of the HCDA classes (defined in Table J-2) is based on a head release (primary system failure category III or IV). This assumption, which implies that all HCDAs are energetic, leads to an overestimate of the frequency with which such releases would contribute to accident consequences. Third, the frequency of failure of containment due to overpressure is overestimated. Thus, the frequency of release due to HCDAs leading to overpressure failure is overestimated. Overall, the risk due to HCDAs as estimated by the Staff in Appendix J is conservative, with the greatest conservatism in HCDA classes 2, 3, and 4 which involve the larger releases.

Q.40. What accident conditions are appropriate for evaluation of the impacts of CRBRP accidents upon the Y-12 and Oak Ridge Gaseous Diffusion Plants?

A.40. To assess the potential impacts of accidents on the Y-12 and Oak Ridge Gaseous Diffusion (K-25) plants, the Site Suitability Source Term (SSST) is the appropriate starting point since, as shown in Applicants' Exhibit 1, Section 4.1, this source term bounds all accidents considered credible.

Q/A 37 presented the results of Applicants' analyses for four HCDA cases which considered a wide range of releases of radioactive material through the reactor vessel closure head. All of those cases also considered whole core melting, reactor vessel and guard vessel penetration, sodium-concrete reactions and melting of the core materials into the concrete. Of the four cases analyzed, the highest radiological releases were associated with Case 2, and this case has been selected for additional evaluation of the impacts of CRBRP accidents on Y-12 and K-25.

In assessing the impacts on Y-12 and K-25, it is not appropriate to combine the already low likelihood HCDA sequence with other independent failures (such as failure of the containment isolation system or failure of the TMBDB mitigating features). Even if the combinations of such failures were considered, the risk from such cases would be comparable to that from Applicants' Case 2, which has been used to assess the potential impacts of HCDAs on Y-12 and K-25. Although the consequences of the combined failures would be higher than Applicants' Case 2, this would be offset by the lower likelihood of such sequences. This can be seen by examining the results in Table J.2 of the ~~D~~FSFES. Estimated probabilities and consequences are provided by the NRC Staff for CDA Classes 1 through 4. CDA Class 1 does not include the combination of other failures with the CDA. CDA Classes 2, 3 and 4 do include such combinations. By multiplying the Staff's estimated probability for each Class by the Staff's calculated consequences (radiological release) for that Class, a measure of relative risk of each of the Staff's four Classes of events is obtained. The following table shows the products, normalized to the Staff's CDA Class 1.

RELATIVE RISK FROM CDA CLASSES IN TABLE J.2

CDA	Containment	Isotope Group						
Class	Failure Mode	Xe-Kr	I	Cs-Rb	Te-Sb	Ba-Sr	Ru	La
1	None	1.00	1.0	1.0	1.0	1.0	1.0	1.0
2	Overpressure	0.01	1.0	1.0	0.6	0.6	0.8	0.8
3	Isolation	0.01	1.3	1.3	0.8	0.8	0.6	0.6
4	Isolation	0.001	0.4	0.4	0.2	0.2	0.4	0.4

Based on this comparison, it is concluded that the NRC Staff's CDA Class 1, which has no containment failures combined with the CDA, provides a representative risk for all four of the Staff's CDA classes. Applicants' Case 2 involves containment conditions consistent with the Staff's CDA Class 1 and results in the greatest consequences of the four HCDA cases analyzed by the Applicants in Section 5.3 of Exhibit 1 and in Q/A 37 above. Consequently, the Applicants' Case 2 is an appropriate case, in terms of representative risk, to assess potential impacts of HCDAs on the Y-12 and K-25 plants.

STATEMENT OF QUALIFICATIONS

George H. Clare
Westinghouse Advanced Reactors Division
Oak Ridge, Tennessee 37830

From 1980 to the present I have served as Manager of Licensing at Westinghouse - Oak Ridge (CRBRP), with responsibility for managing assessment of CRBRP designs and the preparation of licensing material. These activities include consideration of features to prevent accidents, features to mitigate Design Basis Accidents, and margins to mitigate hypothetical core disruptive accidents.

I received a Bachelor of Science in Engineering Physics from Cornell University in 1972 and a Master of Engineering (Nuclear) from Cornell University in 1974.

After receiving my degrees I joined Westinghouse Electric Corporation as an Engineer at the Advanced Reactors Division. Between 1974 and 1979 my position changed from Engineer to Senior Engineer. I was involved in licensing, safety analysis, and systems integration activities for the Clinch River Breeder Reactor Plant.

From 1979 to 1980, I served as Westinghouse Representative at the Fast Reactor Safety Technology Management Center at Argonne National Laboratory. There I participated in the management of activities in the Fast Reactor Safety Base Technology Program. This included monitoring and integration of safety research and development activities of DOE contractors throughout the US.

I am a member of the American Nuclear Society.

STATEMENT OF QUALIFICATIONS

L. Walter Deitrich
Associate Director
Reactor Analysis and Safety Division
Argonne National Laboratory
Argonne, Illinois 60439

In 1980, I became Associate Director, Reactor Analysis and Safety Division, Argonne National Laboratory. My responsibility includes technical direction and administrative guidance of the fuel behavior and accident analysis activities, including phenomenology and code development related to LMFBR HCDAs. In addition, I have responsibility for analysis and phenomenology activities for LWRs.

I received a Bachelor of Mechanical Engineering degree from Cornell University in 1961, a Master of Science degree in Mechanical Engineering from Rensselaer Polytechnic Institute in 1963, and a Doctor of Philosophy degree in Mechanical Engineering from Stanford University in 1969.

Following graduation from Cornell, I joined the General Electric Company, Knolls Atomic Power Laboratory, as Engineer -- Thermal-Hydraulic Design, in which position I remained until 1964, when I left to enter graduate school at Stanford.

I joined Argonne National Laboratory in 1969 as an Assistant Mechanical Engineer in the Reactor Physics Division. I was assigned as a Lead Experimenter in the In-pile Experiments Section, with responsibility for preparation, execution and analysis of TREAT experiments on behavior of fast reactor fuel under accident conditions. In 1970, this program was transferred to the newly formed Reactor Analysis and Safety Division (RAS).

In 1972, I was promoted to Mechanical Engineer and assigned as Group Leader -- Analysis, In-pile Experiments Section. My responsibilities included leading a group responsible for analysis and reporting of TREAT experiments simulating loss-of-flow and transient overpower HCDAs.

From 1974 to 1979, I served as Manager of the Fuel Behavior Section in RAS, with responsibility for modeling of fuel behavior and related phenomenological studies and code development.

From 1979 to 1980, I served as Special Assistant to the Associate Laboratory Director for Engineering Research and Development, providing technical assistance in management and direction of the reactor development programs at ANL.

I was promoted to Senior Mechanical Engineer in 1982.

I am a member of the American Socity of Mechanical Engineers, the American Nuclear Society, and Sigma Xi.

STATEMENT OF QUALIFICATIONS

Lee E. Strawbridge
Manager, Nuclear Safety and Licensing
Westinghouse Advanced Reactors Division
Madison, Pennsylvania 15663

Since 1980, I have been Manager, Nuclear Safety and Licensing with responsibility for directing safety analyses and licensing activities performed at the Westinghouse Advanced Reactors Division, Waltz Mill site for CRBRP and other nuclear projects.

I received a Bachelor of Science degree in Electrical Engineering from Pennsylvania State University in 1958 and a Master of Science degree in Nuclear Engineering from Massachusetts Institute of Technology in 1959.

Following graduation from M.I.T., I joined Westinghouse Electric Corporation in 1959 as a Scientist in the Atomic Power Division and was in the position of Senior Scientist from 1962 to 1964. In these positions, I performed nuclear design analysis for Pressurized Water Reactors and a wide range of advanced reactor concepts including thermal, epi-thermal and fast reactors.

From 1964 to 1966, I was Manager of Nuclear Development with responsibility for developing analytic techniques and applying them to the nuclear analysis of Pressurized Water Reactors and advanced reactors concepts. This included conceptual nuclear design analyses of a modular 1000 MWe LMFBR.

Upon formation of the Westinghouse Advanced Reactors Division in 1966, I was named Manager of Nuclear Development, with responsibility for all nuclear design analyses within the division. This consisted totally of work on sodium cooled fast reactors. I continued in this position until 1968.

From 1968 to 1971, I was Manager of FFTF Nuclear Design, with responsibility for the nuclear analysis and nuclear design of the Fast Flux Test Facility.

From 1971 to 1974, I was Manager of LMFBR Safety and Licensing, with responsibility for the safety and licensing activities associated with the LMFBR Project Definition Phase, which formed the basis for the Westinghouse proposal for CRBRP. The conceptual design activities for CRBRP were completed during this period and the initial specification of structural margin beyond the design base loads was made.

From 1974 to 1976, I was Manager of Safety Analysis with responsibility for directing many of the safety analyses reported in the CRBRP Environmental Report and the Preliminary Safety Analysis Report. In addition, safety analyses were performed and substantial input was provided to the FFTF Final Safety Analysis Report.

From 1976 to 1980, I was Manager of CRBRP Margin Analysis and Design, with responsibility for directing the analyses of hypothetical core disruptive accidents. This included the specification of structural and thermal margin requirements to mitigate the consequences of accidents beyond the design base and the preparation and submittal to NRC of the document CRBRP-3, "Hypothetical Core Disruptive Accident Considerations in CRBRP."

I am a Professional Engineer, registered in the Commonwealth of Pennsylvania since 1967.

A Exh 47

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UNITED STATES OF AMERICA

NUCLEAR REGULATORY COMMISSION

In the Matter of UNITED STATES DEPARTMENT OF ENERGY PROJECT MANAGEMENT CORPORATION TENNESSEE VALLEY AUTHORITY (Clinch River Breeder Reactor Plant)	Docket No. 50-537

APPLICANT'S DIRECT TESTIMONY

CONCERNING NRDC

CONTENTION 5(b)

Dated: November 1, 1982

Q.1. Please state your names and affiliations.

A.1. My name is H. Wayne Hibbitts. I am Chief, Safety and Environmental Branch, Public Safety Division, Clinch River Breeder Reactor Plant Project Office.

Q.2. Have you prepared statements of your professional qualifications?

A.2. Yes. A copy is attached in this testimony.

Q.3. What subject matter does this testimony address?

A.3. NRDC Contention 5b) alleges the following:

Neither Applicants nor Staff have established that the site selected for the CRBR provides adequate protection for public health and safety, the environment, national security, and national energy supplies; and an alternative site would be preferable for the following reasons:

b) Since the gaseous diffusion plant, other proposed energy fuel cycle facilities, the Y-12 plant and the Oak Ridge National Laboratory are in close proximity to the site an accident at the CRBR could result in the long term evacuation of those facilities. Long term evacuation of those facilities would result in unacceptable risks to the national security and the national energy supply.

Q.4. Would you describe the facilities in the vicinity of the CRBRP?

A.4. The major facilities in the vicinity of the CRBRP are as follows:

Oak Ridge Gaseous Diffusion Plant, ORGDP - This facility's primary role is to enrich uranium for commercial power reactors. In addition, development work is conducted on advanced isotope separation technologies. Development of these technologies is also intended for meeting future enriched uranium requirements for power reactors. ORGDP's plant population of approximately 4400 is about evenly split between these two functions.

Y-12 Plant - This is a major facility within the Department of Energy's nuclear weapons production complex. The plant produces components and subassemblies in support of the production of nuclear weapons delivered by DOE to the Department of Defense. The plant also produces components used in the nuclear weapons development and testing programs carried out by the three DOE nuclear weapons design laboratories. The plant population is about 7300, including about 1200 ORNL employees, who work primarily in biological and fusion research, and corporate staff.

Oak Ridge National Laboratory, ORNL - ORNL is a multifunctional research and development facility located about 4-5 miles from CRBRP whose basic mission is the discovery of new knowledge, both basic and applied, in all areas related to energy. To accomplish this mission the laboratory conducts research in many fields of modern science and technology. The Laboratory's facilities consist of nuclear reactors, chemical pilot plants, research laboratories, radioisotope production laboratories, and support facilities. About 4200 employees work at the ORNL site. Since ORNL is a research and development, rather than a production, facility, its temporary loss would not significantly impact national security or national energy supply.

No "other" proposed fuel cycle facilities have been identified in the vicinity of the site which are significantly related to national energy supply or national security.

Q.5. In general terms, what analyses were performed and what conclusions were drawn concerning the impact of accidents on these facilities?

A.5. In order to assess the impact of design basis accidents on DOE facility operations, the

Applicants first conducted an assessment of the effects on these facilities using site suitability source term (SSST) radiation dose calculations. As previously shown in Applicants' testimony concerning NRDC Contentions 1, 2, and 3, dated August 16, 1982, the consequences of the SSST release are more severe than the consequences of any design basis accident (DBA) involving a release of fuel and fission products from the core to the containment. The SSST thus provides a reasonable bound on the effects of CRBRP accidents upon the facilities of interest. This assessment, which is discussed more fully below, shows that neither national energy supply nor national security would be adversely affected by CRBRP accidents.

In order to provide an additional measure of the risks of CRBRP accidents on the facilities in question, the Applicants also calculated dose and ground deposition data at the three DOE Oak Ridge plant locations assuming a hypothetical core disruptive accident (HCDA), as well as the SSST. The HCDA chosen for evaluation was HCDA Case 2 as described in Applicants' Exhibit 1, Section 5.3. Applicants' testimony concerning NRDC Contentions

2d), f), g), h), 3c) and 3d) (Environmental Effects) and 5b) provides the rationale for selection of this case and shows that the consequences associated with this case provide a reasonable representation of the risks of CRBRP accidents that are beyond the design base upon the DOE facilities in question.

Q.6. What meteorological data were used and what assumptions were made in performing these calculations?

A.6. Both sets of calculations used meterological data that were collected and reduced in accordance with NRC regulatory guides. The SSST utilized sector specific 5% meteorology and the HCDA 50% (X/Q values that are exceeded no more than 5% and 50% of the total time). For both SSST and HCDA cases, almost all of the release of fission products occurs during the first few days. For the HCDA case an additional small quantity of core particulates (plutonium dominating) is projected to be released over an approximately six-month period under the calculational assumption that containment venting and purging is continuous.

Q.7. Based on the assessments performed, what is the effect of an accident on the ORGDP for the SSST release?

A.7. Due to their close proximity (about 2.5-3.5 miles) to CRBRP, nonessential personnel at the ORGDP would likely be evacuated should an SSST release occur. About 65 persons are projected to remain onsite to provide security, emergency support, and operational capability to continue production operations. Should it be desired, the enrichment cascade can be placed in an operational standby condition in less than one hour. This condition would involve recycling the gaseous uranium within the process equipment with no uranium being fed into or withdrawn from the cascade.

Those personnel remaining onsite would receive radiation doses much less than DOE occupational standards. Actual doses would be lower than those shown (Table 1) due to such factors as time of occupancy, the use of respiratory protection, possible use of potassium iodide as a thyroid blocking agent and reduced exposure rates to personnel working indoors.

TABLE 1

Estimated Doses and Deposition at ORGDP Due to Site Suitability Source Term Release[1]

rem (% - DOE Annual Occupational Standard)[2]

	Whole Body	Lung	Bone Surface	Thyroid	Liver	Red Bone Marrow
Inhalation	.021(.42)	.39(2.6)	1.3(8.7)	.51(3.4)	.78(5.2)	.098(2.0)
Immersion	.041(.82)	.036(.24)	.064(.43)	.044(.29)	.031(.21)	.059(1.2)
Ground Contamination	.034(.68)	(total deposition 54 uCi/m^2)				
		(plutonium deposition 7.7 x 10^{-3} uCi/m^2)				

Residual contamination (Table 1) would be sufficiently low to require only limited

1 A 7-day release period is assumed for purposes of establishing ground contamination levels including radionuclide decay. Source terms were for a 30-day release. Doses are 50-year dose commitments.

2 DOE 5480.1 Chapter XI. These percentages are shown for reference purposes only.

decontamination of selected plant areas. The major constitutents of deposited radionuclides are the shortlived I-131 (half-life = 8.5 days) and Np-239 (half-life = 2.3 days). Transuranics are well below the EPA proposed screening level guideline for restricted versus unrestricted land surfaces (0.2 uCi/m^2)[3].

Q.8. What is the effect of an accident at the Y-12 facility for the SSST release?

A.8. The Y-12 Plant is located further from the CRBRP (about 9-11 miles) than the ORGDP (about 2.5-3.5 miles), so that calculated SSST doses and deposition are much lower at Y-12 (Table 2) than those at the ORGDP site. As a result, evacuation of the plant site would not be likely, but simply an available option. Should evacuation of non-essential personnel be instituted, about 250 workers would remain onsite. This Y-12 Plant work force is necessary to maintain security and utility requirements. In contrast to the situation at the ORGDP where only a few people can keep the enrichment cascade operating, any need for large scale evacuation would shut down production operations during the short time duration of the

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3 EPA-520/5-77-016, September 1977.

release. The small radiation doses and the limited radionuclide deposition, however, show that this would not be required. Should evacuation be instituted, it would be for a short term and curtailment of operations would not significantly impact production schedules.

TABLE 2

Estimated Doses and Deposition at the Y-12 Plant
Due to Site Suitability Source Term Release
rem (%DOE Annual Occupational Standard)

	Whole Body	Lung	Bone Surface	Thyroid	Liver	Red Bone Marrow
Inhalation	.0013(.026)	.024(.16)	.08(.53)	.031(.21)	.048(.32)	.006(.12)
Immersion	.0025 (.05)	.0022 (.015)	.0039 (.026)	.0027 (.018)	.0019 (.013)	.0036 (.072)
Ground Contamination	.0021(.042)	(total deposition 3.3 uCi/m^2) (plutonium deposition 4.7×10^{-4} uCi/m^2)				

Q.9. Based on the assessments performed, what would be the effects of an HCDA on the Y-12 plant and the ORGDP during the period of initial release of radiation?

A.9. Due to the greater consequences of the HCDA relative to the SSST it is assumed that nonessential personnel from both the ORGDP and Y-12 Plant would not be expected to work for the first few days. The essential personnel operating condition described earlier for these plants would be in effect. Due to the higher radiation exposure levels at the Y-12 Plant (versus the SSST case) protective measures such as those described for the ORGDP might be implemented by those personnel remaining onsite and radiation doses actually received would be smaller than those calculated. Calculated radiation doses and radionuclide deposition (Table 3) from the initial HCDA release would not greatly exceed those calculated for the SSST case. Thus, the conclusions previously drawn (i.e., no significant effects upon Y-12 or ORGDP production) for the SSST case would also apply to the HCDA during the period of initial release.

TABLE 3

Estimated Doses and Deposition Due to Hypothetical Core Disruptive Accident - Presodium Boildry Phase[4]

rem (% DOE Annual Occupational Standard)

	Whole Body	Lung	Bone Surface	Thyroid	Liver	Red Bone Marrow
Inhalation						
2.5mi (ORGDP)	.019(.38)	.49(3.3)	.18(1.2)	7.0(47)	.13(.87)	.028(.56)
9.0mi (Y-12)	.0035(.07)	.091(.61)	.033(.22)	1.3(8.7)	.025(.17)	.0052(.10)
Immersion						
2.5mi (ORGDP)	.086(1.7)	.07(.47)	.13(.87)	.091(.61)	.065(.43)	.13(2.6)

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[4] A 7-day release period is assumed for purposes of establishing ground contamination levels including radionuclide decay. Source terms used were for a 30-day release. Doses are 50-year dose commitments.

9.0mi (Y-12)	.016(.32)	.013(.087)	.025(.17)	.017(.11)	.012(.08)	.024(.48)

Ground Contamination

2.5mi (ORGDP)	.026(.52)	(total deposition 47 uCi/m^2) (plutonium deposition 1.8×10^{-3} uCi/m^2)
9.0mi (Y-12)	.0049(.098)	(total deposition 8.7 uCi/m^2) (plutonium deposition 3.4×10^{-4} uCi/m^2)

Q.10. What would be the long term effects of an HCDA on the ORGDP and the Y-12 Plant?

A.10. Radiation doses and radionuclide deposition (Table 4) at the ORGDP and the Y-12 Plant are calculated to be low. Production levels at each site should be unaffected by the postulated long term release due the HCDA.

TABLE 4

Estimated Doses and Deposition at the ORGDP Due to Hypothetical Core Disruptive Accident Release Post Boildry Phase[5]

rem (% DOE Annual Occupational Standard)

Inhalation	Lung	Bone Surface	Liver	Red Marrow
2.5mi(ORGDP)	.0021(.014)	.029(.19)	.0059(.039)	.0023(.046)
9.0mi(Y-12)	.00036(.0024)	.0049(.032)	.00096(.0064)	.00037(.0074)

Ground Deposition (plutonium)

2.5mi(ORGDP) 3.7×10^{-4} uCi/m^2

9.0mi(Y-12) 6.1×10^{-5} uCi/m^2

Q.11. Will there be any significant impact on national energy supply in the event production were curtailed at ORDGP during the ECDA release?

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5 The release period is 6 months. Doses are 50-year dose commitments.

A.11. In the unlikely event that it were decided to curtail production activities at the ORGDP during the release, the impact on national energy supply is not projected to be significant. In the time frame of CRBRP operation, it is projected that the ORGDP will represent about 18% of the US enrichment capacity while demand is not expected to be high enough to require the use of that capacity. Present plans call for utilization of the much more energy efficient Gas Centrifuge Enrichment Plant, GCEP, which is being built in Portsmouth, Ohio to eventually replace gaseous diffusion capacity.

Q.12. What is your conclusion regarding Contention 5b)?

A.12. The risk from the CRBRP to the DOE facilities in the vicinity of the site is low, long term evacuation is unlikely, and the Applicants' conclusion concerning either the suitability of the Clinch River Site or the environmental effects of accidents are not affected by the presence of these facilities.

STATEMENT OF QUALIFICATIONS

Name: H. Wayne Hibbitts

Education: B. A. Physics 1963, University of South Florida

M. S. Physics 1966, Vanderbilt University (AEC Health Physics Fellowship)

Work Experience: May 1982 to present - Chief, Safety and Environmental Branch, Public Safety Division, CRBRP/PO, U.S. DOE, Oak Ridge, TN

October 1980 to May 1982 - Emergency Preparedness Director, Safety and Environmental Control Division, Oak Ridge Operations Office, U.S. DOE

August 1970 to October 1980 - Environmental Health Physicist, Safety and Environmental Control Division, ORO, USAEC/ERDA/DOE

June 1968 to August 1970 - Occupational Health Physicist, Safety and Environmental Control Division, ORO, USAEC

September 1965 to June 1968 - Occupational Health Physicist, Oak Ridge National Laboratory, Union Carbide Corporation--Nuclear Division

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JUDGE MILLER: Now, is the Staff ready?

MR. SWANSON: Yes, we are.

JUDGE MILLER: Very well. You may proceed.

DIRECT EXAMINATION

BY MR. SWANSON:

Q The first order of business is for the witnesses to identify themselves for the record and indicate their position and affiliation, please.

JUDGE MILLER: Very well.

BY MR. SWANSON:

Q Starting with Dr. Morris.

MS. FINAMORE: Judge Miller.

JUDGE MILLER: Yes.

MS. FINAMORE: You had earlier asked me if we had any objections to Exhibit 47. If I may just make a record, the bases are the same and they relate to the four tables on Page 8, 11, 13, 14 and 15.

JUDGE MILLER: The ruling will be the same on Exhibit 47.

Now, I think you gentlemen were identifying yourselves for the record.

WITNESS MORRIS: My name is Bill Morris. I am Section Leader of the Clinch River Breeder Reactor Program Office, NRC.

WITNESS RUMBLE: My name is Edmund Rumble.

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I work for Science Applications, Incorporated. I am providing technical assistance to the NRC on CRBRP.

WITNESS THADANI: My name is Mohan Thadani. I am Project Manager in Office of Nuclear Reactor Regulations.

WITNESS HULMAN: My name is Lewis Hulman. I am Chief of the Accident Evaluation Branch at NRC.

WITNESS LONG: My name is John Long. I am in the Reactor Systems Branch at NRC and I am assigned, part time, to the CRBR Project Office in NRC.

WITNESS SWIFT: My name is Jerry Swift. I work for the Nuclear Breeder Reactor Program Office of NRC.

JUDGE MILLER: All right.

BY MR. SWANSON:

Q Gentlemen, I refer you to a document entitled NRC Staff Testimony of Bill M. Morris, Jerry J. Swift, John K. Long, Edmund T. Rumble, III, Mohan C. Thadani, Lewis G. Hulman, on Intervenors' Contention 2 and its subparts, 2(c), 2(d), 2(f), 2(g) and 2(h) and Contention 3 and its subparts 3(c) and 3(d) and ask if that document was prepared by you?

BY WITNESS MORRIS:

A Yes.

BY WITNESS SWIFT:

A. Yes.

BY WITNESS LONG:

A. Yes.

BY WITNESS RUMBLE:

A. Yes.

BY WITNESS THADANI:

A. Yes.

BY WITNESS HULMAN:

A. Yes.

Q. Are there any corrections to that document?

BY WITNESS MORRIS:

A. No.

BY WITNESS SWIFT:

A. No.

BY WITNESS LONG:

A. No.

BY WITNESS RUMBLE:

A. No.

BY WITNESS THADANI:

A. No.

BY WITNESS HULMAN:

A. No.

Q. Is it your testimony that this document is true and accurate, then, to the best of your knowledge

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and belief?

BY WITNESS MORRIS:

A. Yes.

BY WITNESS SWIFT:

A. Yes.

BY WITNESS LONG:

A. Yes.

BY WITNESS RUMBLE:

A. Yes.

BY WITNESS THADANI:

A. Yes.

BY WITNESS HULMAN:

A. Yes.

MR. SWANSON: I would ask then, the Board to identify the document that I just referred to, which is dated 11-1-82, as Staff Exhibit 17.

JUDGE MILLER: It may be so marked for identification.

(Staff Exhibit No. 17 was marked for identification.)

MR. SWANSON: And before turning the panel over for cross-examination, I would just make the following offer, that Dr. Morris is the principal spokesman for the panel if there are general questions and that Dr. Morris, Dr. Rumble, Dr. Swift and Dr. Long, by virtue of their education,training and experience are qualified to testify on subjects of accident analysis, in general and, specifically, in the areas of initiation of accidents, probability of occurence and that Messrs. Holman and Thadani are prepared, again, and qualified to testify in the area of the consequences of these accidents, given the accident sequences postulated by the first four gentlemen.

So, if there are any clarifications or corrections to that by the panel, please speak up, but that's the general offer and given that, the panel is available for cross-examination.

JUDGE MILLER: Any corrections? I assume not.

Now, I think we'll have the Applicants cross-examine so that the Intervenors then will have the totality of it and we will then impose the usual limitations on both redirect and recross.

You may proceed.

CROSS-EXAMINATION

BY MR. EDGAR:

Q Referring to Page 13, there are two concepts on Q and A 13. The first is CDA initiation frequency from flow blockage and then the other concept is the loss of heat sync frequency.

In terms of flow blockage and propogation of local fuel failures, has the Staff developed specific criteria or general design criteria for application to the fuel failure propogation issue?

BY WITNESS MORRIS:

A Yes. We have now developed a criterion that will be included among the principal design criteria, that if it's derivative from some of the criteria that were originally transmitted to the Applicant in the May 6th letter, of 1976, from Denise to Caffey, stating that one of the measures to be included in the design, would be one to prevent propogation of fuel failures and that's been developed into a principal design criterion and there are others, more specific criteria that will be reflected in the NRC in the appropriate chapter.

Q Referring you to Page 15, what is the Staff Exhibit No. -- I lost the number --

JUDGE MILLER: Seventeen.

BY MR. EDGAR:

Q Of Staff Exhibit 17. Now, there is discussion of the annulus cooling or invent-purge system.

In regard to these features, what assumptions did the Staff make in its Appendix J analysis concerning the availability and the operation of these mitigating systems, after CDA initiation?

BY WITNESS RUMBLE:

A. On Appendix J, we developed four CA accident classes and in the first class, these systems, vent-purge systems and annulus cooling systems, were not called upon until 24 hours.

In Classes 2, 3 and 4, these systems were not called upon at all.

Q. So if you had a sequence of events from either Class 1, 2, 3 or 4 and you coupled it with loss of off-site power, with respect to the Appendix J conclusions, would the assumption of off-site power change any of your conclusions in regard to the effectiveness or affect the mitigating systems?

BY WITNESS RUMBLE:

A. The answer is no for Classes 2, 3 an 4.

Q. Now, in regard to Class 1, correct me if I'm wrong or let me just clarify --

You indicated that in Class 1 you assumed that the mitigating systems weren't available for 24 hours.

BY WITNESS RUMBLE:

A. That's correct.

Q. After initiation of the event.

So that assuming they weren't available, if you add the assumption of loss of off-site power during that 24-hour period, would you change any of your Appendix J

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conclusions?

BY WITNESS RUMBLE:

A. I am having trouble with that question. I'm trying to understand what you're talking about.

Q. Okay. Let me --

You've got, during the first 24 hours, you're not -- is it true that you are, in fact, assuming that the mitigating systems are not available for operation in the first 24 hours?

BY WITNESS RUMBLE:

A. That's correct.

Q. And is it true that the mitigating systems may be dependent on the -- on off-site power?

BY WITNESS RUMBLE:

A. Yes.

Q. So that if you assumed no off-site power, you can't affect the assumptions or analysis you made with respect to Class 1 during that 24 hour period; is that correct?

BY WITNESS RUMBLE:

A. During that 24 hour period, that's correct.

Q. Okay.

That the loss of off-site power doesn't lead to more severe consequences during the first 24 hour period, than that which you've calculated in Class 1?

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BY WITNESS RUMBLE:

A. That's correct.

Q. In regard to the fuel power pump failure propogation issue that we just discussed, what base of experience or studies did the Staff rely on in coming to its Appendix J conclusions in that respect?

BY WITNESS MORRIS:

A. In our response to our question 11, we have indicated a number of the features that are anticipated for a reactor of the general size and type of Clinch River, employing sodium as a coolant and features that have been generally incorporated in such reactors.

Those are enumerated here in this response. And this expectation of the kinds of systems that would be included and the kinds of design features that would be included, led us to believe that fuel failure propogation leading to CDA is very unlikely and its only a small fraction of those other contributors that we have already identified.

Q. If I could refer you to Q and A 12, which talks about the loss of coolant accident and the bounding of the loss of coolant initiation frequency by the loss of heat sync frequency and the specific question is; is your analysis or your set of conclusions on loss of coolant accident based strictly on fracture mechanics

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principles or is there additional information or considerations which lead you to that conclusion/

B Y WITNESS MORRIS:

A. Well, in our response, A. 12, we've given several reasons.

Fracture mechanics is not particularly one of the major reasons that we've used -- there are a number of things that go into that consideration.

Pre-service and in-service inspection. The detection system. Use of guard vessels and the elevated piping. All of those lead us to believe it's unlikely that a large leak will occur.

Or, that even if it does occur , that it could lead to uncovery of the core and, so, there's a number of factors that went into that decision.

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BY MR. EDGAR:

Q Referring you to Page 15, Q and A 15 and 16, the discussion of the containment failure frequency -- or given certain containment modes, could you describe the base of experience that the Staff has, given this knowledge of technology, to arrive at these conclusions with regard to containment failure.

BY WITNESS MORRIS:

A First, let me indicate that the containment systems, especially the containment isolation function, that we anticipate at Clinch River would be very similar to those at light water reactors.

The system will be subjected to the same design criteria as light water reactors. This is the general background with which we evaluate the Clinch River design.

Mr. Rumble may have some more detailed ...

BY WITNESS RUMBLE:

A Well, I think adding to what Dr. Morris said, using these facts and studies done on modern containment isolation systems, a number of studies, including WASH-1400, helped us to form the basis of our judgment for the unavailability of the containment isolation system upon demand.

Q Referring you to Page 9, Q and A 10, discussion of loss of heat sink events. Is feedwater reliability the sole factor behind the Staff's conclusions on loss of heat sink?

BY WITNESS RUMBLE:

A. No, it isn't.

Q. Why is -- Well, is in your judgment feedwater reliability a major factor in that judgment?

BY WITNESS RUMBLE:

A. Well, maybe I should clarify what we mean by feedwater reliability. Typically when we look at a -- the unavailability calculation for a system, such as the feedwater system -- auxiliary feedwater system in this case, you not only are talking about the front-line parts of the system, the pumps, these protected condensate storage tanks, etc., but also service systems and support systems that are needed to make that system work.

That's one point.

But, in general, in looking at loss of heat sink accidents, one of the first systems that's called upon -- and indeed after TMI, automatically called upon -- is the auxiliary feed system.

So this is a very important system regarding loss of heat sink accidents in LWRs and in this plant also. This system is called upon in the case of loss of main feed.

So from that point of view, it's an important system.

But there are other systems -- for example, DHRS -- in this plant which is also available.

Q. What is the DHRS?

BY WITNESS RUMBLE:

A. Well, the direct heat removal system is that fourth path that we discussed yesterday, which involves piping off the reactor vessel, includes heat -- pumps and heat exchangers and airblast heat exchangers to remove decay heat.

Q. Okay. Referring to Page 43 of Staff Exhibit 17 -- I'll just address these questions to the panel, but if there's a specific panel member who has the information.

There is discussion of the assumptions that the Staff made in regard to evacuation and the analysis -- the analytical assumptions. Implicit in that -- Well, let me ask.

Does the Staff believe that there is adequate medical treatment or medical capability for supportive treatment in the event of a severe accident; and if so, why?

BY WITNESS THADANI:

A. Our analysis showed that we do not expect a large number of people to be exposed to sufficiently large doses that would require a large number of beds in the medical facilities.

We feel that the number of beds will be more than adequate, in the event of an accident.

Q What, if any, role did the document CRBRP-1 play in the Staff's Appendix J analysis?

BY WITNESS MORRIS:

A. We did not rely on CRBRP-1 to form the analysis. I think most of the values for accident initiation were derived from broad experience, either in LWRs or from an examination of the redundancy and diversity and independence that we anticipated for the design features.

Others may have made a reliance, I don't know.

Q If any other panel member has anything to add, please do so.

BY WITNESS RUMBLE:

A. No.

MR. EDGAR: We have no further questions.

MS. FINAMORE: I'd like to begin with a few voir dire questions to Mr. Rumble.

MR. SWANSON: Just for the record, it's Dr. Rumble.

MS. FINAMORE: Excuse me.

JUDGE MILLER: Well, for the record how many doctors do we have?

MR. SWANSCN: We've got four. We've got them on the extremes, two on one side, two on the other.

VOIR DIRE

BY MS. FINAMORE:

Q. Dr. Rumble, would you please explain the extent of your participation in Appendix J?

BY WITNESS RUMBLE:

A. I was involved with the Staff on Appendix J. I helped with the assessment of the frequencies of the CDAs. I helped with the analysis of the source terms, with writing the text and reviewing it.

I think that's ... I participated in those functions.

Q. Did you participate in any way in the discussion of the consequences of HCDAs?

BY WITNESS RUMBLE:

A. I provided with others input -- Mr. Thadani for the CRACK code which was used to calculate the consequences of the four CDA classes that we defined.

Q. Am I correct then that you were involved in providing the probabilities for Categories 1 through 4 on Page J.6?

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BY WITNESS RUMBLE:

A. Could you ask that question again?

Q. There are some probabilities indicated on Page J.6 for Categories 1 through 4 of HCDA accidents --

BY WITNESS RUMBLE:

A. Yes.

Q. -- did you provide those numbers?

BY WITNESS RUMBLE:

A. I participated in the analysis which led to their evaluation to these frequencies, as we have called them -- bounding estimates, frequencies.

Q. Did you provide the probability numbers for containment failures on Page J.7?

BY WITNESS RUMBLE:

A. I guess the word bothers me, "did I provide," like, you know, I opened up a box and out it popped. I worked on the assessment. I worked on the analysis of these numbers with the Staff. I mean ...

Q. Did you suggest these numbers to the Staff?

BY WITNESS RUMBLE:

A. I think it was an iterative process, and I don't remember exactly who suggested what to who at this point. My recollection is I -- I mean I think that it was an iterative process. I'll stop there. I don't know what I suggested first and, you know, in exactly what order things were suggested.

But I don't think the final number here was the one that was first put on the table. I mean the first number we got was iterative, as most of these kinds of analysis are.

Q. Did you provide the numbers concerning the probability of failure of the shutdown systems in Appendix J?

BY WITNESS RUMBLE:

A. In that case I was the primary person involved with the shutdown system. I would say -- and the other people can -- I think I did most of the work on the shutdown system.

Q. Would you also say you were a primary contributor to the other two probabilities I mentioned?

BY WITNESS RUMBLE:

A. The other two probabilities you mentioned. I don't know --

Q. Containment failure and probability of energetic CDAs.

BY WITNESS RUMBLE:

A. I would say containment failure, I was one of three or four people.

Energetic CDAs, I was one of two or three people that participated in the evaluation of those

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frequencies.

Q Did you also provide information for the probabilities regarding the failure of the shutdown heat removal system in Appendix J?

BY WITNESS RUMBLE:

A Yes, I provided information regarding those frequencies.

Q And when you said you provided input to the CRACK code, which specific input are you referring to?

BY WITNESS RUMBLE:

A Well, it's the information on Table J.2 on Staff's -- the Supplement, Page J-8, the release fractions, various isotope release groups, plus the frequencies of these releases.

In addition, there are other inputs, and they have to do with the duration and initiation of these releases and the energy content of these releases and the height of the releases.

This was done in concert with Mr. Thadani.

Q Were you involved in preparation of Table J.4, Page J-13?

BY WITNESS RUMBLE:

A No, I was not.

Q When did you start working on Appendix J?

/

BY WITNESS RUMBLE:

A. I don't remember the exact date. It was in the summertime -- I think, you know, June 21 being the beginning of summer -- June or July. I'd have to get my diary. You know, I don't remember the exact date.

Q. And when did you complete work on Appendix J?

BY WITNESS RUMBLE:

A. I'm presently still working. I mean, your definition of --

Q. Complete work on -- When did you complete work on the Draft Supplement of Appendix J?

BY WITNESS RUMBLE:

A. The draft was completed, I would say, roughly two weeks after -- three weeks after I started work. I'd have to -- I don't have those exact dates in my mind. Something like that.

Less than a month for sure, on the draft.

JUDGE MILLER: When was the draft filed? Do you recall?

WITNESS THADANI: July.

MR. EDGAR: July 19th.

BY MS. FINAMORE:

Q. Did you participate in any significant changes to the draft, if any?

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BY WITNESS RUMBLE:

A. I did participate from July to the present in reviewing and updating the draft where necessary. As far as significant changes, I don't think I participated in any significant changes.

Q. Do you know if there were any significant changes to Appendix J between the draft and final versions?

BY WITNESS RUMBLE:

A. As far as changes that would affect the conclusions of the thing, I would say there was not any significant changes.

Q. Am I correct that you work in the Palo Alto office of SAI?

BY WITNESS RUMBLE:

A. Yes, I still do.

Q. And that you are a vice president of SAI?

BY WITNESS RUMBLE:

A. Corporate vice president of SAI.

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bm

BY MS. FINAMORE:

Q I would like to read the titles of a number of documents to you and ask if they were, in fact, relied upon by you in any way in your preparation of Appendix J, if I may.

I can show these to you, as I read them off, if you prefer.

BY WITNESS RUMBLE:

A I don't know what they are, so I can't answer that yet.

MS. FINAMORE: May I approach the witness?

JUDGE MILLER: Yes.

BY MS. FINAMORE:

Q All of these documents are published by Science Applications, Incorporated. I believe they are all from the Palo Alto office.

The first one is entitled "Fault Trees for the Clinch River Breeder Reactor Plant Protective System," November 1977, No. SAI-066-77-PA.

This document is approximately an inch thick. I don't know how many pages.

The second document --

JUDGE MILLER: Let him identify it, if that is your purpose.

/

BY MS. FINAMORE:

Q Are you familiar with this document?

BY WITNESS RUMBLE:

A. No.

JUDGE MILLER: If we're going to refer -- other than the title, as you've just done, we're going to have to have them marked for identification so the record will reflect what we're talking about.

WITNESS RUMBLE: No, I'm not familiar with that document.

JUDGE MILLER: Do you intend to pursue it any further?

If so, mark it for identification.

MS. FINAMORE: Yes.

Which Intervenor number are we up to?

THE REPORTER: 15 is the next number.

MR. EDGAR: Are we going to get copies of these, if they're marked for identification?

MR. SWANSON: Yes. The Staff was going to request a copy.

JUDGE MILLER: Yes, you're entitled.

MR. SWANSON: -- if there's going to be any further discussion on it.

MS. FINAMORE: Fine.

/

(Intervenors' Exhibit No. 15
was marked for identification.)

BY MS. FINAMORE:

Q. The authors of Intervenors' Exhibit 15 are F. L. Leverenz, L-e-v-e-r-e-n-z, and D. E. Leaver, L-e-a-v-e-r.

Do you know these people, Dr. Rumble?

BY WITNESS RUMBLE:

A. Yes, I do.

Q. Are they currently employed in the SAI, Palo Alto office?

BY WITNESS RUMBLE:

A. No, they're not.

Q. Can you tell me when they left the office?

BY WITNESS RUMBLE:

A. Fred Leverenz left approximately 1980. And Mr. Leaver left, I think, in early '81 is my recollection.

Q. How long have you been employed at the Palo Alto office?

BY WITNESS RUMBLE:

A. Since August 1974.

Q. So you were in -- Am I correct to assume that you were in the Palo Alto office at the time this document was published?

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BY WITNESS RUMBLE:

A. I was working out of the Palo Alto office when the document was published.

Q. Do you know which particular section of your office these people were in at the time?

BY WITNESS RUMBLE:

A. Our office has undergone a number of reorganizations since then. 1977 is the date of this document, November. It would take some time to remember back the number of organizational changes we made to figure -- I guess I can't answer that right now.

They were not in the organization that I was in charge of at that time in November 1977.

Q. Can you tell me what portions of the organization you are in charge of?

BY WITNESS RUMBLE:

A. Well, right now I'm in charge of the Palo Alto office presently.

But at that time I was in charge of an LWR fuel rod modeling group in the period of 1977.

Q. How long have you been president of the Palo Alto office?

BY WITNESS RUMBLE:

A. Oh, well, it's just manager, not --

JUDGE MILLER: Well, what's your title? I

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thought you were a corporate vice president of Science Applications, Inc. Is that your present title?

WITNESS RUMBLE: That's my present title, yes, sir.

JUDGE MILLER: Okay. And what's your title, if it's a different one, in the Palo Alto office?

WITNESS RUMBLE: Well, we just very recently are undergoing another organizational change. On February 1 I will be the manager of an operation in the Palo Alto office, which is comprised of three divisions.

We're in a transition period right now. I report to an executive vice president in LaJolla, and we're in this transition phase.

JUDGE MILLER: While in transition, what, if anything, do you by virtue of your various titles have to do with the Clinch River Breeder Reactor Project program, in any aspect?

I'm just trying to get your relationship.

WITNESS RUMBLE: The only -- At the present time this project is the only interface I have with the Clinch River program.

BY MS. FINAMORE:

Q How about at the previous times? What involvement have you had with the Clinch River Breeder Reactor Program?

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BY WITNESS RUMBLE:

A. Yes. During the initial phases of the probabilistic risk assessment which was started in 1976 or 1977 -- in that time frame, I participated in the planning and development of some of the methodology for probabilistic risk assessment that was performed, which is now CRBRP-1.

But very soon after that project started, I moved on to this LWR fuel rod modeling project, and Mr. Leaver, whose name is on that report, took over my position on the PRA.

Q. Would you explain for the record what CRBRP-1 is?

BY WITNESS RUMBLE:

A. It's a report -- document, describing a risk assessment of Clinch River.

JUDGE MILLER: Which document now is that? Oh, I'm sorry. I thought you were referring to a document.

WITNESS RUMBLE: Yes, I was referring to -- The question was: Can I describe what CRBRP-1 is?

JUDGE MILLER: Oh, I see.

WITNESS RUMBLE: That was my answer.

BY MS. FINAMORE:

Q. And in the Palo Alto office, are there others who are involved in the Clinch River Breeder Reactor

Plant Project, other than in the Appendix J analysis?

BY WITNESS RUMBLE:

A. The answer to that is no at this present time.

Q. Isn't it true that the Palo Alto office of Science Applications, Incorporated is presently involved or plans to be involved in the preparation of the Applicants' probabilistic risk assessment?

MR. SWANSON: Objection. That was just asked and answered. He said they're not currently involved in any Clinch River activities, other than involvement in Appendix J. That was the prior answer.

JUDGE MILLER: Well, he can answer again. This is a specific question.

WITNESS RUMBLE: That's correct. This -- You're right there.

There are plans for people in the Palo Alto office to act -- to provide technical help to the NRC in reviewing the Applicants' PRA that they're now performing.

That would be an NRC function -- I mean, performed for the NRC.

That's right. But that work has not started to any extent yet.

BY MS. FINAMORE:

Q. And does this work on Applicants' PRA involve any work performed for the Applicants?

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BY WITNESS RUMBLE:

A. No. It would be for the NRC.

JUDGE MILLER: Under a separate contract?

WITNESS RUMBLE: We have a fairly large contract with the NRC. It would be on a task ordering format, and it would be another task on that contract.

JUDGE MILLER: What was the nature of your relationship to the Applicants for the work that you have done -- or that your company has done for the Applicants?

WITNESS RUMBLE: You're talking about the first PRA -- the CRBRP-1?

JUDGE MILLER: I assume that's what it is. I know -- I think there were about three.

WITNESS RUMBLE: There's the one in 1977. There's one going on now. They're separate.

As far as I know, our company has no relationship with the present one.

The one in 1977, we performed -- the company performed a major part of that.

JUDGE MILLER: Was that for ERDA?

WITNESS RUMBLE: That was -- I do not know how the contracting was arranged, either through Westinghouse or DOE or what at that time. I do not know.

JUDGE MILLER: There wasn't any DOE then. I know that.

WITNESS RUMBLE: Then it wasn't DOE. It was ERDA.

JUDGE MILLER: That's why I suggested ERDA possibly --

WITNESS RUMBLE: It could have been ERDA possibly.

JUDGE MILLER: Well, let's just get the record straight without any confusion.

Why don't you start at the very beginning of the relationship, in terms of work performed by your company, first for the Applicants. Give me the date, the nature of the work, the title of the end product, if there was one. Go through the present time.

Then do the same thing for NRC, so we'll have it all in one place.

MS. FINAMORE: If I may add one point.

JUDGE MILLER: Yes.

MS. FINAMORE: I'd like him to respond to all the work for all the SAI offices, not just the Palo Alto office.

I believe there's one in Sunnyvale as well.

JUDGE MILLER: Well, Sunnyvale is very close to Palo Alto.

MS. FINAMORE: Yes. And I think both should be included.

JUDGE MILLER: I didn't think he was going to exclude it. Were you going to exclude anything? Mountain View, San Jose --

WITNESS RUMBLE: There are something like 4000 employees in SAI and somewhere around 80 offices. I do not have at my disposal now enough information to really in this situation testify regarding all of these offices from the period 1975 through 1982.

Again, I spent a lot of my time in LWR research and was not even aware of what was going on Clinch River-wise in the company, up until -- you know -- 1980, for example, from 1977 to 1980.

JUDGE MILLER: Where would such information be available? Clinch River and its contract with your company, I assume, are available someplace.

WITNESS RUMBLE: They would be available, and it would have to be a corporate type entity that would have this kind of information.

JUDGE MILLER: How big is your company?

WITNESS RUMBLE: $300 million per year, 4000-employee company.

JUDGE MILLER: Located essentially in the California area?

WITNESS RUMBLE: Its two major offices are in McLean, Virginia and LaJolla, California.

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There are about 1000 people in McLean, Virginia.

JUDGE MILLER: Well, how close are you going to be able to come in telling us what work has been done -- I don't care about the contracts now, but if you can furnish them -- regarding the Clinch River Project, either for the Applicants, ERDA and its successor, DOE, or NRC?

WITNESS RUMBLE: Well, I know for sure that we've done the -- we've had a major role in the Clinch River probabilistic risk assessment that was performed in the 1977 time frame.

That's one we've done. We've also had other studies that were done of more of a generic nature in the Department of Energy's or ERDA's base program --

JUDGE MILLER: "Pace"?

WITNESS RUMBLE: "Base." Their base program, their base research program, that was funded either by Westinghouse or General Electric.

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JUDGE MILLER: Do you know what kind of research or consultation generally was performed under that aspect?

WITNESS RUMBLE: Yes. Some of it was post-accident analysis after a core melt accident, analyzing containment response of a generic type of a fast reactor to look at containment failure and --

JUDGE MILLER: Was that fast breeder reactor?

WITNESS RUMBLE: Fast breeder reactor.

JUDGE MILLER: Not lightwater?

WITNESS RUMBLE: Fast breeder reactor. I'm just trying to stick to fast breeder technology here.

I think there have been other studies done for vendors such as Westinghouse and General Electric regarding Clinch River, but I don't have those, the topics of those studies.

JUDGE MILLER: I see.

MS. FINAMORE: I have a 1982 Progress Report on the Clinch River Breeder Reactor Plant Project in front of me.

JUDGE MILLER: Who put it out? Who is responsible for it?

MS. FINAMORE: I believe this was the Breeder Reactor Corporation.

JUDGE MILLER: Who is the Breeder Reactor Corporation?

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MS. FINAMORE: Am I correct that this was put out by the Breeder Reactor Corporation, to your knowledge?

MR. EDGAR: I have no idea.

MS. FINAMORE: Breeder Reactor Corporation is -- I believe it's -- oh, here it is, Page 23.

JUDGE MILLER: What is it they say, success has many fathers; failure is an orphan.

Would anybody claim paternity for this thing?

MS. FINAMORE: The BRC is a consortium of 750 electric utilities that are providing funding to the Clinch River Breeder Reactor Project.

JUDGE MILLER: Okay, thank you.

DR. COCHRAN: I picked the document up at the Breeder Reactor Project Office, if that's any help.

JUDGE MILLER: We'll let you identify whatever we can't otherwise, Dr. Cochran. Stand by.

BY MS. FINAMORE:

Q On Page 21 of this document there's a list of companies and project employment, and it includes Science Applications, Incorporated, Sunnyvale Office, ten employees.

Also, on Page 22 of that document there's an entry for Science Applications, Incorporated, McClain, Virginia, Office, two employees.

Did I read that correctly, Dr. Rumble?

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BY WITNESS RUMBLE:

A. Yes.

Q. Do you have any basis for disagreeing with those numbers?

BY WITNESS RUMBLE:

A. I don't have any basis for disagreeing or agreeing with them. I assume they are okay.

It would be useful to know what time frame this document --

Q. This is the 1982 Progress Report.

BY WITNESS RUMBLE:

A. The question I have is whether these are projects that were performed or are underway. I don't understand.

JUDGE MILLER: By whom?

WITNESS RUMBLE: By Science Applications and other vendors. They have a big table here of companies that are working on the project.

JUDGE MILLER: I haven't seen the document, but what I'm wondering is, what do you think it is?

Dr. Rumble, what does it appear to be?

WITNESS RUMBLE: Well, for example, the Sunnyvale Office is, as far as I know, not working on the Clinch River Project at all right now, so I --

JUDGE MILLER: That's your company's Sunnyvale

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office?

WITNESS RUMBLE: Science Applications at Sunnyvale, our Sunnyvale office is not presently performing Clinch River work.

JUDGE MILLER: Does that brochure purport to at least intimate the Sunnyvale office is performing work connected with Clinch River?

WITNESS RUMBLE: It indicates that we have ten employees from the Sunnyvale office working on the project, and I don't think there are even ten employees right now in Sunnyvale --

JUDGE MILLER: Let alone --

WITNESS RUMBLE: -- total, let alone working on Clinch River.

JUDGE MILLER: There seems to be a certain lack of foundation for this document, whatever it is. It's a pleasant looking brochure, but I'm concerned about what it shows.

Now when you read things off and you say, "Is that what it shows," minimally, of course, the witness was certifying both your literacy and your integrity as to which there's no question.

But beyond that, it doesn't say very much for the record. I think we're going to have to do a little bit better to make it meaningful.

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MS. FINAMORE: Well, this seems to me to indicate, at least as a preliminary matter, and maybe it can serve just to refresh the recollection of the witness, that there are employees of Science Application, Incorporated, at the present time who are performing work for Applicants on the Clinch River Breeder Reactor Project.

JUDGE MILLER: That sure isn't true of Sunnyvale, apparently.

He doesn't even think they have the ten employees, or whatever it is, at Sunnyvale, and if they were there, whatever number, he doesn't think they are doing any work on the Clinch River.

So that comes up to a double zero for your purposes, I believe, or zero squared, as Judge Linenberger reminds us.

I'll tell you what. Let's take an hour for lunch and then let's regroup and find out just what information is productive, because remember now, you set this schedule, you three parties, and we agreed to it.

(Whereupon, at 12:30 p.m., the hearing recessed, to reconvene at 1:30 p.m., the same day.)

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AFTERNOON SESSION

1:30 P.M.

JUDGE MILLER: All right.

Are we ready to resume cross-examination of the panel?

MS. FINAMORE: Yes.

I have a few more questions on voir dire, if we can move through this quickly.

BY MS. FINAMORE:

Q. Dr. Rumble, you mentioned earlier that the SAI is presently conducting research for the LMFBR base program; is that correct?

BY WITNESS RUMBLE:

A. No, that was in the past tense.

We previously did work on the base program.

Q. When was that?

BY WITNESS RUMBLE:

A. 1978. Perhaps as late as 1980, in that time frame, I would say.

Q. And what did that consist of, briefly?

BY WITNESS RUMBLE:

A. These are a number of small tasks. Typically these were done for subcontractors, such as General Electric.

I can recall one task which was post accident analysis of an LMFBR containment following a core melt event.

To really develop a model of the containment after a vessel meltthrough.

Q Now, would you consider that as useful input on a probabilistic risk assessment of the Clinch River Breeder Reactor Plant?

BY WITNESS RUMBLE:

A. Well, that project didn't use specific design features of Clinch River Plant. It was a generic assessment of sensitivity information.

For example, looking at the affect of vessel meltthrough time on containment processes -- more of the physics of the situation, from the point of view of base knowledge, it's useful information.

As far as base knowledge, but you can't rely on anything in that work because it wasn't specific to the Clinch River Plant.

Q Dr. Rumble, do you recall haveing a conversation with Dr. Cochran in July of this year concerning Appendix J?

BY WITNESS RUMBLE:

A. Yes.

Q And do you recall being asked about how you derived some of the probability figures in Appendix J?

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BY WITNESS RUMBLE:

A. Yes.

Q. And do you recall being asked what you relied upon for the proability of -- or your estimate of core degradation frequency 10^{-4} reactor year due to loss of heat sync events?

BY WITNESS RUMBLE:

A. I know we discussed that matter. I don't think I was -- my recollection is that I was asked what I relied upon.

I certainly -- during that conversation talked -- I don't think I felt like I was on a witness stand at the time. I tried to discuss the matter but I didn't feel like I needed to answer the question fully or whatever.

So, your question to me was, was I asked about relying upon something to get these frequences. I don't recollect the word "relying" coming up in our conversation.

Q. I'd like to read to you a couple of sentences from a document entitled Memorandum to Files, from T.V. Cochran, dated July 27, 1982.

MR. SWANSON: Objection.

Well, were you about to read it?

MS. FINAMORE: Yes.

MR. SWANSON: We don't have a foundation for what this document is, how it was prepared.

Objection is lack of foundation, thus far. Liability.

JUDGE MILLER: That's true.

Sustained.

MS. FINAMORE: I'd like to put Dr. Cochran on the stand to establish the foundation of the document; if I may.

JUDGE MILLER: It isn't your turn. You'd be out of order. It isn't your turn to put on your case. You will put Dr. Cochran on what, I think shortly or following some panel. He's scheduled but you can't just ring off somebody else's witnesses.

MS. FINAMORE: Well, I'd like to use it as the basis for -- If this is the purpose of voir dire, I won't be able to get back to Mr. Rumble afterwards.

JUDGE MILLER: That could be true.

You could go now to opposing Counsel and attempted to secure a stipulation on foundation.

MR. SWANSON: There's no problem in asking the witness what his position is, of his own knowledge. What he relied on, this, that and the other thing, I don't understand what the problem is.

JUDGE MILLER: The problem is obviously attempted impeachment.

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That's a horse of a different color.

MR. SWANSON: That's right. Thus far, we don't have any basis for asking admissable questions from the document at this time.

JUDGE MILLER: That's very true.

Proceed.

MS. FINAMORE: Well, I'd like to possibly use it then to refresh the witness' recollection of the phone conversation. He says he doesn't recollect what he was asked.

MR. SWANSON: He said he recollected what he said. He said he doesn't think the word"rely" was used. That's his testimony.

JUDGE MILLER: That is what he testified.

MS. FINAMORE: Well, I would like to use this to see if I can refresh his recollection, since he didn't quite recall.

JUDGE MILLER:Well, how are you going to refresh it when he says he didn't.

MS. FINAMORE: He says he didn't recall.

JUDGE MILLER: You've asked him. You got an answer. You've got the record.

MS. FINAMORE: He said he couldn't recall. If I could refresh his recollection, he might recall.

JUDGE MILLER: I don't know how you're going

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to refresh it with a memorandum of some kind, apparently, which has not been in handled in the way of an impeaching document.

You know what the rules are for impeachment.

MS. FINAMORE: Well, I would like to show it to the witness to see if it accurately reflects the substance of the conversation.

JUDGE MILLER: Any objection?

MR. SWANSON: Objection. Same basis.

JUDGE MILLER: It is sustained, then.

MS. FINAMORE: Well, I'd like to get a stipulation from the parties as to the foundation for the document.

JUDGE MILLER: That's something that you do usually out of the presence of a tribunal and it's -- does anybody feel disposed to stipulate?

(No response.)

JUDGE MILLER: I don't see any dispostions.

MR. EDGAR: I have the read document and I am not disposed to stipulate.

JUDGE MILLER: You have read the document?

MR. EDGAR: Yes, I have.

MR. SWANSON: I have not seen it.

JUDGE MILLER: There is no willingness to stipulate, Ms. Finamore, so there is nothing more that I can do for you in that department.

MS. FINAMORE: Well, I'd just like to request permission to put Dr. Cochran on the stand for two minutes to establish the foundation for the document, then we can return --

JUDGE MILLER: Any objection?

MR. SWANSON: Yes, I object.

JUDGE MILLER: And I sustain the objection. We have orderly procedures that are established both by our own regulations and by those Rules of Practice which govern Courts or adjudicatory bodies.

You can't interrupt someone else's case and put on something of your own. There's no procedure that permits that, Ms. Finamore.

This is the Applicants -- I mean, the Staff's case now.

MS. FINAMORE: I would like to request permission to have Dr. Rumble return to the stand afterwards, so we can go ahead with the impeachment document.

MR. SWANSON: I think this is just a substitute for discovery. That the Intervenors just didn't bother to go forward with.

To my knowledge, I don't think Dr. Rumble or the Staff was ever asked specifically the question that

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was asked before that, about reliance on CRBRP-1. There was certainly plenty of time for written interrogatories or otherwise to ask these questions.

Now, isn't the time to establish discovery materials for the purpose of impeaching witnesses.

JUDGE MILLER: Well, the witness has testified under oath as to what he recalls or doesn't recall and --

MR. SWANSON: That is correct.

JUDGE MILLER: -- he has not testified that he has relied upon the document in question. In fact, he stated that he didn't.

MR. SWANSON: That's right.

JUDGE MILLER: That's the state of the record. We can't twist his arm.

MS. FINAMORE: I would like to be afforded the opportunity to at least show this document to the witness in order to refresh his recollection. He said he did not recall whether a particular word was used or a particular question was asked.

JUDGE MILLER: My memory was he said he didn't say he relied upon it. Isn't that --

What did you testify?

WITNESS RUMBLE: I don't remember exactly what I testified but --

JUDGE MILLER: In substance.

WITNESS RUMBLE: In substance, in my answers during that discussion with Dr. Cochran, I never intended to say that I relied upon a specific document.

JUDGE MILLER: Well, did you say that or not?

WITNESS RUMBLE: I don't remember saying that.

JUDGE MILLER: Well, could you have said it and not remember it?

WITNESS RUMBLE: That's a possibility.

But I don't think so.

JUDGE MILLER: Well, go ahead.

There's nothing more you can do. The witness' testimony is there and this is your problem of proof.

Go ahead.

MS. FINAMORE: He said he didn't remember.

JUDGE MILLER: That's correct.

MS. FINAMORE: I'd like to be able to refresh his recollection.

JUDGE MILLER: How are you going to refresh his recollection?

MS. FINAMORE: I would like to show him this document.

JUDGE MILLER: That document is not an admissable document. That's a self-serving paper prepared by an expert witness in other functions of this case, Dr. Cochran; isn't it?

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MS. FINAMORE: Well, it's my understanding that anything can be used --

JUDGE MILLER: Well, is that correct so far? Just yes or no. Prepared by Dr. Cochran?

MS. FINAMORE: It's prepared by Dr. Cochran.

JUDGE MILLER: Okay.

MS. FINAMORE: It is my understanding that anything can be used to refresh recollection. It need not be an admissable document in and of itself.

JUDGE MILLER: I think you're wrong.

I'm ruling that you're wrong in that.

MS. FINAMORE: That I cannot use it to refresh his recollection?

JUDGE MILLER: That's right.

It's got nothing to do with it.

MS. FINAMORE: Okay.

JUDGE MILLER: He's got nothing to do with the document. The document is in the nature of self-serving. It's by a person who is a witness, who also has to interrogate us or were Dr. Cochran, we'd grant him permission, as a matter of fact, to appear and argue Thursday.

So, therefore, -- well it is just not admissable. It's just not proper. It's contrary to the Rules of Evidence. We have to follow our Rules of

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Evidence.

BY MS. FINAMORE:

Q Dr. Rumble, do you recall whether you were asked what the basis for your LOHS probability estimate was?

BY WITNESS RUMBLE:

A I know we discussed the LOHS frequency. I don't know how the specific question was asked and I don't remember my specific answer.

Q What was the basis for your LOHS frequency estimate?

BY WITNESS RUMBLE:

A First of all, I would like to point out that there is no such thing as "my personal LOHS frequency estimate". That, as I said before, was interactive, team effort to derive an LOHS frequency.

That's the first point.

The second point is that, in our testimony we discuss the LOHS frequency and its basis and I should start there and describe what that basis is.

Q Which documents did you rely upon?

JUDGE MILLER: What was the question, now? What's the pending question?

MS. FINAMORE: Which documents did you rely upon for your estimate of LOHS frequency?

WITNESS RUMBLE: I don't -- I didn't rely on any documents.

BY MS. FINAMORE:

Q Didn't you rely on CRBR -- wasn't CRBRP-1 a basis for your LOHS frequency estimate?

In part.

BY WITNESS RUMBLE:

A CRBRP-1 is a piece of information. I have read the document and have formed some background information that I have in my mind. It did not form the basis for these numbers.

JUDGE MILLER: You say it did not form the basis --

WITNESS RUMBLE: Did not form the basis. I did not rely on that document. There are traps in that document --

JUDGE MILLER: Now, wait a minute.

If you didn't rely on it, that's all you were asked. You have testified in effect, no.

Next question.

BY MS. FINAMORE:

Q What documents formed the basis for your conditional frequency estimate for primary system failure category 4, which is 0.1 per CDA?

BY WITNESS RUMBLE:

A. There are no documents that form the basis for that estimate.

Q. Did you use CRBRP-1 in any way in deriving that conditional frequency?

BY WITNESS RUMBLE:

A. The --

JUDGE MILLER: First of all, did you or did you not, use it in any way to arrive at that particular conclusion?

Let's have the answer first, then see whether an explanation is required or not.

You can say yes; you can say no; you can say 'I don't know'.

WITNESS RUMBLE: Yes.

JUDGE MILLER: He takes that option. Yes.

MS. FINAMORE: May I approach the witness?

JUDGE MILLER: Yes.

Have you shown these documents to opposing Counsel?

MR. SWANSON: No.

JUDGE MILLER: It is the primary obligation of Counsel before showing any document to any witness, to be sure that in advance and prior to that, you have shown it to opposing Counsel.

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This is an ABC of trial practice, and I have mentioned it to you, Ms. Finamore.

MS. FINAMORE: I'm willing to show it to them right now.

JUDGE MILLER: You better bundle up and show them everything you want to show right now, that you are going to try to use with the witness and this is standard procedure. You always must do this in any trial.

MS. FINAMORE: I could mark these for identification right now. It might speed up things to --

JUDGE MILLER: Yes. They will have to be marked for identification so the record will reflect what they are.

Now, your next one in order was 15. Have you already marked that one?

MS. FINAMORE: Yes.

JUDGE MILLER: Okay.

MS. FINAMORE: This one is Intervenors' Exhibit 16, marked for identification. It's a document by Science Applications Incorporated, Palo Alto Office, entitled Modeling of Core Melt Accident Management in the Clinch River Breeder Reactor Plant. Subtitled II, CACECO, Code results for 0 to 110 days with sodium recycle. Date January 19, 1979, submitted to CRBRP Program Office, Oak Ridge, Tennessee, submitted by J. Maly and R. L.

Ritzman.

(Intervenor Exhibit No. 16 was marked for identification.)

BY MS. FINAMORE:

Q Are you familiar at all with this document, Dr. Rumble?

BY WITNESS RUMBLE:

A No.

Q Have you ever read this document?

BY WITNESS RUMBLE:

A No.

Q Are you familiar with the authors of this document?

BY WITNESS RUMBLE:

A Yes.

Q Are they in the division that you are in at this time? Or are they under your supervision?

BY WITNESS RUMBLE:

A Completion of a transition phase will place me as their supervisor.

JUDGE MILLER: That's in January?

WITNESS RUMBLE: February 1.

JUDGE MILLER: Of 1983?

WITNESS RUMBLE: Of 1983.

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by MS. FINAMORE:

Q Second document is called Risk to Residents --

JUDGE MILLER: What's that number?

MS. FINAMORE: Intervenor's Exhibit 17, marked for identification.

JUDGE MILLER: Very well.

(Intervenor Exhibit No. 17 was marked for identification.)

BY MS. FINAMORE:

Q Entitled Risk to Residents of the CRBRP Vicinity Due to Seismically Induced Collapse of or Damage to Structures.

Prepared by Science Applications, Incorporated for the Clinch River Breeder Reactor Plant, Project Office, December 5, 1977. No. SAI-071B-77-PA.

Q Are you familiar at all with this document?

BY WITNESS RUMBLE:

A. No.

Q Have you read it at all?

BY WITNESS RUMBLE:

A. No, I haven't.

Q The next document is entitled -- I'll mark it for identification as Intervenors ' Exhibit 18.

It's entitled, The Consequences of

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Catastrophic Floods in the CRBRP Vicinity Due to Partial Collapse of Major Dams Induced by Large Earthquakes. Prepared by Science Applications, Incorporated for the Clinch River Breeder Reactor Project Office, dated December 5, 1977, from the Palo Alto Office. Number SAI-071C-77-PA.

JUDGE MILLER: Pardon me. Did you give the date on that?

MS. FINAMORE: Yes. December 5th, 1977.

JUDGE MILLER: Thank you.

BY MS. FINAMORE:

Q Are you familiar at all with this document, Dr. Rumble?

BY WITNESS RUMBLE:

A. No.

Q Have you read this document at all?

BY WITNESS RUMBLE:

A. No, I haven't.

(Intervenor Exhibit No. 18 was marked for identification.)

Q The next document, marked for identification as Intervenors Exhibit 19, is entitled Modeling of Core Melt Accident Management in the Clinch River Breeder Reactor Plant. Subheading, I, Results from the first 245

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Hours using the CASECO Code, Dated December, 1978. Submitted to CRBRP Program Office, Oak Ridge, Tennessee. Submitted by J. Maly and R. L. Ritzman, from the Palo Alto Office. Number SAI-107-78-PA.

(Intervenors Exhibit No. 19 was marked for identification.)

BY MS. FINAMORE:

Q Are you familiar with this document at all, Dr. Rumble?

BY WITNESS RUMBLE:

A. No.

Q Have you read it at all?

BY WITNESS RUMBLE:

A. No, I haven't.

Q The final document is entitled Intervenors Exhibit 20, marked for identification, entitled Flood Hazard for the CRBRP, prepared by Science Applications, Inc., for the CRBRP Project Office, Oak Ridge, Tennessee, December 1978. Number SAI-122-78-PA, from the Palo Alto Office.

(Intervenors Exhibit No. 20 was marked for idnentification.)

BY MS. FINAMORE:

Q Are you familiar at all with this document?

BY WITNESS RUMBLE:

A. No.

Q. Have you read it at all?

BY WITNESS RUMBLE:

A. No, I haven't.

Q. Do you have any reason to belive that these documents were not, in fact, prepared by the Palo Alto Office of SAI?

BY WITNESS RUMBLE:

A. No.

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BY MS. FINAMORE:

Q Dr. Rumble, one final question on voir dire. In preparing on participating in Appendix J, did you read or review any documents prepared by SAI?

BY WITNESS RUMBLE:

A Yes.

Q Which ones were they?

BY WITNESS RUMBLE:

A Well, there is a document by Ritzman and Maly, which talks about the fuel vapor bubble and calculates rise time for fuel vapor bubbles which I read during that time frame.

The second document is the CRBRP-1, which was -- there was participation of SAI people in preparation of that document.

Q Did you review CRBRP-1 for accuracy before you --

BY WITNESS RUMBLE:

A No, I didn't review it for accuracy.

Q Did you draw any judgments in your Appendix J analysis from information in CRBRP-1?

BY WITNESS RUMBLE:

A Could you repeat that question again?

Q Did you draw any judgments in Appendix J from information in CRBRP-1?

BY WITNESS RUMBLE:

A. The answer is no, not solely on CRBRP-1.

Q. Partly on CRBRP-1?

BY WITNESS RUMBLE:

A. Partly, and I'd like to explain that, in that it was part of the information basis that I used in deriving some judgments in participation with a team here at NRC to develop Appendix J.

Q. Which judgments are you referring to?

BY WITNESS RUMBLE:

A. Those judgments would be more in -- not in the frequency area, but in looking over some of the information regarding source term, regarding some CACECO runs that were performed that are displayed in the Volume 2 of that report.

Q. That Ritzman and Maly document you just referred to, was that performed under contract to the Applicants?

BY WITNESS RUMBLE:

A. Yes, it was.

Q. Did you use the information in that document in any way for your work on Appendix J?

BY WITNESS RUMBLE:

A. No, I didn't. No.

MS. FINAMORE: This concludes my voir dire.

JUDGE MILLER: Very well.

CROSS-EXAMINATION

BY MS. FINAMORE:

Q I'd like to move to Page 5 of the testimony. What documents did you rely upon, Dr. Rumble, for the estimate of probability of failure of CRBRP systems?

BY WITNESS RUMBLE:

A. I didn't hear the end of that question.

Q This is the failure of the LOH system frequency, the LOHS system frequency.

JUDGE MILLER: Do you have the question in mind?

WITNESS RUMBLE: Yes, I have the question, and I did not rely on any documents specifically for quantifying LOHS frequency.

BY MS. FINAMORE:

Q On Question 9 on Page 7, what documents did you rely upon for your judgment that the -- regarding the reliability of the auxiliary heat removal system?

BY WITNESS MORRIS:

A. Are you referring to Page 7 still? That's discussing the shutdown system, I believe.

Q Excuse me. Dr. Rumble, on Page 7 you are talking about the failure rate attributed to ATWS events.

BY WITNESS RUMBLE:

A. Yes. I would say that no, we didn't rely on any documents. As discussed in the testimony, NUREG-0460 is a document which provides a survey of work performed in this area for LWR's and was used in helping us to form our basis for quantification of the shutdown frequency.

Q. On Page 6 of your testimony you state that, "Numerous detailed reliability analyses have been conducted...and form a portion of the knowledge base from which judgments regarding these frequencies were drawn."

Which specific documents are you referring to?

BY WITNESS RUMBLE:

A. Excuse me. I am just trying to find that sentence.

Q. Answer 7.

JUDGE MILLER: The first line.

WITNESS RUMBLE: Yes. These documents, one I just mentioned previously. There are a number of documents sponsored by the NRC, for example; the work at MIT and UCLA and at Sandia, which are some of the documents.

I don't have those document numbers on me.

BY MS. FINAMORE:

Q. What was the document that you said you referred to previously?

BY WITNESS RUMBLE:

A. The document I referred to previously was the NUREG-460 document, part of Answer A-9.

Q When you say it "forms a portion of the knowledge base from which judgments regarding these frequencies were drawn," do you mean that you read these documents before you performed your Appendix J analysis?

BY WITNESS RUMBLE:

A. I read parts of these documents before, during, after, in review, and previously. There's no real pattern that I could give you for each document.

Q And did you review any of these documents for their accuracy as you were performing your review?

BY WITNESS RUMBLE:

A. I did not review them for the sole purpose of accuracy at any point in time, but -- no, the answer is no.

Q Did you assume that they were accurate as you read through them in your Appendix J analysis?

BY WITNESS RUMBLE:

A. I guess no. The answer is no.

Q Well, then, how did you know whether or not to use any of that information in your Appendix J analysis?

BY WITNESS RUMBLE:

A. Based on judgment, based on the authors' past reputation, personal knowledge of the authors, based on the kinds of results they obtained and their discussion of these results and certainties, their reasonableness and their -- by benchmarking them with other reports.

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Q So am I correct, then, you gave more weight to some of those reliability analyses than to others?

BY WITNESS RUMBLE:

A. I don't know.

Q Did you give equal weight to each of the analyses?

BY WITNESS RUMBLE:

A. The weighting factors that I applied to each of the analyses, they were not given exactly equal weight, no.

Q So did some of them -- Did you consider some of these analyses more important than others in your Appendix J review?

BY WITNESS RUMBLE:

A. No, I consider them all important.

Q Did you consider some of them more reliable than others?

BY WITNESS RUMBLE:

A. Yes, I did, and I should explain that answer, if possible.

Some documents have a range of applicability which is greater than others. Some documents may consider various failure modes when other documents do not, and this has to be part of the consideration.

Q Well, did you consider CRBRP-1 to be more

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applicable than other documents?

BY WITNESS RUMBLE:

A. No.

Q. Did you consider it to be more reliable than other documents?

BY WITNESS RUMBLE:

A. No.

BY WITNESS MORRIS:

A. Could I point out that the basis for the Staff's estimate is to some extent weighted heavily by the NUREG-460 estimate of ATWS, and the subsequent judgment by the Commission that the range of frequencies for ATWS expected for lightwater reactors may be somewhere in the range of one per thousand reactor years.

That, coupled with the extra redundancy, independence and diversity in the Clinch River shutdown systems were major factors.

That document stands out somewhat in our testimony as the only one we've actually referred to. That document, NUREG-460, has been the basis of the ongoing ATWS considerations by the Staff and has come to have what we think of as a fairly good generic basis; and subsequently has not been found to be discounted as a basis for ATWS.

Q. Thank you. Dr. Rumble, is it correct that of the numerous reliability analyses you reviewed, CRBRP-1 was the only one that dealt specifically with the Clinch River Breeder Reactor?

BY WITNESS RUMBLE:

A. No, that's not correct.

Q. Which other ones did you rely upon?

BY WITNESS RUMBLE:

A. Documents from MIT and the documents from UCLA.

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BY MS. FINAMORE:

Q. Please describe --

BY WITNESS RUMBLE:

A. And also a document from Sandia.

BY WITNESS MORRIS:

A. I would also point out that there's a document prepared by the Staff by Brookhaven National Laboratory that also was specific to Clinch River which predicted failure frequencies.

Q. Did you rely upon those documents in any way?

BY WITNESS RUMBLE:

A. No, I did not rely on them in any way. I think I misspoke. The document from MIT is really the document from Brookhaven, with an MIT professor participating, I think.

Q. Do you recall the titles of those two documents?

BY WITNESS RUMBLE:

A. No, I do not.

Q. But you reviewed those two documents before you completed your work on Appendix J?

BY WITNESS RUMBLE:

A. Yes, I reviewed those documents.

Q. Did you disagree with any of the information in any of those documents?

BY WITNESS RUMBLE:

A. If I remember, the UCLA documents were pertaining to loss of heat sink. The answer was yes there.

The Brookhaven document, the answer would be yes there, too.

Q. Yes, you disagreed?

BY WITNESS RUMBLE:

A. Yes, I did disagree.

Q. Did you disagree with any of the information in CRBRP-1?

BY WITNESS RUMBLE:

A. I don't think -- No, I didn't disagree with any in CRBRP-1.

I'd like to explain that answer. I didn't specifically use CRBRP-1 to any extent, such that I would agree or disagree with what was in there.

Q. Did you review it before you completed your Appendix J analysis?

BY WITNESS RUMBLE:

A. I reviewed some parts of it.

Q. The parts that were applicable to Appendix J?

BY WITNESS RUMBLE:

A. I reviewed just some parts of CRBRP-1. There are other parts of CRBRP-1 that are applicable to

Appendix J which I did not review.

Q. Can you briefly state the parts that you did review?

BY WITNESS RUMBLE:

A. The parts that I reviewed were in the containment analysis area.

Q. Referring to the documents by Sandia Labs and Brookhaven Labs, do you believe it appropriate to look at such documents before performing an Appendix J analysis?

BY WITNESS RUMBLE:

A. Yes.

Q. Do you believe such documents provide useful information in an analysis such as that in Appendix J?

BY WITNESS RUMBLE:

A. Yes.

Q. Do you believe those analyses support your conclusions in Appendix J?

BY WITNESS RUMBLE:

A. That's a very hard question to answer. I guess we'd have to specifically talk about what conclusions and -- you know -- go into what we're talking about there.

Q. Well, did you believe that the --

BY WITNESS MORRIS:

A. Could I respond to that in part, too?

Some of these analyses in these various documents by UCLA, Brookhaven and CRBRP-1, I believe -- although I haven't looked at that in great detail -- predict, I think rather optimistically -- the possibility of the failure of the shutdown systems and the heat removal systems at Clinch River.

When we prepared Appendix J, we certainly had all of this information and all of his perspective -- you know -- in our minds, but it seemed that it would not be prudent to accept these very optimistic values. Instead, we felt that we should go back to the kind of estimates that were made, as I suggest, in NUREG-460 and that were the basis for, say, the ATWS rulemaking.

So although those documents may have been available to us and we may have been aware of the estimates that were made there, and they may have given some kind of supporting evidence -- that is, they showed high reliabilities for the systems, it's because of that optimism that they embodied that we were reluctant to rely upon them.

Q Dr. Rumble --

BY WITNESS MORRIS:

A -- we preferred to rely upon those pieces of information, plus our own judgment about what all of the information told us.

Q Dr. Rumble, do you believe the information in

CRBRP-1 might be useful in determining which event sequences were of interest in Appendix J analyses?

MR. EDGAR: I'm going to object to the line of questioning. This is ranging far beyond the scope of Appendix J. We're going around and around on CRBRP-1, and it's of no direct relevance to Appendix J, or the Staff's testimony.

JUDGE MILLER: What is the significance of this line of inquiry? Where are you going?

MS. FINAMORE: Well, Dr. Rumble stated that he formed portions of the knowledge base that he used in deriving Appendix J.

JUDGE MILLER: That's fairly innocuous so far. Are you challenging that?

MS. FINAMORE: No, I'm just trying to find out how he thinks it is useful in determining Appendix J --

JUDGE MILLER: Does it matter --

MS. FINAMORE: -- in particular.

JUDGE MILLER: He's the expert. He has done some writing on it. He thought it was useful, and he wrote it.

Now why are we spending all of this time on his mental processes on something that doesn't seem to be an issue?

MS. FINAMORE: We need it in order to determine the basis for Staff's assertions in its testimony.

JUDGE MILLER: You're not going to get it from this line of inquiry, are you?

MS. FINAMORE: Yes. In particular, my last question in this line was whether or not the information is useful. And then I'm going to ask if he used it in determining which failure event sequences are of interest in the Appendix J analysis.

JUDGE MILLER: Well, this is all very interesting, but I fail to see what it is in terms of proof.

MR. SWANSON: The last question that we're supposedly leading up to has already been answered. They didn't rely on it.

JUDGE MILLER: That's true.

MS. FINAMORE: Well, he said he used it as a portion of the knowledge base. I'm not sure how one distinguishes between the two. But in terms of the knowledge base, I want to know if that is what -- the portion of Appendix -- of CRBRP-1 that he used.

JUDGE MILLER: What is it that you wish to challenge about the testimony, the documents or the witness? What is it that you challenge?

MS. FINAMORE: Well, we challenge a number of things. One of them is that the Staff did not have an adequate basis for the probability and consequence figures in Appendix J.

JUDGE MILLER: Well, why don't you ask somebody what they did use? Not what's interesting or what documents are floating around --

MS. FINAMORE: I will ask him.

BY MS. FINAMORE:

Q Did you use the event sequences in CRBRP-1 --

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JUDGE MILLER: Ask him what he did use, instead of telling him what he did or didn't use. Why don't you ask him and get the information on the record?

MS. FINAMORE: All right.

JUDGE MILLER: Don't tell him; ask him.

BY MS. FINAMORE:

Q What did you use to determine which event sequences are of primary interest in Appendix J analysis?

JUDGE MILLER: Well, instead of the term "interest," what did you use to arrive at the conclusions that are expressed in the Appendix J, in whole or in part?

Can you answer any part of it?

WITNESS RUMBLE: That's a large question.

JUDGE MILLER: I know it.

WITNESS RUMBLE: And, again, I was a part of a team.

JUDGE MILLER: Hold on just a minute. Hold your team.

What portion of Appendix J are you questioning or challenging?

MS. FINAMORE: Right now I'm --

JUDGE MILLER: Zero in on whatever it is that you want, and let's get some specificity here.

MS. FINAMORE: I believe that the Staff thinks the reactor shutdown system and the --

JUDGE MILLER: Well, what section? What page is this?

MS. FINAMORE: Loss of heat systems are of primary interest.

JUDGE MILLER: I don't like the term "interest." You know, a comic strip can be of interest. Doonesbury is great, but what are you zeroing in on here in a substantive way?

MS. FINAMORE: ATWS events, as discussed on Question 9 on Page 7.

JUDGE MILLER: All right. Question 9 on Page 7.

MS. FINAMORE: The auxiliary feedwater system --

JUDGE MILLER: The witness -- Take them one at a time. Write them down so you'll be ahead of the game.

Okay. Look at 9 on Page 7. Ask the panel: Who was primarily responsible for that answer and the underlying data and conclusions? Who had primary responsibility?

WITNESS MORRIS: I believe I had primary responsibility --

JUDGE MILLER: Okay. Will you tell us what it was based on. Go ahead and start it off.

WITNESS MORRIS: Okay. Well, I just refer to the answer there. The Staff --

BY MS. FINAMORE:

Q. Okay. Is that the basis -- Is there anything else other than what's in your answer that you relied upon for your frequency of ATWS events?

BY WITNESS MORRIS:

A. No. But I should make it clear that when we say -- specifically taking into account the number of years of operating experience and the frequency of anticipated transients and occurrence of failure of shutdown systems, that embodies a large amount of information in a number of documents.

I just want to make it clear that it doesn't mean that we don't have a lot of things that we've got in our minds as we make that judgment.

I want to make it clear, too, that I was primarily responsible for this, but Mr. Rumble was -- essentially -- an important member of that team, and he has his own basis perhaps --

JUDGE MILLER: All right, Mr. Rumble. What basis above and beyond that which has just been described or is contained in Answer 9? Anything else? And if so, describe it.

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WITNESS RUMBLE: No, there's nothing else. Answer 9 is --

JUDGE MILLER: All right. On that point then they're telling you that the information is contained in 9. Okay. Now where do you want to go?

BY MS. FINAMORE:

Q Am I correct, Dr. Rumble, that you considered the ATWS failures and the auxiliary feedwater failures to be the most important contributors to CDA initiation?

BY WITNESS RUMBLE:

A. They form part of the most important contributors.

Q What were the other contributors?

BY WITNESS RUMBLE:

A. I think they're in our testimony. I can refer you to Answer A.4, the third paragraph: "These sequences form a broad characterization of CDAs initiated by," and there are -- I won't read them -- one, two, three, right there in that paragraph.

Q How did you -- What information did you rely upon to choose those sequences instead of other sequences?

BY WITNESS RUMBLE:

A. The information as to picking the broad characterization of CDA initiators is basically experience, knowing that the only way you can initiate a CDA, first of all, is by either excess power or under cooling, and then looking at the ways you can get excess power or under cooling, you quickly come to a categorization, such as in Paragraph 3 on Page 5 of our Exhibit 17.

Q. Did you use any fault tree/event tree analysis to eliminate other event sequences from your review?

BY WITNESS RUMBLE:

A. I didn't do any specific fault tree/event tree analysis.

Q. Did you use anyone else's fault tree/event tree analysis to eliminate other event sequences from your analysis?

BY WITNESS RUMBLE:

A. I didn't use anybody else's fault tree/event tree analysis, no.

Q. Did you examine any such analyses?

BY WITNESS RUMBLE:

A. Again, I can only state that we went through the document question -- in the documents, the Brookhaven, Sandia, UCLA documents, documents about LWRs, WASH-1400. For example, there are fault trees/event trees in there. And they formed part of the basis for discussion in Answer A.4.

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Q Are those probabilistic risk assessments?

BY WITNESS RUMBLE:

A. The WASH-1400 study is a probabilistic risk assessment. The others are not what I would define as a complete probabilistic risk assessment.

Q Are they partly involved with probabilistic risk assessments?

BY WITNESS RUMBLE:

A. They do portions of a probabilistic risk assessment. They are probabilistically-oriented documents.

Q Do they contain event tree and fault tree analyses?

BY WITNESS RUMBLE:

A. Yes.

Q On Page 7 of your testimony, the first line -- or starting on the bottom of Page 6, moving to the top of Page 7, you say, "Secondly, we considered the potential for achieving high reliability in the design through implementation of an effective reliability program."

Do you feel, Mr. Morris, that the Zimmer and Midland had effective reliability programs, to your knowledge?

BY WITNESS MORRIS.

A. I don't know anything about those reliability programs.

Q. Did you consider --

BY WITNESS MORRIS:

A. -- if they had them.

Q. Do you know anything about the quality assurance programs of Zimmer and Midland?

JUDGE MILLER: Objection sustained.

MR. SWANSON: Objection --

(Laughter.)

BY MS. FINAMORE:

Q. The final sentence on Page 7, you state, "Quantitative bounding CDA initiation frequencies for the CRBR design were estimated based on the above and on relevant LWR" --

JUDGE MILLER: Where are you reading?

MS. FINAMORE: This is the first full sentence on Page 7.

JUDGE MILLER: Oh, the first full sentence? I thought you said the last. I'm sorry.

MS. FINAMORE: The last sentence in Answer 8.

JUDGE MILLER: Okay.

BY MS. FINAMORE:

Q. The sentence reads, "Finally, quantitative bounding CDA initiation frequencies for the CRBR design were estimated based on the above and on relevant LWR operating experience including the pertinent information available from reliability oriented studies of LWRs and LMFBRs."

Am I correct in that sentence that you used the potential for an effective reliability program as a basis for your quantitative CDA initiation frequencies, Dr. Rumble?

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BY WITNESS RUMBLE:

A. Yes.

Q. Can you explain how you get a quantitative failure frequency from the existence or the potential for an effective reliability program?

BY WITNESS RUMBLE:

A. An effective reliability program will help insure that reliability goals of the plant -- specific systems are met. And from that point of view, it provides assurance that the systems will perform at a certain level, comparable to systems in LWRs, for example.

It helps provide a basis to compare potential performance of CRBRP systems with those of LWRs that have been analyzed.

Q. Are you assuming that the LWRs do not have an effective reliability program?

BY WITNESS RUMBLE:

A. No, I'm not.

Q. You're assuming that both have effective reliability programs?

BY WITNESS RUMBLE:

A. Yes.

Q. And how does that enter into your comparison of CDA initiation frequencies for LWRs as opposed to breeders?

BY WITNESS RUMBLE:

A. You'll have to repeat the question. I misunderstood it.

Q. You said the existence of a reliability program can affect your quantitative failure estimate; is that correct?

BY WITNESS RUMBLE:

A. Yes.

Q. Can you tell me by what factor it might reduce the probabilities of CDA initiation?

BY WITNESS RUMBLE:

A. No, I can't right now. You're looking for a number? No, I can't.

BY WITNESS MORRIS:

A. Could I mention that in our view the reliability program that we anticipate for Clinch River may be somewhat different from that for LWRs in general, and that it will be unique by having had an NRC review after a formal reliability program has been proposed by the Applicant.

Typically, in LWRs there has not been an NRC review of the reliability programs that may exist. And our anticipation of the kinds of measures that we're going to require in that review adds some weight to the importance of the reliability program.

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But, again, it doesn't produce a demonstrable factor of -- a reliability enhancement, but merely it confirms that the inherent potential reliability embodied in the redundance and independence and diversity in the design can be achieved and really put into effect when the plant is in operation.

Q Dr. Rumble, do you have any familiarity with the proposed reliability program of the Applicants?

BY WITNESS RUMBLE:

A. Yes.

Q Can you explain the extent of that familiarity?

BY WITNESS RUMBLE:

A. Basically what Dr. Morris said, to that level only. Just the function of it and the purpose it is to serve.

Q Do you have any judgment as to the effectiveness of that reliability program, as presently stated?

BY WITNESS RUMBLE:

A. At this present time I do not.

Q So isn't it true that you're assuming that the program will be effective?

BY WITNESS RUMBLE:

A. Yes.

Q Is it possible that it will not be effective?

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BY WITNESS RUMBLE:

A. It's possible, yes.

Q. And you don't know the probability, do you?

BY WITNESS RUMBLE:

A. I would say it's very, very low.

Q. Based on what?

BY WITNESS RUMBLE:

A. Confidence in the people in the organization, the NRC.

Q. Thank you.

BY WITNESS MORRIS:

A. Again, let me clarify that the reliability program that's proposed by the Applicant now may not be the reliability program that will be eventually imposed in the SER.

We have criteria that we will intend to apply to that program that will bring it up to whatever degree of reliability that we think is necessary.

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ged

BY MS. FINAMORE:

Q. So am I correct, then, Dr. Morris, that you are relying on the feasibility of developing an effective reliability program?

BY WITNESS MORRIS:

A. Yes, we have indicated in responses to interrogatories and in our Final FES Supplement some of the features of a reliability program that we anticipate would achieve the objectives implied by our answer, A8, I guess.

Q. Dr. Rumble, I'd like to refer to your Answer 9 on Page 7. The middle of that answer says that NUREG-460 gave an estimate of the frequency of ATWS for typical LWR's as 2×10^{-4} per year; is that correct?

BY WITNESS RUMBLE:

A. The document gives a number of frequencies. I think that's -- I would have to have the document to verify. It's in that -- it's very close to that; it isn't exactly that. One point something -- it's very close to that number.

Q. You then go on to state that, "Estimates in this same range were subsequently quoted by the Commission in its statement regarding ATWS rulemaking."

What do you mean by "in this same range"?

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BY WITNESS RUMBLE:

A. In the range on the order of 10^{-4} or 10^{-3}.

Q. So that the difference in the Commission's estimate went as far above as a factor of 5 from the estimate you have stated here, 10^{-3}?

BY WITNESS RUMBLE:

A. I'm not sure I -- excuse me?

Q. You said that the Commission's estimate went up to a factor of 10^{-3}; am I correct?

BY WITNESS RUMBLE:

A. I'd say no in that I'm not sure there's such a thing as a Commission's estimate. I'm not sure.

Q. I'm referring to the one you stated in your answer, "Estimates in the same range were subsequently quoted by the Commission in its statement regarding ATWS rulemaking."

BY WITNESS MORRIS:

A. Perhaps I can clarify. I believe the words in the Commission's ATWS rulemaking document say that we anticipate that ATWS frequencies may be less -- may range from one in ten thousand to one in a thousand years, but they may not be much less than one in a thousand years for some kinds of reactors.

I think that's the kind of thing we're trying to reflect here in this wording.

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Q Am I correct --

BY WITNESS MORRIS:

A. You understand that we're talking about different kinds of reactors. They are all embodied in this generic concept of a generic ATWS number, and that's the reason that the range is what's being used.

Q Am I correct, Dr. Morris, that the Commission in its statement regarding ATWS rulemaking relied upon the document you've cited entitled, "NUREG-460"?

BY WITNESS MORRIS:

A. I believe they did.

Q I'd like to read you a sentence from that document, if I may. Do you have that in front of you?

This document is entitled, "NUREG-0460, Volume 4, Anticipated Transients Without Scram for Light Water Reactors, Resolution of Unresolved Safety Issue TAPA-9," March 1980.

JUDGE MILLER: Is that the document that's contained in the panel's Answer 9?

WITNESS MORRIS: We were quoting from Volume 1. It's the same total document. It's the same NUREG.

WITNESS RUMBLE: This is Volume 4 here.

BY MS. FINAMORE:

Q I quote: "In NUREG-0640, Volumes 1 and 2, we evaluated the information available to the Staff at that time and concluded that the ATWS events presented an unacceptably high risk to the public during service life of nuclear power plants."

Did I read that sentence correctly, Dr. Morris?

BY WITNESS MORRIS:

A. Yes.

Q. Do you have any basis for disagreeing with that statement?

BY WITNESS MORRIS:

A. No.

JUDGE MILLER: Let me ask you, Dr. Morris.

Answer 9, Page 7, the panel, whoever wrote this testimony, cites NUREG-460, as described, and so forth.

Now, is that the section that was just identified by you from Volume 4 of NUREG-460?

WITNESS MORRIS: No. We were quoting from Volume 1 and she was quoting from Volume 4, and from the wording, I assume that Volume 4 was issued sometime later. I don't know the exact dates of issuance of these various volumes.

JUDGE MILLER: Maybe you had better look at them.

What I want to know is, you just identified Volume 4 and a statement contained therein, right?

WITNESS MORRIS: Yes.

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JUDGE MILLER: What did that statement refer to?

WITNESS MORRIS: It referred to an unacceptable risk from LWR's having a single shutdown system, that had a range of frequencies somewhat, perhaps, not much less than one per one thousand reactor years; and I think for clarification, we are talking about here in CRBR an additional backup shutdown system.

We've said, okay, let's take at face value one in a thousand is the upper range of the frequencies for LWR's. Taking into account the additional backup shutdown system, we feel that we will be able to put the upper bound -- the ATWS frequency for CRBR one in a thousand -- one in ten thousand per reactor year, essentially an order of magnitude gain in reliability.

Given that -- even assuming that such an event would occur, that CRBR has these additional TNBDB mitigation features to mitigate the risk to these events.

I think that's -- I can agree with the comment for LWR, because the Commission has made that judgment. I don't disagree with that, but --

JUDGE MILLER: Wait a minute.

WITNESS MORRIS: Okay.

JUDGE MILLER: What judgment has the Commission made that you don't disagree with? What are we talking

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about?

WITNESS MORRIS: That there is, because of that one in a thousand reactor frequency for ATWS, that something should be done about ATWS, either to enhance the reliability of the LWR shutdown systems or to mitigate the ATWS events.

JUDGE MILLER: Well, what was it that was regarded as unacceptably optimistic?

WITNESS MORRIS: I don't know what you are --

JUDGE MILLER: What did you just agree to?

WITNESS MORRIS: Okay. I said that I would --

JUDGE MILLER: Let's have that document again. Let me just see the portion that you read.

The portion that you identified, I believe, is at Page 3 of that identified document, "In NUREG-0460 Volumes 1 and 2, we evaluated the information available to the Staff at that time and concluded that the ATWS events presented an unacceptably high risk to the public during the service life of nuclear power plants."

That's what you identified, wasn't it?

WITNESS MORRIS: Yes, and I believe that's --

JUDGE MILLER: What I am inquiring, then, is what is the significance of this statement, Page 7, Answer 9, which identifies the NUREG-0460 (which shows as 460 and I take it it's the same), which is discussed in the first several sentences, and, "Estimates in this same

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range were subsequently quoted by the Commission in its statement regarding ATWS rulemaking," and so forth.

I don't see anything there that shows the significance for the statements in the testimony or takes into account the fact that something was concluded subsequently to constitute an unacceptably high risk to the public.

What are we talking about here?

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WITNESS MORRIS: What we are talking about is we are using these frequency, ATWS frequency estimates, for LWR's, a generic number, as the starting off point from which we would derive ATWS frequency estimates for CRBR, taking into account the additional backup shutdown system.

JUDGE MILLER: But that -- Was that taking into account the unacceptably high risk to the public?

WITNESS MORRIS: Well, it --

JUDGE MILLER: Was it taken into account?

WITNESS MORRIS: I think it was, yes. We had --

JUDGE MILLER: Well, look at your testimony. Somebody is responsible for this testimony.

WITNESS MORRIS: Yes.

JUDGE MILLER: All right. Now, who is it that put in this statement from NUREG-460 that says that these estimates were quoted by the Commission in the statement concerning rulemaking.

That isn't the statement I just read to you, is it, from Volume 4?

WITNESS MORRIS: No.

JUDGE MILLER: All right. What I'm trying to find out now is why, if these two somewhat dissimilar statements have any bearing at all, it should be in your testimony at all -- this is your sworn testimony -- why did

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you put down something from the 460 Volume 1, which is subsequently determined by the same Agency to have an unacceptably high risk to the public, without saying so, without identifying it, without indicating what the reference in the first place is, this unacceptably high risk not described as such, unless I'm missing something in this answer that you can call to my attention?

WITNESS MORRIS: I think it's because we weren't trying to address the risk from LWR's in this document.

We were trying to address the risk from CRBR.

JUDGE MILLER: Whatever you were trying to do, I'm looking at what you wrote and what you're swearing to under oath.

WITNESS MORRIS: I still swear to it.

JUDGE MILLER: All right. So you swear that the information I get in the first two sentences if found by you, as a representative of NRC, to constitute an unacceptably high risk to the public?

WITNESS MORRIS: That's from LWR's.

JUDGE MILLER: This is talking about LWR's. That's what the title of it is.

WITNESS MORRIS: Okay, but --

JUDGE MILLER: Lightwater reactors. It's given in the title, but there's no indication that this statement here about LWR's was found, later on apparently, to be an unacceptably high risk. Now why not?

LWR, the same terms. You put it in here.

WITNESS MORRIS: Well, when we refer to -- this next sentence, "Estimates in this same range were subsequently quoted by the Commission in its statement regarding ATWS rulemaking" --

JUDGE MILLER: All right, now, stop right there. Stop right there.

Was that also an unacceptably high risk?

WITNESS MORRIS: Yes.

JUDGE MILLER: Then why doesn't it say so?

WITNESS MORRIS: It just didn't seem relevant to me.

JUDGE MILLER: Well, it sure seems -- what's the term they are kicking around? It seems interesting to me.

I am puzzled by the fact you put in something here. I know it's LWR's. I heard your explanation, but nowhere did I find out this information that later on this statement that you are making here in the first two sentences constituted an unaccpetably high risk to the public.

Shouldn't we at least be warned if somebody is cnanging gears, and given some explanation if you are going to inject it in your answer. By "you," I don't mean

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you personally, Dr. Morris, but I sure mean NRC Staff who prepared this testimony, whatever way it was prepared.

MR. SWANSON: Mr. Chairman, I wonder if this might be an appropriate time to take a break. I think we've got a disconnect in communication, because the Staff is not making the claim that that number was acceptable, and that's where I think the problem is.

MR. EDGAR: That statement is grossly out of context, might I add.

The Commission's rulemaking notice on ATWS is abundantly clear here. The key language in that statement and the topical report to Volume 4 is "during the service life."

You've got to underline that.

The Commission in the rulemaking notice says, and I quote at 46 FED. REG. 57522: "The Commission believes that the likelihood of severe consequences arising from an ATWS event during the two- to four-year period required to implement a rule is acceptably small."

The Commission has made a judgment that action should be taken on risk, but they are talking about the 30-year service life, or the Staff was in that document, and I think if you'll look at the rulemaking notice, the Commission has indicated in publishing the rulemaking notice the desire to do something.

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But there isn't any interim safety problem in the judgment of the Commission.

JUDGE MILLER: Well, let me read in the rest of this Paragraph 1.2, NUREG-0460, Volume 4, and then we'll take the recess.

I'm going to read the entire paragraph:

"In NUREG-0460, Volumes 1 and 2, we evaluated the information available to the Staff at that time and concluded that the ATWS events presented an unacceptably high risk to the public during the service life of nuclear power plants. As more and more plants come on line, the risk to society increases further. Therefore, the Staff concluded that some corrective measures were required to reduce the risk of severe consequences arising from possible ATWS events. It is further recommended that new systems (or modifications to existing systems) to mitigate the consequences of ATWS events be provided. The bases for these conclusions were the estimated frequency of severe ATWS events and the level of safety believed to be necessary. The required level of safety was specified

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in numerical terms."

MR. EDGAR: All I was trying to point out here is that the Commission has an explicit statement on the basis of interim measures that there is reasonable assurance of safety for continued operations until implementation of the rule is completed.

JUDGE MILLER: Which contemplated a short period of time, relatively speaking, several years, two to four years, but that when you go much beyond that, these risks start to pile up to where something should be done.

That's lightwater reactors, isn't it?

While we are in recess, consider this, and this is directed to the Staff, the technical Staff. My question is why that information isn't contained in this testimony, or why the testimony doesn't fully indicate the status of things, or why if it's not desired to do so, it's included at all?

That's the question.

Now we are taking a recess.

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JUDGE MILLER: Okay.

MS. FINAMORE: Judge Miller.

JUDGE MILLER: Yes.

MS. FINAMORE: If I may point one thing out for the record, Mr. Edgar just referred to the Commission's proposed rule for ATWS, which is what is cited in the Staff's testimony, saying that the Commission has found reasonable assurance that no interim control measures are needed.

MR. EDGAR: Wrong.

MS. FINAMORE: Excuse me. I may have misrepresented him, but there's one other portion of this proposed rule I'd like to direct the Board's attention to.

I can read it into the record, if you wish.

JUDGE MILLER: Well, what is it that you are referring to?

MS. FINAMORE: It's a sentence in 46 FEDERAL REGISTER 57522, November 21st, 1981, first column:

"There have been roughly one thousand reactor years experience accumulated in foreign and domestic commercial lightwater cooled reactors without an ATWS accident. This experience suggests that the frequency of ATWS accidents is less than or of the order of once in a thousand reactor years.

There have been several precursor events, i.e., faults, detected that could have given rise to ATWS events. This suggests that the frequency of ATWS events, though less than one in a thousand reactor years, may not be very much less. Such frequencies are too high for accidents of the severity described above."

JUDGE MILLER: Okay. I'll return your Volume 4 for comment. Thank you.

Who is interrogating whom now?

WITNESS MORRIS: I believe I was to respond to your question.

I want to try to make it clear that there was certainly no intent at all and trying to hide any information. This --

JUDGE MILLER: I understand. It's simply this is testimony. It's public and I think that it should be complete.

I suggest, in fact, that the Staff consider rewriting at least a portion of Answer 9 so there will be no question of its completeness, including subsequent events and the like.

No, I don't question there's any willful attempt to conceal. I don't believe that.

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WITNESS MORRIS: I think that part of the reason that we didn't go into these other areas was because I felt that all the parties, and I may not have the right to make this kind of assumption, were all aware of the ATWS rulemaking and that the Commission had in fact decided that something had to be done.

JUDGE MILLER: Now, remember, this is a public hearing. These transcripts are public. They go all over the country. They are read by people.

These are nicely typed and all that, just as though you and your colleagues here were under oath saying it orally.

Therefore, when you go into something, when you start describing something, if you deem it necessary or significant enough to do it, then do it completely.

If there are subsequent matters that could bear upon it, give the whole background of the description, or else don't go into it.

That's my point. I think there should be some rewriting, and I'm requesting Staff to consider some rewriting of the first paragraph of A9 on 7.

MR. SWANSON: I think it's very important to give Dr. Morris a chance to explain, because I still think there may be a failure of the Staff to communicate just what was the purpose of that testimony and just what some

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of the assumptions were, because I think there may be assumptions --

JUDGE MILLER: Well, that may be, but it's beside the point.

MR. SWANSON: No, I mean which renders that point not at all misleading, because I think there's an assumption on the part of the Board that by putting that statement in there that there's an implicit conclusion by the Staff that 10^{-4} frequency is somehow acceptable, and that's what I'm concerned about.

JUDGE MILLER: No, we are not making any such conclusions at all. We are saying that this testimony which will appear in the transcript is incomplete, because there's something that's alluded to in Volume 4 that puts some kind of background (if you want to say it that way) of the quotation or the paraphrasing from Volume 1.

If you are going to give anything from Volume 1, for whatever purpose, do it completely, and if there's some reference in Volume 4 or some other, put it in context.

That doesn't appear here. I mean, I can read, and it doesn't appear here.

I'm not questioning the motives of the Staff, but I do say that we're not going to let this go where you are going to go into Volume 1 and ignore Volume 4.

MR. SWANSON: Okay. All I'm saying is I think

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Dr. Morris and, I think, Mr. Hulman also wanted to explain.

This isn't the only document that's been introduced, either, on this matter, and I think the Staff has stated in previous testimony that there is a need to have more than one shutdown system.

JUDGE MILLER: Yes.

MR. SWANSON: And that's the -- I think those two gentlemen might be able to help explain just why you can't just take this sentence alone --

JUDGE MILLER: We're taking the whole paragraph.

MR. SWANSON: -- or even the whole paragraph, and assess whether or not that might have been incomplete.

JUDGE MILLER: Well, I can count on my fingers one, two, three, four. If Volume 1 says one thing and I know Volume 4 says something else that might tangentially affect it, I know either you put the two together in context and give your explanation or you don't give me Volume 1.

Now that's just plain logic. I'm not questioning their motives. That's why I don't need explanation, although I'm perfectly willing to let them make it for the record.

All I want is for the written record to be clear and complete, and that can be done.

Okay. That's all that I'm saying.

Now, are there any more where things have been

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taken for granted and you've mentioned one document but don't mention something that's going to come up later? If there is, I suggest that that be corrected.

WITNESS HULMAN: Judge Miller, may I suggest that I attempt to amend Answer A9 right now to incorporate your suggestion

JUDGE MILLER: Fine. I think you probably can.

WITNESS HULMAN: I would propose to insert a new sentence after the first sentence in A9, and I suggest something as follows, if Dr. Morris would agree to it:

"In Volume 4 of NUREG-0460, the Staff found that the risks of ATWS were unacceptable for lightwater reactors. For the CRBR, however, because of redundancy and diversity of shutdown systems, the same conclusion with respect to unacceptability does not apply."

JUDGE MILLER: Have you covered all the reasons that it doesn't apply?

WITNESS HULMAN: Yes.

JUDGE MILLER: You've given one; is that sufficient?

WITNESS HULMAN: Redundancy and diversity of shutdown systems.

JUDGE MILLER: Okay. That is what my technical colleague suggested was the nature of what should be done. We find it perfectly acceptable to put the matter into context and right where it was made.

WITNESS HULMAN: And my question to Dr. Morris, just to make certain that we have agreement on the panel with those words, since it's jointly sponsored testimony, is whether he agrees with it.

WITNESS MORRIS: I think "independent" should be included, to make sure the systems are independent.

JUDGE MILLER: Right.

WITNESS HULMAN: Okay.

JUDGE MILLER: You had better restate that portion so that Mary will have it for the record.

No, I don't mean to repeat the whole thing, simply the part of the statement where you add the "independent."

WITNESS MORRIS: It would just be "for reasons of diversity, redundance and independence."

JUDGE MILLER: Okay. We will consider that it be amended, and we'll ask Mary to check it when it comes out, to add simply that third element.

Okay. Now, does anybody have any objection to that? I don't say you have to agree with it, but does anybody have any objection?

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MS. FINAMORE: No.

JUDGE MILLER: Okay. Hearing none, now the testimony will be amended as just dictated by Mr. Hulman.

Okay. Now you may proceed.

BY MS. FINAMORE:

Q Dr. Morris, you stated in the testimony that you relied upon NUREG-460 for your Answer 9 in part; is that correct?

BY WITNESS MORRIS:

A Yes.

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Q. I have a document in front of me numbered NUREG-CR-0040, entitled, "Risk Assessment Review Group Report to the U.S. Nuclear Regulatory Commission," September 1978, by an Ad Hoc Review Group chaired by H. W. Lewis.

Are you familiar with that document?

BY WITNESS MORRIS:

A. To some extent.

Q. Can you explain what the purpose of that report was?

BY WITNESS MORRIS:

A. I believe that group had been asked by the Commission to provide an independent assessment of the WASH-1400, the NRC risk study.

Q. Did you review that report in your Appendix J analysis?

BY WITNESS MORRIS:

A. Yes. We referred to that report in the section titled, "Uncertainties" on Page J-22.

"Uncertainties" starts on J-22, and specifically, we address the so-called Lewis Report on Page J-23, starting with the third paragraph.

Q. I'd like to read you a couple of sentences from that Lewis Report, if I may, that relate to NUREG-0460.

MS. FINAMORE: May I approach the witness?

JUDGE MILLER: Yes.

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BY MS. FINAMORE:

Q I'm on Page 46 of that document, under Heading 11, entitled, "ATWS, Anticipated Transients Without Scram."

"The Division of Systems Safety of NRC has since issued NUREG-0460, which provides a position on ATWS which it is proposed that NRC adopt in future safety applications.

"NUREG-0460 develops its argument through dependence on purely actuarial information on common load failure probability to scram.

"All new relays in the scram circuit of the Kahl (that's K-a-h-l) reactor in Germany were found at one point to have a scram defect due to an inability to open on spring action when the current is cut off, because the protected plastic coating has not been cured properly.

"This is one statistic, along with an estimate of the probability that a severe transient requiring scram might take place while the inability to scram persisted, led to a calculated frequency of anticipated transients without scram of about 2×10^{4}

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per year for a lightwater reactor."

Did I read that sentence correctly?

JUDGE MILLER: Is that 10^{-4}?

MS. FINAMORE: That's correct, minus four.

BY MS. FINAMORE:

Q. Did I read that sentence correctly, Dr. Morris?

BY WITNESS MORRIS:

A. Yes.

Q. Are you familiar with the one statistic on the German reactor to which they are referring?

BY WITNESS MORRIS:

A. I'm familiar with its existence. I think Mr. Rumble knows a good bit more about the actual details.

BY WITNESS RUMBLE:

A. Yes.

JUDGE MILLER: You have to speak into the mike.

WITNESS RUMBLE: Yes, I know about the Kahl reactor.

BY MS. FINAMORE:

Q. Is it a fair inference from this paragraph that only one statistic formed the basis for NUREG-0460, to your knowledge?

BY WITNESS RUMBLE:

A. No.

Q. Do you agree with the statement that I just

18-12

read into the record?

BY WITNESS RUMBLE:

A. Yes.

Q. And can you explain why you don't believe that's the correct inference to draw from that paragraph?

BY WITNESS RUMBLE:

A. Because the one you talk about was the one failure, but there were hundreds and hundreds of successes that were factored in to get to the 2 x 10^{-4} per year.

Q. Well, is it a fair inference from this statement that there is some degree of uncertainty as to the actual failure rate due to ATWS in lightwater reactors?

BY WITNESS RUMBLE:

A. Yes, there's uncertainty.

Q. Given the fact that there was only one failure used in this NUREG-0460, wouldn't you say that the uncertainties in that final failure estimate are rather large?

BY WITNESS RUMBLE:

A. The uncertainties would be more a function of the total number of trials in this test or event that we're looking at, not the number of failures.

It's a function of the total number of demands that were placed on the systems, and there are statistical analyses using X^2 distributions that can give you a confidence distribution on the failure frequency of the scram system.

It's directly proportional to the number of trials, not failures.

Q But wouldn't you agree that the limited failure data this study is based upon would contribute to the uncertainty in the over-all frequency --

MR. SWANSON: Objection. There's a premise in the question which is directly contrary to the evidence, that there is limited data base.

MS. FINAMORE: I said limited failure data, which the witness has just stated that he agreed with.

MR. SWANSON: I think you just amended the question, but....

JUDGE MILLER: All right. Can you answer it, as amended?

WITNESS RUMBLE: I guess it would be best if I had the whole question restated again.

JUDGE MILLER: All right. Restate the question.

BY MS. FINAMORE:

Q Am I correct that this NUREG-0460 was based on limited failure data?

BY WITNESS RUMBLE:

A. I think it's based on all the failure data available. The word "limited," I don't understand the context of what you mean by "limited."

Q. It's based upon an extrapolation from one failure that was noticed?

BY WITNESS RUMBLE:

A. No, it's not based on any extrapolations. It's a typical statistical technique.

You take a total number of trials and you find out how many failures you had in those trials to determine the frequency.

Q. Turn to Answer 9.

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bm

BY MS. FINAMORE:

Q. On Page 8, the middle of the first paragraph, Dr. Rumble, you state that, "We also took into consideration the potential frequency of occurrence of transients at CRBR."

Can you tell me how you know what the potential frequency of transients at the CRBR is?

BY WITNESS RUMBLE:

A. An estimate of the potential frequency of transients at CRBR can be made, first of all, by noting that the steam plants -- the steam plant at CRBR is similar to that of an LWR.

Therefore, transients initiated in the steam plant at CRBR, their rate would be comparable to that in an LWR, plus taking into account any other differences in the remainder of the plant between that and an LWR.

Q. When you say steam plant failure, do you mean steam generator plant failure?

BY WITNESS RUMBLE:

A. I mean -- not failure. I mean initiators of transients that would occur in the steam portion of the plant.

What I mean by steam is from the steam generators to the main condenser or condensate system, main feedwater system. That loop of the plant.

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Q So you applied the LWR failure rates for the occurrence of transient rate to the CRBR for this statement; is that correct?

BY WITNESS RUMBLE:

A. That, plus -- you know, the judgment of the differences between CRBR and LWR in other areas.

Q So when you say --

JUDGE LINENBERGER: Ms. Finamore, excuse me, but I think -- again without intending to do so -- something that is a bit misleading, the witness explicitly stated that with respect to any comparison with LWR's and Clinch River, if only at the steam cycle part, you came back and bolted together a comparison of complete systems, which does not agree with what he said.

Now, I worry that the public will read this in a bad light here, and I don't think you want that.

BY MS. FINAMORE:

Q Well, returning to my original question, I'm trying to find out what the Staff used -- or how the Staff took into consideration the potential frequency of occurrence of transients at CRBR, which there's a statement in their testimony that applies to all transients at CRBR.

MS. FINAMORE: Now, if the witness only answered for a portion of the CRBR system, I'd like to

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hear how you took into consideration the potential frequency of occurrence of other transients as well.

BY WITNESS RUMBLE:

A. It was judgment, and there are -- besides the steam plant, there are other parts of the plant that you want to look at for initiators. And the PSAR talks about initiators that could potentially -- the frequency of other initiators that could potentially occur. And that was used also.

Q. So you used the PSAR estimates of frequency of occurrence?

BY WITNESS RUMBLE:

A. No. I said that's -- No, I didn't use as part of the basis for coming up with that number --

Q. Well, my question remains: How did you take into consideration the potential frequency of occurrence? Where did you get that information that you took into consideration for CRBR transients?

BY WITNESS RUMBLE:

A. Well, it's a two-step process. Let's start it this way. A two-step process.

Part of the CRBRP is similar to that of an LWR. Compare that part to LWRs. There's part that isn't.

Parts that aren't, the PSAR is consulted, plus judgment.

Q. Okay. For the parts that aren't, you said the PSAR was consulted. Is that where you got your information on the potential frequency of occurrence of transients for those portions of the system?

BY WITNESS RUMBLE:

A. Yes. They have in there a list of potential initiators and the frequency.

Q. And where is that list? What portion of the PSAR?

BY WITNESS RUMBLE:

A. I don't remember right now.

Q. Do you recall, Dr. Morris?

BY WITNESS MORRIS:

A. I believe such a list would be in Chapter 15 of the PSAR.

Q. The frequency of the initiators or just the list of initiators?

BY WITNESS MORRIS:

A. I don't think it gives numerical values. It probably gives a range.

Something like once per year, something like that.

Q. Those are not beyond the design basis initiators? Those are initiators within the design basis --

BY WITNESS MORRIS:

A. No, those -- I believe he's referring to a -- anticipated transients that could occur -- Well, as he mentioned, a large number of them -- I mean the predominant part would probably come from the steam side.

They may be anticipated to occur -- a token trip, for instance -- would be anticipated to occur maybe once a year or several times during the life -- well, several times a year probably.

Q. Dr. Rumble, am I correct then that for the steam generators, you've assumed there would be the same frequency of occurrence of transients in CRBR as in light water reactors?

BY WITNESS RUMBLE:

A. Steam generators didn't add any significant amount to the transient initiator number. They're not a big part of that number at all.

Q. My question was: Did you think -- Did you apply the same failure frequency to steam generator transients in the CRBR, as was used in LWRs?

BY WITNESS RUMBLE:

A. I didn't consider steam generator transients because they are an insignificant part of the total number of transients.

Q. In light water reactors?

BY WITNESS RUMBLE:

A. In Clinch River.

Q. Well, how do you know that? I thought you just said you -- for the steam system you compared CRBR with light water systems?

BY WITNESS RUMBLE:

A. But not the steam generators. After the steam generators, through to the main condenser, condensate system and feedwater system are not the steam generators themselves. They're different in the Clinch River than they are in LWRs.

Q. Do you think the frequency of transients of Clinch River steam generators is higher than at LWR's?

BY WITNESS RUMBLE:

A. Well, first of all, let's define -- A transient is something that initiates a scram. That's the definition of a transient. It has to initiate a scram.

I think that the number of steam generator pipe transients that will initiate scrams will be small and not a major part of the number that we use for total transient frequency per year.

Q. Will it be smaller than in light water reactors?

/

BY WITNESS RUMBLE:

A. No. I don't know exactly what the number would be.

Q. Might they be higher than in light water reactors, Dr. Rumble --

BY WITNESS MORRIS:

A. Maybe I could clarify --

Q. If I could have Dr. Rumble answer, and you can add.

BY WITNESS MORRIS:

A. Certainly. I'm sorry.

BY WITNESS RUMBLE:

A. They might be.

BY WITNESS MORRIS:

A. I think one of the differences is that perturbations in the steam side -- and especially to the steam generator at Clinch River, I don't think they have quite the impact on core parameters for an LMFBR because of that intermediate loop and the essential -- the physical things that separate that part of the system from the core.

And I don't think you need the kinds of protective -- reactor trip initiation systems hooked up to that system for Clinch River that you do for light water reactors.

So I believe there may be a basis -- I think there is a basis for saying that it probably would have fewer trips initiated per year for Clinch River from the steam generator type transients than you would for an LWR.

Q Dr. Rumble, am I correct then that you got the potential frequency of occurrence of steam generator transients at CRBR from the PSAR in order to determine that they were a small contributor?

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BY WITNESS RUMBLE:

A. I don't recall if that's in the PSAR or not, in that list. I'd have to look at the list.

Q. Do you rely on your own judgment for the fact that they're a small contributor?

BY WITNESS RUMBLE:

A. Partly, yes.

Q. Dr. Rumble, do you know or do you have any estimate of the probability of a common mode failure of reactor safety systems due to external hazards, such as seismic events, tornadoes or hurricanes or dam failures?

BY WITNESS RUMBLE:

A. Let me -- I don't know the answer to that.

Q. Would you agree that the largest cause or the primary contributor to common cause failures of reactor safety systems would be external hazards, such as I've mentioned above?

BY WITNESS RUMBLE:

A. I wouldn't agree to that.

BY WITNESS HULMAN:

A. May I add, please, that the Staff is involved in such a review now on Indian Point. The Staff has concluded external hazards -- some of them -- may be contributors to common cause failure modes.

But at Indian Point, the probabilities of such events are in the same order of magnitude, as is represented in Table J.2; that is, they would not dominate.

BY WITNESS MORRIS:

A. Perhaps I can also add that the plant is to be designed against a range of external events: tornadoes, floods, earthquakes, fires. There are protective measures inherent in the design to make the risks from those kinds of events from common cause or whatever quite low.

It's these deterministic criteria that will be applied to achieve those design measures that makes us believe that in any case the risks from those kinds of events at Clinch River will be comparable to LWRs and quite low.

Q. Thank you.

Mr. Hulman, are you involved in that review you've just mentioned for Indian Point?

BY WITNESS HULMAN:

A. Yes, ma'am.

Q. Are you familiar with the report prepared by Sandia regarding that subject of external events?

BY WITNESS HULMAN:

A. Yes, ma'am.

Q. Isn't it true that that report states that the dominant cause of core melts, or the predominant contributor to core melts would be external events?

BY WITNESS HULMAN:

A. My recollection of the Sandia conclusions were that they concluded that one event dominated -- one external event dominated the risks.

But when it's compared with internal generators, the Staff's conclusions have yet to be heard. Sandia did conclude that one external event -- the hurricane -- dominated the risk of common cause failure mode at Indian Point.

Q. On Page 8 of the testimony, Dr. Rumble, you state that "Some LWR ATWS precursors seem relevant to CRBR but others do not."

Can you explain which precursors you're referring to as relevant and which ones as not relevant?

BY WITNESS RUMBLE:

A. I can start, and perhaps some people might want to add.

I think what we're talking about in that sentence is specifically, for example, as you've pointed out before, the Kahl failure, where the relay contacts had a certain varnish on them and would not open on loss of power.

That, in principle, is applicable to any system that has relays, although the process of rectification -- now that we're aware of that problem -- we would anticipate

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that that would not recur.

That would be one that would seem relevant. Another one that perhaps is not relevant happened in one of the -- I guess it was a reactor in Hanford, the end reactor, which had a control system different than Clinch River.

Therefore, it would not be appropriate to the Clinch River plant in general.

Perhaps somebody else.

BY WITNESS MORRIS:

A. I think one of the other precursors we recall is a problem in a BWR with the scram discharge volume; in some cases that that doesn't operate properly. That could be a precursor.

This plant will not have such a system, and we feel that that precursor is not relevant.

Q. On Page 9 of your testimony, Dr. Rumble, you refer to the reliabilities of the auxiliary feedwater system in the Clinch River Breeder Reactor.

Am I correct that you base your estimate on the reliability of such a system on the reliability of a PWR auxiliary feedwater system?

BY WITNESS RUMBLE:

A. Yes, in part.

Q. And is that because -- Why do you base your reliability estimate on an estimate of the reliability of the PWR system?

BY WITNESS RUMBLE:

A. Because of the similarity between the two systems.

Q. What portions of the system are you referring to when you say they're similar?

BY WITNESS RUMBLE:

A. Well, nearly all of the system from the tanks that store the auxiliary feedwater through the auxiliary feedwater pumps, the valving, the automatic initiation, the function, the requirement of power, these things are similar.

The number of trains, redundancy and diversity.

Q. The number of steam generators is not the same, for example; is that correct?

BY WITNESS RUMBLE:

A. That's correct.

Q. Dr. Rumble, I have a document in front of me entitled -- or numbered NUREG-CR-1659-3 of 4. It's entitled "The Reactor Safety Study Methodology Applications Program, Calvert Cliff, No. 2 PWR Power Plant." The authors are Steven W. Hatch, Gregory J. Kobe, dated May 1982.

Two other authors are Peter Cybulskis,

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C-y-b-u-l-s-k-i-s, and Roger O. Wooton, W-o-o-t-o-n.

This is a document prepared by Sandia National Laboratories for the Division of Risk Analysis, Office of Nuclear Regulatory Research, U. S. Nuclear Regulatory Commission.

I'd like to read you a sentence -- or a couple of sentences that relate to the analysis of failure rates among various PWRs.

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MS. FINAMORE: May I approach the witness?

JUDGE MILLER: Yes.

BY MS. FINAMORE:

Q By way of background, Dr. Rumble, isn't it true that the WASH-1400 document you relied upon did contain a probabilistic risk analysis for a PWR?

BY WITNESS RUMBLE:

A. Yes.

Q And that WASH-1400 was also called "The Reactor Safety Study." Is that correct?

BY WITNESS RUMBLE:

A. Yes.

Q Now, if you'd read the Executive Summary here. I'd like to ask you -- again by way of background -- your understanding that this study of the Calvert Cliff feedwater system attempted to apply the methodology and results of the WASH-1400 PWR system.

BY WITNESS RUMBLE:

A. Yes.

Q I'd just like to read to you from Page 3-2 of that document.

"A word of caution should be made about comparing the system failure probabilities of both plants. The comparison given in the following descriptive summaries is based on an independent comparison of the systems.

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Interdependencies among the various systems at the plant are not considered at this point. Because of this fact, a statement such as 'Calvert Cliff System A has a failure probability five times greater than Surry System A has no safety significance, unless the systems being compared are truly independent of other systems at the plant and have an equivalent role in performing a post-accident function.' For purposes of comparing safety then, the appropriate place of comparison is the accident sequence, since it is at this point where all system inter-dependencies are considered."

Did I read that statement correctly?

BY WITNESS RUMBLE:

A. Yes.

Q. Do you have any basis for disagreeing with that statement?

MR. SWANSON: Can we have -- I guess I had better object until we have a better showing of relevance to their testimony at this point.

I just haven't heard any foundation leading up to this question of showing any relevance at all to the Staff's prefiled testimony.

JUDGE MILLER: Well, we don't know, but it's a little late to be raising that question.

MR. SWANSON: Well, she read a statement and

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now she's asking him the first question.

I --

JUDGE MILLER: The first question was whether or not she read it correctly, wasn't it?

And the witness agreed that she had.

MR. SWANSON: Now she's asking for this witness' opinion on a matter related to that. I'm objecting, absent a showing of relevance.

JUDGE MILLER: We can't really tell one way or the other at this point. What is your next question?

MS. FINAMORE: My next question was if he has any basis for disagreeing with this statement.

JUDGE MILLER: Had he answered?

WITNESS RUMBLE: No. I haven't answered yet. I'm thinking.

JUDGE MILLER: You really haven't suffered any prejudice unless he disagrees with that, have you?

MR. SWANSON: I'm just not sure why we're taking up the time now --

MR. EDGAR: Unless we have --

MR. SWANSON: -- without any foundation or relevancy.

JUDGE MILLER: I suppose because it's a cautionary note. I think I've heard some cautionary notes when Ms. Finamore was trying to analogize things. I think

I've heard people saying they're not analogous.

This is some of the things that you look at, I believe.

WITNESS RUMBLE: I agree in part with that statement. I don't agree with it in total.

JUDGE MILLER: That's a Solomonesque pronouncement!

(Laughter.)

JUDGE MILLER: Now can you disintangle the two? Or the part, I suppose, that you disagree with is the one that's being inquired about.

WITNESS RUMBLE: I understand the concern about independence. I disagree with the last statement, "For the purpose of comparing safety then, the appropriate place of comparison is the accident sequence." And then it goes on.

BY MS. FINAMORE:

Q. What is the basis for your disagreement?

BY WITNESS RUMBLE:

A. Well, I think that -- as I mentioned before -- in our comparison of aux feed systems, if you look at the entire function in itself, including all its service and interacting systems, you can make a comparison at that point.

You don't have to look at the initiator

frequency, for example, or other parts of the sequence.

You have to be very careful about independence and all that, but I don't think that in general you can make a blanket statement like they have in this paragraph here about always having to go over the entire accident sequence in order to make comparisons.

JUDGE MILLER: It sounds relevant.

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BY MS. FINAMORE:

Q Isn't it true that the auxiliary feedwater system is not truly independent of other systems at the plant?

BY WITNESS RUMBLE:

A. True.

JUDGE LINENBERGER: The Board would like a brief clarification.

I believe it was in the first sentence of that quotation, the word "both", b-o-t-h, appeared. It was not clear whether both was defined later on as meaning Calvert Cliffs contrasted with Surrey or whether both meant something else.

Can somebody clarify that, please?

MS. FINAMORE: Yes.

This report goes on to compare the Calvert Cliffs system with the Surrey system. So those are the two plants they are referring to.

It is my understanding that they are both PWR systems.

JUDGE MILLER: Is that what the "both" refers to in that context?

MS. FINAMORE: Yes.

MR. EDGAR: I'm sorry. I can't find the "both".

JUDGE LINENBERGER: Well, the very first

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sentence that was read, the word both appeared.

And it wasn't until later that I heard two things that I thought might comprise the both and I guess those two things are Calvert Cliffs and Surrey and I'm asking you to tell me if I' m right.

MS. FINAMORE: Well, if you look at the immediately preceding sentence on Page 3-1 --

JUDGE LINENBERGER: Excuse me. Can you just affirm or deny whether I'm right.

JUDGE MILLER: Do all Counsel agree that the "both" refers to the two plants named Surrey and Calvert Cliffs?

MS. FINAMORE: Yes.

MR. EDGAR: Yes.

MR. SWANSON: Since we weren't provided a copy by Intervenors, we would like to look at it right now.

JUDGE MILLER: Okay. Take a look.

MR. SWANSON: It would appear that way.

JUDGE MILLER: Do you have any reason to believe that it is not so?

MR. SWANSON: No.

JUDGE MILLER: Thank you.

JUDGE LINENBERGER: I would like to ask the witness a question, by way of explanation of his answer to your --

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Dr. Rumble, you disagreed in part with the statement that was read to you and the thing I'm having difficulty with is whether your disagreement is founded on what the author was saying with respect to the comparison of dose of those specific two plants or whether your disagreement was founded on how you approached and how the Staff approached the intercomparison of comparable systems in LWR's and in Clinch River or was your disagreement with respect to both aspects?

WITNESS RUMBLE: I had a generic disagreement with that last statement, being a blanket statement. It isn't always applicable. Sometimes it is and sometimes it isn't.

BY MS. FINAMORE:

Q. Dr. Rumble, do you believe that one should at least examine the accident sequences to determine whether or not that statement is applicable?

BY WITNESS RUMBLE:

A. Yes.

Q. Now, this statement applies to two PWR's. Isn't it true that it would apply with even greater force when one is comparing a PWR with an LMFBR?

BY WITNESS RUMBLE:

A. I would use -- it's of paramount importance in both cases. So, greater in this case doesn't apply.

It's a primary consideration in both cases.

It's LWR to CRBRP.

Q Isn't it true, though, that although the auxiliary feedwater systems might be similar in lightwater reactors than in the CRBR, that accident sequences involving those systems might be very different, for the two types of reactors?

BY WITNESS RUMBLE:

A. I Have a problem answering that because of the very different -- your very different may be different than my very different.

I would say no, they are not very different. Perhaps.

Q But they are different?

BY WITNESS RUMBLE:

A. There are differences.

JUDGE MILLER: You are getting pretty fine now.

BY MS. FINAMORE:

Q On Page 9 of your testimony, can you tell me which documents you relied upon for your judgment that the frequency of core degradation failure due to LOHS events is less than 10^{-4} per reactor?

BY WITNESS RUMBLE:

A. No specific documents relied upon. I think

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the Answer A10 tells you how -- what the basis for that estimate was.

Q So am I correct then, in that the only document you relied on is WASH-1400?

BY WINTESS RUMBLE:

A No. Basically, it's part of the bases for Answer A10 are all mock feedwater LWR studies that have been done, such as the RSMAP study you have there and the IREP studies, designs, PRA, basically there is quite a large library of auxiliary feedwater systems studies and there is an NRC Report -- I think perhaps Dr. Norris knows more about that report -- but that talks generically about auxiliary feedwaters systems, their attributes and their reough reliabilities.

These kind of documents were used.

Q So you relied upon those documents for your answer 10?

BY WITNESS RUMBLE:

A I continue to have trouble with the word rely upon. It is part of our basis of our judgment.

Q Well, which documents did you rely upon? The only one you've mentioned in the Answer is WASH-1400.

Am I correct to infer that is the only specific document you relied upon?

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BY WITNESS MORRIS:

A. Perhaps I can clarify this --

Q. I'd like Dr. Rumble to answer first and then you can add, if you wish.

BY WITNESS RUMBLE:

A. I can't really add much more than what I've already said, about how we got to quantification of loss heat sink events.

Q. My answer (sic) is capable of a yes or no.

Is WASH-1400 the only specific document you relied upon in Answer 10?

BY WITNESS RUMBLE:

A. No.

Q. What other specific documents did you rely upon? For the judgment of the estimated bounding frequency of LOHS events?

MR. SWANSON: We've already had a discussion by the witness of documents that he used. He talked about a large library of auxiliary feedwater studies -- I don't know how many more times he has to keep repeating this statement.

MS. FINAMORE: He did not answer my question.

JUDGE MILLER: Well, he's already said he didn't rely on any. He was having trouble with the word "rely".

It's going to be zero to a thousand, I guess.

20-7

So when you come back with a reliance upon you, you're going to get the same negative from the witness, I believe.

WITNESS MORRIS: Could I try to clarify now?

BY WITNESS FINAMORE:

Q Maybe you could explain the difference in your mind between forming the basis and relying upon a document, Dr. Rumble.

BY WITNESS RUMBLE:

A. I'll try to do that.

The documents forming a basis by which a judgment is made, we used as part of our process evaluating these frequencies, our own minds. We post process these documents, weighed their relative merits, their relative accuracy -- I think that's a poor way to put it -- the quality, the amount of effort that went into these documents, plus we applied our own judgment, as stated in the testimony, regarding potential of a strong reliability program.

Other aspects in arriving at the frequency.

Q So you used --

BY WITNESS RUMBLE:

A. In relying, I interpret that to mean, you take a document and you get a number and you use that number, period, and without post processing it.

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That's what rely means to me. Without using any judgment, you just pick a number out of a document and use it.

Q So when you said you used these other documents in arriving at an estimate, meaning you -- they formed the basis for your conclusion or part of the basis for your conclusion?

BY WITNESS RUMBLE:

A Yes.

Q Am I correct in that you did rely upon WASH-1400?

BY WITNESS RUMBLE:

A No. That's not correct.

Q Did you rely upon any specific documents for your conclusion that the auxiliary feedwater system is controlling in determining LOHS failure frequencies?

BY WITNESS RUMBLE:

A No, I didn't.

Q Did you use any documents for the basis of that conclusion?

BY WITNESS RUMBLE:

A The same documents I mentioned before were also part of the determination that the auxiliary feedwater system was an important system in lost heat sink events.

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Q Are you familiar with a report entitled Precursors to Potential Severe Core Damage Accidents, 1969-1979, A Status Report, Numbered NUREG/CR-2497, Dr. Rumble?

BY WITNESS RUMBLE:

A I think so. I could better answer that if I could see it.

Q Do you have the impact statement in front of you?

I'd like to refer you to Page 12-75.

Am I correct that you referred to that document in your environmental impact statement?

BY WITNESS RUMBLE:

A That's NUREG -- what's that, 2497 document? That's what's quoted here, yes.

Q Do you have the page in front of you?

BY WITNESS RUMBLE:

A Yes.

Q Did you review that document in your preparation of Appendix J?

BY WITNES S RUMBLE:

A My timing -- I think that document, I think I reviewed that between the draft and the final stage of Appendix J.

I don't think that was available or I did not review it before the draft was issued.

Q Did you, Dr. Morris?

BY WITNESS MORRIS:

A. No. In the original preparation of Appendix J, we did not have this available to us. We didn't review it until we were comparing responses to comments from the public.

It was available to us as we prepared the final FES supplement.

Q Did you consider the information in that document in preparing the final --

BY WITNESS MORRIS:

A. Yes, we took it into consideration, as explained on Page 12-75 and 12-76 and based on the explanation here, we didn't feel it was necessary to change any of the conclusions or any of the initiating frequencies in Appendix J.

Q Isn't it true that this report found that the frequency of generic core melt was not controlled by shutdown system or AFWS failure rates?

BY WITNESS RUMBLE:

A. That could be, yes.

Q Dr. Rumble --

WITNESS MORRIS: Excuse me --

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BY MS. FINAMORE:

Q Turning to the LOHS and the cooling system in the PWR and CWR -- I'm referring to the system as a whole -- you said that there were some differences between a PWR and an LWR in the accident sequences, am I correct? For loss of heat sink.

BY WITNESS RUMBLE:

A. I think you misspoke.

Between the Clinch River and an LWR.

Q And a PWR.

BY WITNESS RUMBLE:

A. And a PWR. Yes.

Q Is it not also true that there are differences in the cooling system between LWR's and PWR's?

BY WITNESS RUMBLE:

A. Between Clinch River and PWR's, differences in the cooling --

Q CRBR and PWR.

BY WITNESS RUMBLE:

A. Yes. That's correct.

Q Can you briefly state what those differences are?

BY WITNESS RUMBLE:

A. Well, starting from the primary heat transport loops, we have sodium, Clinch River, and water in the LWR

20-12

and intermediate heat exchanger and intermediate loop, plus we've noted this differences in steam generators.

There are some of the major differences there.

Q When you say intermediate loop and intermediate heat exchangers, are you saying that they are present in the CRBR and are not present in a PWR?

BY WITNESS RUMBLE:

A. Yes.

Q Is that correct?

Now, given those additional systems, wouldn't it be true that the faulttree/event tree analysis for accident sequences of those systems would be different between a CRBR and a PWR? Since it must take those systems into account?

BY WITNESS RUMBLE:

A. Yes.

Q And given that fact, isn't it true that you would introduce different failure modes in a CRBR than you would have -- cooling system, than you would have in an LWR cooling system?

BY WITNESS RUMBLE:

A. Yes, there's that potential for different failure modes, yes.

Q Now, did you analyze those two different failure modes or accident sequences for PWR's and the

20-13

CRBR?

BY WITNESS RUMBLE:

A. Yes. Part of the loss of heat sink analysis we analyzed. We didn't do any fault tree or event tree work but certainly looked at potential initiators from primary loop and from the secondary loop, as far as loss of heat sink goes.

Q. But that does not include a fault/tree event tree analysis; does it?

BY WITNESS RUMBLE:

A. That's what I said. No. We did not do a fault tree/ event tree analysis.

Q. When you say that you looked at the PWR auxiliary feedwater system, can you tell me what components you included within that system, for PWR's?

BY WITNESS RUMBLE:

A. PWR's.

Basically, the major components of a system, an auxiliary feedwater system you would want to look at, include first of all, the water supply. How many storage tanks and and how are they valved into the system?

Are they manually valved, automatically valved? Are they protected or are they not protected?

Following that, you look at the supply headers to the auxiliary feedwater pumps and the number and kinds

20-14

of auxiliary feedwater pumps that the system has and the discharge header and the valving on the discharge header and whether they are automatic or manual.

The electrical power and control power for this, requirements of service water and chill water and the amount -- and the other thing that's important is, the timing.

The specific time you have to initiate auxiliary feed and get in some initiator before you would run into trouble.

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Q Did you include in that definition of the auxiliary feedwater system any of the components that Applicants refer to as the direct heat removal service?

BY WITNESS RUMBLE:

A. No, that's a completely different system. We certainly know about the direct heat removal system and included it, but it's not part of the auxiliary feedwater system, as far as I'm defining it here.

Q What are the major systems -- components involved in the direct heat removal service, briefly?

BY WITNESS RUMBLE:

A. The direct heat removal system is a simple system. It has valves, air blast heat exchangers and pumps and pipes, and connects to the reactor vessel.

Q Did you consider the probability of failures of any of those components in the direct heat removal service for your conclusions in Answer 10?

BY WITNESS RUMBLE:

A. Well, we looked at that system and tried to analyze its unavailability upon demand.

Q Do you know what the probability of failure of the protected air cooled condensers are in the direct heat removal service?

BY WITNESS RUMBLE:

A. I think that -- I wouldn't want to state any

21-2

specific number for that, but I can tell you that they would not be the limiting factor of that system.

In other words, if one did a fault tree analysis of that system, the specific failure of an air blast heat exchanger would not show up as a dominant failure mode.

Q But you have not done such a fault tree/event tree analysis?

BY WITNESS RUMBLE:

A. Not on a piece of paper, no, looked at the system and looked at what would be major components to its failure.

Q Are you saying you performed an event tree/ fault tree analysis in your head, not on paper; is that what you're saying?

BY WITNESS RUMBLE:

A. Having worked in the risk assessment area on and off for eight years, I tend to think fault tree/event tree when looking at systems.

There probably was some fault tree/event tree analysis done when I looked at that system, in my head.

Q Isn't it possible that when you performed a comprehensive fault tree/event tree analysis, you might discover other failure modes that you might not have thought of in your head?

21-3

BY WITNESS RUMBLE:

A. There may be some, but that system has some dominant failure modes which I do not feel there would be any failure modes that would be more significant than the ones that we've found.

Q. Can you explain to me briefly what alternative ways you could reach a loss of heating event, other than the ones you've described -- loss of heat sink events?

BY WITNESS RUMBLE:

A. Loss of heat sink occur when there's no way to remove heat from the core. Therefore, initiator would require the knocking out of all four possible paths for removing heat.

Thus, we would look at initiators that would prevent heat flow from the reactor to the heat sink, which is ultimately the Clinch River and the air environment.

Possible ones would include potential problems in the intermediate loop or the primary loop, combined with problems with the DHRS. Those kinds of combinations could lead to a loss of heat sink event.

Q. Well --

JUDGE LINENBERGER: Let me just inject a comment here, please. Intervenor's Counsel has every right to pick the panel member to which he wishes to address a question.

21-4

If the answer to that question indicates that panel member has not performed some analysis, and indeed, the Staff knows that it has performed that analysis, albeit by someone else, the Board would caution the Staff that they should make this known, lest the record reflect that one member not having done something does not speak for the total record.

So let's be cautious on that point.

Thank you. I'm sorry for the interruption, Ms. Finamore.

BY MS. FINAMORE:

Q. Dr. Rumble, assuming hypothetically that the auxiliary feedwater system did continue to operate, what would be the most likely scenario of the ones you've just described that would lead to a loss of heat sink event?

BY WITNESS RUMBLE:

A. That question doesn't make any sense to me. Could you repeat it, please?

Q. Well, is it possible to have a loss of heat sink event, if the auxiliary feedwater system is in operation?

BY WITNESS RUMBLE:

A. It's possible, yes.

Q. Okay. Can you describe that accident sequence to me?

21-5

BY WITNESS RUMBLE:

A. It would be a sequence in which there is interruption of heat flow from the reactor to the auxiliary feedwater system, and the DHRS system, the direct heat removal system has also failed.

Q. Do you know the probability of such an accident occurring?

BY WITNESS RUMBLE:

A. It would be -- We have looked at these kinds of sequences, and it would be less than 10^{-4} per year. It would be quite a lot less than 10^{-4} per year.

Q. How did you get that quantitative estimate?

BY WITNESS RUMBLE:

A. Well, in the analysis you have to look at, first of all, the initiator frequency. The frequency of losing all three loops, the normal heat loops, combined with the loss of the DHRS.

So it's an analysis of those factors.

Q. Have you performed a calculation to reach the 10^{-4} number?

BY WITNESS RUMBLE:

A. Well, we've performed that, yes, simple calculations of estimates of these failure modes and combined them appropriately.

Q. Turning to fuel failure propagation, Dr. Rumble, you referred to local perturbation such as gas bubbles or debris particles as a contributor to fuel failure propagation; is that correct?

BY WITNESS RUMBLE:

A. Yes. I would like to say that Mr. Morris was the person that primarily did the fuel failure propagation work.

Q. You had no connection with this work; is that correct?

BY WITNESS RUMBLF:

A. He was the primary person. I had only, at best, secondary involvement with this one.

Q. Dr. Morris, isn't it true that there are other ways to get fuel failure propagation other than gas bubbles or debris particles?

BY WITNESS MORRIS:

A. Yes.

Q. And isn't it true that such an event occurred in the FERMI plant when it was a --

JUDGE MILLER: Did an event occur in the FERMI plant?

WITNESS MORRIS: I thought she was -- I'm sorry.

MS. FINAMORE: I withdraw that question.

JUDGE MILLER: I was just asking. Did something occur in the FERMI plant?

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WITNESS MORRIS: Yes, a fuel blockage in the single fuel assembly occurred.

MS. FINAMORE: Fuel blockage. I'll get to that in a minute.

BY MS. FINAMORE:

Q. What other ways are there to get fuel failure propagation other than gas bubbles or debris particles?

BY WITNESS MORRIS:

A. Well, as you alluded to the FERMI event, which there was a blockage, a flow blockage. You could have a flow blockage either at the inlet or conceivably somewhere above up in the actual body of the fuel bubble itself.

Another possibility would be a fabrication flaw that could have been built into one of the fuel tubes, something like pinhole failures that could occur.

Q. What's the actual quantitative probability of fuel failure propagation at Clinch River Breeder Reactor?

BY WITNESS MORRIS:

A. As you know, we didn't come up with an actual quantitative value for that. We examined the various design features that would help prevent such fuel failure propagation, and on the basis of the nature of those design measures, we felt that this just was not an important contributor to the CDA probability.

Q. Was that a qualitative analysis that you

21-8

performed?

BY WITNESS MORRIS:

A. Yes.

Q. Now, can you apply that to a quantitative analysis without having a particular number in mind or range of numbers?

BY WITNESS MORRIS:

A. It's simply a judgment based upon these various features that we enumerate in our response A 11 and folded in with that is the nature of those features.

They are not active features; they are passive and inherent design features. Admittedly, that is a judgment. That doesn't involve a quantification.

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Q. Now, isn't it true that a probabilistic risk assessment of this particular event will be performed at some time in the future by the Applicants and reviewed by the Staff?

BY WITNESS MORRIS:

A. We anticipate that that will be performed at some time.

Q. And at that time, won't there be a quantitative probability assigned to such an event?

BY WITNESS MORRIS:

A. Yes, but I anticipate that, too, will be based on judgment.

Q. That work is presently ongoing; am I correct?

BY WITNESS MORRIS:

A. Yes. It will be completed, I think, something like 1984 is the schedule.

Q. That quantitative number might be equal to 10^{-4} probability; is that correct?

BY WITNESS MORRIS:

A. It may be. We project it to probably be smaller than that.

Q. But you're not sure?

BY WITNESS MORRIS:

A. I can't say with complete confidence that it won't be that high.

21-10

Q If it were that high, wouldn't it be reasonable to add that failure probability to that for the other CDA initiators in arriving at an over-all probability of CDA initiation?

MR. SWANSON: Objection. Now we're asking him to speculate as to what the results might be of his analysis, and now we're going beyond that to ask him, "Well, if you speculate that, now speculate something else," and we are asking for speculation on speculation.

BY MS. FINAMORE:

Q Well, let me ask you this, Dr. Morris. Isn't it true that you combined the probabilities of two of your CDA initiating events in order to arrive at an over-all probability of CDA initiation?

BY WITNESS MORRIS:

A We have attempted to include all the initiators in that combined value, and that reflects a judgment that taken all together they would be unlikely to exceed 10^{-4} per year in frequency.

It means that we've made a judgment that the dominant two are ATWS and loss of heat sink, and that LOCA initiated CDA's and fuel failure propagation initiated CDA's are somewhat lower than that and really aren't a major contribution to that.

Q When you say "somewhat lower," what factor lower are they in your estimation, a factor of 10 lower?

BY WITNESS MORRIS:

A. It would be inappropriate to put much quantification on that. A factor of 10? I would not be willing to say a factor of 10 lower, no.

I just don't know enough about it to make that judgment. It's just our belief that they would be enough lower that they would only be adding a fraction to the contribution --

Q. What fraction are you referring to? How much lower is it?

JUDGE MILLER: Are you able to answer that, Dr. Morris?

WITNESS MORRIS: I think it would be -- I don't believe it would be an appropriate reflection on our ability to quantify for me to --

JUDGE MILLER: We don't want you to speculate or surmise. When you reach the edge of where you can testify with reasonable certainty, just tell us.

We don't want you to go beyond.

WITNESS MORRIS: I think I've reached the edge.

JUDGE MILLER: Very well.

BY MS. FINAMORE:

Q. You also refer to a "tag gas" system in your answer on Page 10, the final paragraph.

You state that, "To assure early warning of fuel cladding failures there will be a 'tag gas' system."

How do you know the "tag gas" system will respond quickly enough to prevent fuel failure propagation?

BY WITNESS MORRIS:

A. Well, it isn't intended to be a rapidly responding system. We envision that one of these fuel fabrication related pinholes might occur, and if that happens, there will be a leakage of this "tag gas" out into the coolant, and then that will be detected.

This is just an early warning that something is going on. It would allow one to monitor the possibility that these things are progressing.

So I don't think that we intended to make you believe that this was the only factor. This is just one of many of the factors that go into this judgment.

Q. Do you know the failure rate of the "tag gas" system?

BY WITNESS MORRIS:

A. We have no specific failure rate attributed to it. We think it will be a fairly simple system, and such a system shouldn't have a very high failure rate.

Q. Isn't it true that the CRBR would be permitted to operate with a certain percentage of failed fuel, as

21-13

with lightwater reactors?

BY WITNESS MORRIS:

A. That has been proposed by the Applicant, but we don't yet know whether -- what that precise level would be.

We haven't finished our review in that regard.

Q. Assume hypothetically for a moment that you do concur with Applicants' proposal in that regard.

Is it then not true that although the "tag gas" system identifies failed fuel that continued operation might occur without repair of the failed fuel?

BY WITNESS MORRIS:

A. Well, I think that's exactly the kind of factor that we would have to take into account in our ongoing review, whether or not operation with failed fuel would mask the signals from the "tag gas" system or the delayed neutron monitor.

So that's the reason I can't tell you what the conclusion of the review is. That has to go on to determine whether there could be a masking.

Q. You state on Page 11, third paragraph, that, "Quality assurance and quality control programs are to be employed for the manufacture of the CRBR fuel pins and assemblies, to assure that fuel with manufacturing defects will not be loaded into the reactor."

21-14

When you say "assure," do you mean that they will, with 100 percent reliability, prevent fuel with manufacturing defects from being loaded into the reactor?

BY WITNESS MORRIS:

A. No. When I use the word "assure," that just means that it provides us a level of confidence.

I can't think of anything that provides you 100 percent confidence.

Q. When you say it provides you "a level of confidence," are you taking into account in any way problems with quality assurance that have occurred in fuel failure or fuel manufacture programs in other plants?

For example, the problems with quality assurance program in the Kerr-McGee Fuel Manufacturing Plant for the FFTF?

BY WITNESS MORRIS:

A. We recognize that there may be breakdowns in quality assurance programs, but we believe that continued emphasis on developing better and better quality assurance will prevent those kinds of breakdowns.

The possibility of a breakdown of quality assurance is in our minds, and that's part of the reason for all the other provisions that are there, so that you have defense in depth.

You have quality assurance, plus other things

21-15

that are done to make sure that if the quality assurance breaks down, that you catch the problem in time.

Q. Now, am I correct that for your conclusion that fuel failure propagation is bounded by ATWS and loss of heat sink event you rely on systems such as quality assurance, detection systems, redundant systems, et cetera?

BY WITNESS MORRIS:

A. Well, we rely on these measures that are enumerated in this answer, and there are a number of different measures.

That defense in depth adds up to our level of confidence and makes us believe it is relatively unlikely these are going to occur, compared to some of the other events.

Q. Now, taking quality assurance for an example, isn't it true that there will also be quality assurance and quality control programs for ATWS -- to prevent ATWS events and loss of heat sink events?

BY WITNESS MORRIS:

A. That's correct.

Q. And isn't that also true for detection systems?

BY WITNESS MORRIS:

A. That's correct.

Q. And redundant systems?

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BY WITNESS MORRIS:

A. Correct.

Q. And so that shouldn't be a basis for distinguishing between probabilities of ATWS systems and fuel failure propagation systems?

BY WITNESS MORRIS:

A. That alone is not the basis. As I say, that's only one of a number of factors that are taken into account.

Q. But if you are comparing the probability of two systems and if a factor is common to both, then isn't it true that it should not affect the relative probabilities of the two systems?

BY WITNESS MORRIS:

A. It certainly affects absolute probabilities of each of the two, and that's what we had to take into account here.

Q. But does it affect the relative probabilities?

BY WITNESS MORRIS:

A. This is not something that one can quantify with the kind of precision that you might think. Quality assurance programs that apply to fuel pins are probably, I think, different from the quality assurance programs applied to the components in a protection system; and I don't think there's any scientific way to make a numerical comparison.

22-1
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BY MS. FINAMORE:

Q. Are you saying then that the quality assurance program would be any less effective for any of those systems?

BY WITNESS MORRIS:

A. No. I just can't quantify them numerically. I don't know any way to do that.

Q. Aren't you assuming then that they would be equally effective in all of the systems?

BY WITNESS MORRIS:

A. I think they will be adequately effective in all of the systems, but I can't say that it's equal.

JUDGE MILLER: Let's take about a ten-minute recess.

(A short recess was taken.)

JUDGE MILLER: Let's resume.

Let me inquire: We haven't really interfered much in the timing of the various activities, since the parties themselves and their counsel have set up the schedule agreeable to them and the Board.

It would not appear to us that you're going to be on it, but we expect to adhere to it. So I'm counseling you people to do what is necessary to adhere to the schedule you've recommended.

MR. EDGAR: I would say for us that we can't control that. We haven't had an opportunity to cross-examine yet. It's our belief that NRDC has gone far over their alloted time.

JUDGE MILLER: You haven't cross-examined this panel?

MR. EDGAR: We've cross-examined this panel. We've got Dr. Cochran to come. We have another Staff panel to come.

In our judgment the time has been excessive. The cross-examination has been non-productive. We're off schedule.

JUDGE MILLER: Did you not take this into consideration when you participated in the production of that schedule?

MR. EDGAR: I took into consideration the representation of counsel for NRDC that we could finish all of the accident panels by the end of today.

I did not, by accepting that recommendation or that representation, agree to limit my cross-examination, which I think can be done in three to four hours -- quickly --

JUDGE MILLER: What's three to four hours?

MR. EDGAR: My cross-examination of Dr. Cochran on these issues.

JUDGE MILLER: Three to four hours?

22-3

MR. EDGAR: Yes, sir.

JUDGE MILLER: That was fed into this schedule?

MR. SWANSON: The schedule contemplated that Intervenors would cross-examine the Applicants' two panels and the Staff's two panels Monday and Tuesday -- the first half of Tuesday, and that cross-examination by Staff and Applicant of Dr. Cochran would be on Tuesday afternoon.

JUDGE MILLER: This is Tuesday evening. We expect to have closing arguments Thursday. Something is going to give?

MR. SWANSON: Well, we're over schedule, I agree. At this point --

JUDGE MILLER: Maybe we had better have a look at it and foreshorten time right down the line then.

MR. SWANSON: Maybe we should find out how much more Intervenors contemplate because we've got the other Staff panel, too, on 5(b), which is supposed to have been completed by like noon also.

JUDGE MILLER: All right, we'll review everybody. Let's start off with Intervenors. They say you're the ones who are already half a day behind.

MS. FINAMORE: Okay. Part of the reason for that is -- what happened yesterday, as I stated before, that did run a little bit over; and I didn't get started on my cross of the panel the first thing this morning either.

I did mention, however, that -- I think we're still on schedule.

(Laughter.)

JUDGE MILLER: Are you marching to a different drummer perhaps? Are you thinking of next week?

(Laughter.)

MS. FINAMORE: No.

JUDGE MILLER: Okay. Tell us what you propose then.

MS. FINAMORE: I still have a few more pages of this panel. I have much more limited cross of Panel 5(b), and again very limited cross of the panels on 7(a) and (b). That's all the cross-examination that I have remaining.

MR. EDGAR: What do you estimate it will take?

MS. FINAMORE: Well, I guess I said yesterday that 7(a) and (b) would probably take a couple of hours at the outside.

Contention 5(b), half an hour to an hour.

The remainder of this panel, I'd say an hour or an hour and a half.

MR. EDGAR: We are off our schedule. We are seriously off our schedule.

JUDGE LINENBERGER: Well, I think we are, and I'm a little concerned that an hour and a half will complete this panel when there's 50 pages of testimony, and we're at present at Page 11.

MS. FINAMORE: Yes. That takes into account the fact that there are portions that we have no cross on. It's not of equal depth on all portions.

MR. SWANSON: I guess what that means is that if we plow through, by about 7:00 or 7:30 tonight, we'll only be half a day behind.

JUDGE MILLER: We're going to stop at 6:00 tonight.

MR. SWANSON: That's the problem. We're already --

JUDGE MILLER: That's easy. I can solve that.

(Laughter.)

MR. SWANSON: We're already half a day behind.

JUDGE MILLER: Well, we'll start at 8:00 in the morning.

But the point is this: You're going to have to foreshorten -- See, the Board usually keeps a certain schedule, like the tree in the head business, but we have a certain timing that we will pretty much adhere to.

And where it is necessary, we will shorten the cross-examination on an issue basis where possible, and if not, on a time basis. Now we haven't done that. We've just gone along with your schedule.

That didn't mean we were going to sit here and permit this thing to get as seriously off as it is now, because we do mean to start the closing arguments by -- at 1:00 or thereabouts Thursday, extending over till 11:30 perhaps Friday -- half a day Friday.

Now that gives you and there will be some Board questions from some of my colleagues as well. That gives you the remaining time.

Now you've got till 6:00 tonight, an hour and a half. We'll start at 8:00 tomorrow, and we'll run until about 5:30 or a quarter of 6:00 tomorrow.

Thursday we may run a little later. We'll see how it goes -- 6:00 or 7:00.

But, as I say now, we are going to move into closing arguments. You're going to have to back off. You've got only so much time, a lot less than you've set up.

So your choices are simple: You can pay me now or pay me later. You agree now what you're going to do, or we'll put a time on all of you. It's going to be cut down pretty sharply.

MS. FINAMORE: I would like to hear from the

22-7

other counsel, how long they expect their cross-examination to take, and maybe we'll have a better idea of where we stand.

JUDGE MILLER: I got an estimate on Dr. Cochran. We're going to have to cut that. We can't allow three or four hours and stay within this schedule.

MR. EDGAR: Well, now let me understand one thing. You were suggesting that we begin the oral arguments at 1:00 Thursday.

JUDGE MILLER: Half a day Thursday and half a day Friday, yes.

22-8

MR. EDGAR: That's understood --

JUDGE MILLER: Taking about a day.

MR. EDGAR: Understood.

On that basis, I had projected half a day on Dr. Cochran. I had projected half a day on Dr. Johnson.

Ms. Finamore indicated yesterday that she had two hours on both the Staff panel and the Applicants' panel on 7(a) and (b) -- Contention 7(a) and (b).

JUDGE MILLER: Wednesday.

MR. EDGAR: If we can get agreement to finish both the Staff's accident panel and 5(b) panel today, then I think the schedule can come back to a close at about noon on Thursday.

JUDGE MILLER: Has the Staff been heard from?

MR. SWANSON: Well, I agree that we could accommodate the Board's desire to start argument by early afternoon Thursday, if we make up for the time by finishing up with the Staff's two panels today and starting -- well, either with Dr. Cochran or Dr. Johnson tomorrow morning, whatever.

I didn't know if there was a schedule problem, but that would at least put us on a track of being ready to start argument by mid-day Thursday. And as I said before, we will adhere to the pre-agreed times allotted to us.

22-9

That means half a day total for Applicants and Staff on Cochran and half a day total Staff and Applicant on Johnson.

MS. FINAMORE: If I could make one minor --

JUDGE MILLER: What about the Applicants' panel on 7(a) and (b)?

We've got 7(a) and (b). The Applicants' three-person panel.

MR. EDGAR: That's correct.

JUDGE MILLER: And the Staff has a three-person panel.

MR. SWANSON: That's correct.

JUDGE MILLER: And the Intervenors have Dr. Johnson.

MS. FINAMORE: Not on that contention, no.

JUDGE MILLER: But you've got him on the same day.

MR. SWANSON: That's right.

JUDGE MILLER: You've got him on the same day, Wednesday.

MS. FINAMORE: Yes.

JUDGE MILLER: That assumes that we get through today with all of these other matters.

MS. FINAMORE: If I can make one slight proposal change to that. I can, I think, finish up with this panel today. I had half an hour with 5(b).

If that could be moved to tomorrow, I don't think we'd have any problem making the schedule.

JUDGE MILLER: But the problem is that you're taking off the time necessary for the cross-examination of Dr. Cochran, which is not minimal apparently, as well as the cross-examination of the Applicants' and the Staff's panels on 7(a) and (b), as well as apparently several hours projected on Dr. Johnson.

MS. FINAMORE: Well, that --

JUDGE MILLER: That doesn't add up.

MS. FINAMORE: Okay. On 7(a) and (b) it is a very short contention.

JUDGE MILLER: It gets shorter all the time.

MS. FINAMORE: Yes.

(Laughter.)

MS. FINAMORE: And I'd be much more willing to cut time on that rather than on finishing this panel.

MR. SWANSON: I think that's already the choice that has been made, I'm afraid. I think --

MS. FINAMORE: I see no reason, if we have until 1:00 on Thursday -- you have nothing scheduled for that at the moment.

Thursday morning --

JUDGE MILLER: The Board has scheduled --

22-11

MR. SWANSON: Well, I think what Ms. Finamore is saying is we didn't have anything scheduled before, but we sure do now, because everything is being pushed back.

And the problem is it's pushed back more than half a day, if we finish up only with the accident panel.

MS. FINAMORE: No, the 5(b) panel, I said before, would take half an hour, from 8:00 to 8:30. We'd be through with that.

I'm willing to move ahead right now and finish up with this panel and get us out at a reasonable hour today.

MR. EDGAR: Judge Miller, if Ms. Finamore will commit to finish at 8:30, I will commit to finish Dr. Cochran's cross at 12:15.

JUDGE MILLER: Tomorrow?

MR. EDGAR: Yes, sir.

JUDGE MILLER: Let's write this down now. What is it?

MR. EDGAR: If she will commit to finish the Staff 5(b) panel at 8:30 tomorrow morning, with an 8:00 start, I will commit to finish Dr. Cochran's cross-examination at 12:15.

JUDGE MILLER: Staff?

MR. SWANSON: The Staff's position is that if we committed to finish up with the accident panel 5(b) today, then we'd be done with Cochran at a quarter of 12:00.

I just don't see any reason for giving yet another extension of time. Let's stick as close as we can to the schedule.

MS. FINAMORE: Well, I'm ready to move ahead right now with this panel and get this finished as much as possible. If we can agree to that and move 5(b) to tomorrow, I think it would be more productive than arguing over half an hour right now.

JUDGE MILLER: The reason we've taken the time, you're the one that has used up your time. Now we're trying to figure out what it will do to everybody else.

It's easy for you to say, "Let's move on." I mean, where were you yesterday?

You're about through. I think about 15 minutes is all we're going to give you, Ms. Finamore. So look through now and get your priorities straight.

MR. SWANSON: We have to factor in that we do have some redirect now. There has been a considerable amount of cross. We have some redirect.

JUDGE MILLER: Take ten minutes on redirect. You have 20 minutes to finish totally. 10 to 15 minutes on redirect. I think you can do it in that, can't you?

MR. SWANSON: Ten to 15 minutes, I think so.

JUDGE MILLER: You've had your cross.

That will get us out of here. Okay. Take your -- Get your priorities.

MS. FINAMORE: I'm going to need a little bit more time than that.

JUDGE MILLER: Now you tell me you want more time.

MS. FINAMORE: Well --

JUDGE MILLER: That should have occurred to you sooner. I told you we've held off for two days and left you to your own devices. Your own devices have brought us to this stage.

MS. FINAMORE: Well, I'm willing to go on to 6:30 today, if it means I can have more time, if the other parties --

JUDGE MILLER: We're going to go until 6:00. We'll give you 20 more minutes on this panel.

Staff, about ten or so.

You're going to have to zing right along with the 5(b) panel, because we've got to get this thing finished by 6:00. I hate to put it on this basis, but we've given you two days of self-discipline.

Proceed.

BY MS. FINAMORE:

Q. I'd like to turn to Page 13 --

22-14

JUDGE MILLER: We expect everybody's co-operation. Witnesses, answer the questions. Don't volunteer. You're not here to educate anybody. Answer what's asked.

This is cross-examination. We're going by the rules of evidence.

Let's go.

BY MS. FINAMORE:

Q. Dr. Morris, isn't it true that the Staff has stated to Applicants that there is a need for a loose parts monitoring system?

BY WITNESS MORRIS:

A. Yes.

Q. Isn't there such a system described in the PSAR?

BY WITNESS MORRIS:

A. Probably. I'm not familiar with the details of it.

Q. Now doesn't that mean that there is a potential for loose parts to cause flow blockage in the CRBR?

BY WITNESS MORRIS:

A. No, because the Staff has in mind the --

JUDGE MILLER: What the Staff has in mind is something else.

Go ahead.

WITNESS MORRIS: Yes.

BY MS. FINAMORE:

Q There is no potential?

JUDGE MILLER: No? You've testified no, haven't you, Dr. Morris?

WITNESS MORRIS: No, to the probability of flow blockage.

JUDGE MILLER: Go ahead.

BY FINAMORE:

Q There is no probability of flow blockage from loose parts?

BY WITNESS MORRIS:

A A small one.

Q What is the probability, to your knowledge, Dr. Rumble?

BY WITNESS RUMBLE:

A Small. Miniscule --

Q Isn't there a mechanistic means for positive debris or loose parts?

BY WITNESS RUMBLE:

A I don't know.

Q Dr. Morris?

BY WITNESS MORRIS:

A We have no mechanistic mode in mind. The strainers and the design of the inlet ports should prevent mechanistic ways to block flow.

Q There is the potential for mechanistic deposition, is there not?

BY WITNESS MORRIS:

A. A small potential.

Q What's the largest loose part that it's feasible could be left in the reactor vessel during the fabrication process, or maintenance process?

BY WITNESS MORRIS:

A. I don't have a number for that.

Q On Page 13 you talk about the mitigation system is totally passive. Is that correct?

BY WITNESS MORRIS:

A. Yes, I believe that's what we say there.

Q Isn't it true that it also requires operator action? You state the --

BY WITNESS MORRIS:

A. The loose parts monitoring system would cause a sensor and some signal that will alarm the operator, requiring him to take some action.

Q On Page 14 you say that -- on the second line, "CDAs resulting from flow blockage are very unlikely to occur." What is the probability?

BY WITNESS MORRIS:

A. We think some fraction of the contribution to CDAs from loss of heat sink, but we can't quantify it much more precisely than that.

Q Your total probability for CDA initiation is 10^{-4}. Can you be more specific? In other words, is it possible for you to get a number that is 1×10^{-4} or 2×10^{-4}, based on your level of analysis?

BY WITNESS MORRIS:

A. We have chosen a number that we believe bounds a large fraction of the possible events. There is some residual probability that the frequency could be greater than this.

However, we believe that it is unlikely.

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Q Based on your analysis, could you be any more specific?

For example, does your degree of analysis -- would it enable you to give a number such as 3×10^{-4}?

BY WITNESS MORRIS:

A. I think Mr. Rumble has made a judgment about the uncertainty range on this.

Maybe he could tell you.

Q Dr. Rumble.

BY WITNESS RUMBLE:

A. No, I can't be more specific about that 10^{-4}. It was a level of detail et cetera.

Like Dr. Morris said, I think I would just emphasize what he said.

Q So you have no basis for a distinguishing -- at this level of analysis, between 10^{-4} and 2×10^{-4} ; is that correct?

BY WITNESS RUMBLE:

A. That's essentially correct.

BY WITNESS MORRIS:

A. May I just say that we have made that distinction. We've made the judgment that 10^{-4} is a bound. We simply say that we cannot guarantee that we have gotten everything that could happen included in that number.

hop

23-2

Q. Thank you.

On Page 35 of your testimony, Dr. Rumble, you talk about the conditional frequency of Category 4 CDA's.

Specifically, ten percent of them would be highly energetic in your mind; is that correct?

BY WITNESS RUMBLE:

A. That's correct.

Q. Now, when given the reason for this figure on Page 36, you state that:

> "Specific CDA initiators do not have equal potential for resulting in an energetic CDA. The fraction 0.1 was, therefore, in part, employed to compensate for this simplification."

That does not give you a quantitative reason for choosing the 0.1 percent in and of itself; does it not?

BY WITNESS RUMBLE:

A. No. It's part of the answer.

Q. And just to compensate for this simplification, you could have chosen a number such as 5 percent or 15 percent; is that correct?

BY WITNESS RUMBLE:

A. That's correct.

23-3

Q Or a number as high as 20 percent? That would also compensate for the simplification?

BY WITNESS RUMBLE:

A Correct.

Q Now, you also state several factors that are more likely to occur than others, on Page 36, for your choice of the 10 percent figure; is that correct?

BY WITNESS RUMBLE:

A Correct.

Q Do you have quantitative probabilities for any of those factors?

BY WITNESS RUMBLE:

A No.

Q Does this 10 percent figure appear in any other documents, to your knowledge?

BY WITNESS RUMBLE:

A No.

Q Does it appear in any other Staff internal publication?

BY WITNESS RUMBLE:

A I can't answer that.

Perhaps my staff can.

Q In your Table J.2 you refer to probabilities of NRC classes 1 through 4.

23-4

Cases 2 and 3, have you taken into account the probability of a higher -- of a highly energetic CDA which also leads through spray fires or missiles to a failure of the containment immediately.

BY WITNESS RUMBLE:

A. No.

Q. Do you know the probability of such an event?

BY WITNESS RUMBLE:

A. Very, very small.

Q. Can you preclude this possibility, given the present design?

BY WITNESS RUMBLE:

A. Yes. I think there is an answer in the testimony that alludes to this phenomenon.

I don't know which one it is.

I'm trying to find it as fast as possible.

Q. Dr. Swift, how do you know that whatever conservatisms you've built into each of these factors bounds the probability of common mode failures between these two systems? Between CDA initiation and containment failure.

I'm referring to a CDA initiation frequency of 10^{-4} and a containment isolation failure probability of 10^{-2}.

23-5

BY WITNESS SWIFT:

A. Well, we really feel there is a fair amount of conservatism in the 10^{-4} figure and we also feel a containment isolation of frequency failure of 10^{-2} is also conservative, in the context in which we used it.

Q. Do you know for sure whether the conservatism bounds the probability of common mode failure of the two systems?

BY WITNESS SWIFT:

A. We can't say we have a hundred percent confidence in that, no.

Q. You don't know for sure, in other words?

BY WITNESS SWIFT:

A. That's right.

Q. Dr. Rumble or Mr. Thadani, if there were a common mode failure such as I've described, how would that affect your consequences analysis regarding the effectiveness of evacuation?

BY WITNESS THADANI:

A. Well, it would depend on the frequency that was assigned to that common mode failure.

Q. I'm assuming that the accident has occurred. What effect would that have on your analysis of evacuation effectiveness?

23-6

BY WITNESS THADANI:

A. We have used a delay time of 12 hours.

Q. Would that be effective in such a situation?

BY WITNESS THADANI:

A. It should be.

Q. If the containment failed immediately?

BY WITNESS THADANI:

A. I don't think it makes any difference as long as some action was taken within a 12-hour time period.

Q. Have you analyzed a situation in which the containment fails immediately upon initiation of the CDA?

BY WITNESS THADANI:

A. Well, I have analyzed a case where the release occurs immediately and evacuation occurs after twelve hours delay and the numbers are based on those assumptions.

Q. Dr. Rumble.

BY WITNESS RUMBLE:

A. I would like to add that CDA classes 3 and 4, the containment fails immediately, due to the failure of containment isolation.

BY WITNESS HULMAN:

A. In effect, we've analyzed your postulate.

Q. Dr. Rumble, what leak rate is associated with containment isolation failure?

23-7

BY WITNESS RUMBLE:

A. It depends on the gas generation rates and things along the containment, period.

Q. Did you take into account actual experience with failure leak rates in containments of LWR's?

BY WITNESS RUMBLE:

A. Yes.

Q. Where is the analysis that shows you considered actual experience with LWR containment failures?

BY WITNESS RUMBLE:

A. The question alludes to that in the testimony. The experience is relfected in deriving the failure to isolate containment, in the documents that were part of the basis for the estimate, WASH-1400 and other PWR systems use experience.

Q. On Page 15 of your testimony, you state several factors upon which you relied to get a 10^{-2} containment system failure.

Am I correct that you do not have an equivalent level of LWR experience with the annulus cooling and vent-purge system?

BY WITNESS RUMBLE:

A. True.

Q. Did you assume any failures in the reliability

-8

program in developing that 10^{-2} number?

BY WITNESS RUMBLE:

A. No.

Q. Aren't you just assuming that if the containment is not actually that effective, that you can improve the performance by changing the requirements for containment design so that it will reach a 10^{-2} failure rate?

BY WITNESS RUMBLE:

A. I don't understand that question.

I'm sorry.

Q. Well, the fourth line from the bottom on Page 15, you mention the feasibility of improving systems peformance, should this be deemed necessary.

BY WITNESS RUMBLE:

A. Yes.

Q. So you are relying on the ability to improve the containment system failure reliability, if in fact, it is higher than 10^{-2}; is that not correct?

BY WITNESS RUMBLE:

A. Yes.

Q. In other words, you don't know now whether or not the probability is, in fact, that low; is that correct?

BY WITNESS RUMBLE:

A. I am confident that it is going to be less

23-9

10^{-2}.

Q But you don't know for sure?

BY WITNESS RUMBLE:

A. Yes, that's true.

Q Are the engineered safeguards on that containment well-proven, in your judgment?

BY WITNESS RUMBLE:

A. Most are.

Q How about the annulus cooling and vent-purge system?

BY WITNESS RUMBLE:

A. It's a simple system that's conceptually been used in other plants. I'd say yes.

Q But you don't have much experience with LWR's on those systems; isn't that correct?

BY WITNESS RUMBLE:

A. True.

Q In your category 1, have you taken into account the potential for recriticality after the sodium boils dry in your reactor cavity?

Or in any of your categories?

BY WITNESS RUMBLE:

A. Yes.

Q Can you point to where that is taken into account?

BY WITNESS RUMBLE:

A. That phenomena is part of considerations in forming the ten percent frequency for primary system failure, Category 4.

Q. Isn't it true that the Applicants assume there would not be such a phenomenon?

BY WITNESS MORRIS:

A. I believe there is a misconception.

You're talking about a recriticality in the reactor cavity -- okay.

Q. That's correct.

BY WITNESS MORRIS:

A. I believe in that case, we're thinking of that material as spreading out quite broadly over that region and not likely to form a recriticality; even if one were to occur, it would simply disrupt the fuel and cause it to redistribute.

Q. So you haven't taken into account the potential of eating into the concrete at a non-level -- in a non-level manner?

BY WITNESS RUMBLE:

A. That's a different question.

For the record, I thought your CDA recriticality question regarded in-vessel behavior.

I understand the question now.

23-11

No. Recriticalities in the reactor cavity are unlikely to cause much problem.

BY WITNESS MORRIS:

A. Dr. Long could possibly shed some more light on this. He's looked at this in very great detail.

Q. My question, Mr. Long, is, isn't it possible that the sodium could eat through the concrete, not in the level manner but in a cut manner, so that recriticality might occur in a reactor cavity?

Isn't it possible?

BY WITNESS LONG:

A. We think --

Q. Please answer quickly.

BY WITNESS LONG:

A. We think that recriticality is possible on a small scale, in the reactor cavity and it would tend to redistribute the material and make it more level, so that subsequent penetration would be more uniform.

Q. Now, what is the probability of such recriticality?

BY WITNESS LONG:

A. We don't know but we think it unlikely but not very significant, anyway.

Q. So you haven't analyzed that in your Appendix J?

BY WITNESS LONG:

A. That's the only analysis we've given.

Q. You haven't analyzed the consequences of such recriticality; is that correct?

BY WITNESS LONG:

A. That's the only analysis we given to it.

JUDGE MILLER: Your time is up. We've given you another ten minutes because we feel that you are trying in good faith to proceed and cooperate.

BY MS. FINAMORE:

Q. Mr. Thadani, what are the primary uncertainties in the crack consequence analysis you performed for Appendix J?

BY WITNESS THADANI:

A. Are you referring to the analysis of CRBR site or what in general?

Q. I'd like to know which input parameters to your CRBR consequence analysis or -- are most sensitive in the results of that analysis.

BY WITNESS THADANI:

A. The source term.

Q. Are there any other inputs that are very sensitive?

BY WITNESS THADANI:

A. The meteorology and the recreation parameters.

Q The results of your CRAC 2 analysis are most sensitive to which input parameters?

BY WITNESS THADANI:

A. I did CRAC analysis. They are sensitive to source term. They are sensitive to some extent to meteorology and to some extent to recreation parameters.

Q Are they not also sensitive to population distribution?

BY WITNESS THADANI:

A. They are but since we had site specific data, the error could be small.

Q Aren't they also sensitive to vertical plume rise?

BY WITNESS THADANI:

A. Yes.

Q Did you assume no plume rise in your CRAC analysis?

BY WITNESS THADANI:

A. In the nominal case, yes.

Q What do you mean, "in the nominal case"?

BY WITNESS THADANI:

A. The basic analysis that was performed, we assumed zero energy in the plume, but subsequently, we did an additional analysis where we did consider the effect of energy in the plume rise.

8-14

Q. And what factor of difference did that make to your analysis?

BY WITNESS THADANI:

A. I don't have the numbers right here but --

MS. FINAMORE: I'll withdraw the question.

BY MS. FINAMORE:

Q. Isn't the result of your analysis sensitive to the assumed value for LD-50/60?

BY WITNESS THADANI :

A. Could you please repeat that question? I didn't catch it.

Q. Aren't the results of your CRAC analysis also sensitive to the assumed value for LD-50/60?

BY WITNESS THADANI:

A. They are.

Q. Can you explain why you didn't use CRAC- 2, rather than CRAC-1?

BY WITNESS THADANI:

A. Perhaps Mr. Hulman can answer that question.

BY WITNESS HULMAN:

A. We have not yet benchmarked CRAC-2 against CRAC-1 and we have no confidence yet that CRAC-2 can be used.

Q. How sensitive are your results to evacuation speed, Mr. Thadani?

23-15

BY WITNESS THADANI:

A. If I reduce the speed by a factor of 2, I guess I'll have to look at my data in order to answer your question.

JUDGE MILLER: Do you want him to look at his data?

BY MS. FINAMORE:

Q. Well, I'd like to show you a graph and see if you agree with it.

It plots the sensitivity of evacuation speed to results.

This is a document entitled Overview of the Reactor Safety Study Consequence Model, NUREG-0340, paper presented at the International Conference of Nuclear Systems Reliability Engineering and Risk Assessment, June 19th to 28th, 1977.

MR. SWANSON: Who is the author of that?

MS. FINAMORE: The Nuclear Regulatory Commission.

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Q. There are six authors I can give you if you wish.

MR. SWANSON: Just show that to the witness.

MS. FINAMORE: I believe it may have been performed by Sandia Labs. Okay.

BY MS. FINAMORE:

Q. Are you familiar with this document, Mr. Thadani?

BY WITNESS THADANI:

A. Yeah.

Q. I'd like to refer you to Page 29, Figure 5, entitled, "Conditional Probability of Early Death as a Function of Distance From the Reactor for Three Effective Evacuation Speeds Given a PWR-1A Release."

Can you describe that graph to me, please?

BY WITNESS THADANI:

A. This graph gives the conditional probability of early death as a function of distance from the reactor for no evacuation versus 1.2 miles per hour evacuation speed.

Q. Yes, and what -- looking at this graph what information can you get regarding the sensitivity of the number of early deaths, probability of early deaths related to evacuation speed?

BY WITNESS THADANI:

A. This says that if the deaths occur nearby, the differences are small than if the deaths occur further out.

Q. That's right. What does that tell you about the sensitivity to evacuation speed? Doesn't it prove or indicate that the probability of early deaths is reliant upon evacuation speed to a large degree?

BY WITNESS THADANI:

A. Yes. This tells me that if you do evacuate, you save some lives, yes; but if you don't evacuate, you are going to have higher fatalities.

Q. Can you put a factor number on the effectiveness of early evacuation?

BY WITNESS THADANI:

A. I think I can give you a relative magnitude from my numbers, if I can get a hold of them.

BY WITNESS HULMAN:

A. I would like to comment that the study you have shown us is based upon generalizations for population, generalizations for meteorology and generalizations for source terms, all of which are different than the CRBR site.

The computations that Mr. Thadani has in front of him are site and plant specific.

Our experience has been that when one looks at the specific site, the results one gets can differ appreciably compared to the kind of results you've shown us from Sandia.

BY WITNESS MORRIS:

A. I also recall that Mr. Thadani, you assumed a delay before beginning evacuation. That somewhat reduces the sensitivity to the evacuation.

BY WITNESS THADANI:

A. That's correct. If I were to assume one hour delay in evacuation, I get zero fatalities at the same site. If I were to assume -- that's at one meter per second evacuation speed.

If I were to drop that speed to half a meter per second, my fatality goes up from zero to 7×10^{-8}, which is a very small number.

Q. Did you report the uncertainties in the sensitivity of the early evacuation figures?

BY WITNESS THADANI:

A. I think we have mentioned something in our testimony.

BY WITNESS HULMAN:

A. But we did not report them. We discussed them.

Q. I'd like to show you one other sentence from that document, if I may.

This is Page 28 of the same document. "As a measure of this sensitivity, a reduction in LD-50/60 from 510 to 340 rads would increase the expected number of early fatalities by a factor of 3 to 4, depending upon circumstances."

Did I read that sentence correctly, Mr. Thadani?

MR. SWANSON: I'll object right now. To the contrary of having a foundation of relevance, the testimony thus far is that this document may be grossly in error when compared with the site specific analysis.

I think we just failed to have a foundation of relevance.

JUDGE MILLER: The objection will be overruled. You are going to have ten minutes in which to have your redirect shortly.

Proceed. Answer the best you can.

BY MS. FINAMORE:

Q. Did I read that sentence correctly, Mr. Thadani?

BY WITNESS THADANI:

A. Yes, you did.

Q. Do you have any basis for disagreeing with that statement?

BY WITNESS THADANI:

A. If you accept the first assumption, that the LD-56 you would drop from 510 to 340, then the second consequence follows, yes.

(Wristwatch alarm sounds.)

JUDGE MILLER: That's the beep. Have you got one more question?

MS. FINAMORE: Let me confer with Dr. Cochran.

JUDGE MILLER: Staff, we are going to give you ten minutes on redirect. We think you can probably cover what you need in that period of time.

I take it you are about through with this panel.

MR. SWANSON: I think we can.

BY MS. FINAMORE:

Q. Dr. Morris, do you know whether the uncertainties in your ATWS 10^{-4} numbers are less or more than in WASH-1400, relative uncertainties?

BY WITNESS MORRIS:

A. I can't give you a specific comparison of that. We have discussed uncertainties in our Appendix J, and they are consistent with the uncertainties attributed to WASH-1400 type risk studies.

JUDGE MILLER: One more, and don't make a request for another half hour like that fairy tale.

You might as well be getting your 5(b) people ready to go pretty soon, too.

BY MS. FINAMORE:

Q. Page 46 of the testimony. Your sensitivity analysis in A57, do these values chosen in the sensitivity analysis reasonably reflect the uncertainties in the source term that you've analyzed? Mr. Thadani?

BY WITNESS THADANI:

A. I didn't hear the full question. Could you repeat it, please?

Q. Referring to your sensitivity analysis of the source term, and do the values chosen in your sensitivity analysis reasonably reflect the uncertainties in the source term that you've analyzed?

BY WITNESS THADANI:

A. I discussed this question with Ed Rumble and he seemed to think that a factor of three was a reasonable upper bound, which accounted for all the uncertainties that could be considered.

Q. So it does?

BY WITNESS THADANI:

A. Yes.

MS. FINAMORE: Thank you.

JUDGE MILLER: Okay, thank you.

Staff, we would like -- pardon?

MR. SWANSON: If we could have just a moment or two before we begin redirect.

JUDGE MILLER: It's your time. You have ten minutes from now, to finish that is.

REDIRECT EXAMINATION

BY MR. SWANSON:

Q. The Staff was asked about the uncertainty analysis before, which is in the FES. I was wondering if you would briefly explain the purpose for putting that

24-7

section in the Supplement?

BY WITNESS HULMAN:

A. The historical background with accident evaluations for Environmental Impact Statements has indicated there's considerable uncertainty associated with such assessments.

The intent of our discussion on uncertainties was to try and put bounds on our numerical conclusions.

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24-8

Q Mr. Thadani, why was the LD-50/60 number chosen for the Staff review?

BY WITNESS THADANI:

A There is an LD-50/60 response curve, which was the basis that was developed in WASH-1400 for assessing the early fatalities as a result of exposures from accidents.

WASH-1400 gives three sets of response curves. The first one is if you did not have significant medical treatment, and the second curve is if you have supportive medical treatment, and the third one is if you had heroic medical treatment.

We have chosen the supportive medical treatment because we feel that adequate medical facilities can be provided to -- adequate medical facilities could be found in the area to handle any events.

BY WITNESS HULMAN:

A But the ultimate basis for those curves is WASH-1400 and the panel of health physicists and physicians that advised the Rasmussen Study Group.

It's basically the same as the BEIR III.

Q Thank you. Dr. Morris, the Staff was asked about the precursor document referenced on Page 12-75 of the FES Supplement, and you answered a question regarding the conclusion of that report that shutdown systems and auxiliary feedwater systems are not the predominant modes.

24-9

Do you treat that document as being applicable to the Clinch River review?

BY WITNESS MORRIS:

A. Certainly, there are aspects of the document that tell us something about Clinch River.

However, the three major contributors noted in that document as being contributors to core melt frequency were events such as the Browns Ferry fire, the TMI event and the Rancho Sequo non-nuclear instrumentation failure.

As we pointed out on Page 12-75 or 12-76, we believe that there are reasons why these major contributors are of somewhat less importance for Clinch River, leaving a residual predominant impact on core melt frequencies from loss of heat sink and ATWS events, and that's explained here, and I think I'll just leave it at that and refer to that as pertinent.

Q. Thank you.

Either Dr. Morris or Dr. Rumble, you were asked about a RSS MAP Study, R-S-S M-A-P, which you were read a quote on it comparing Surry versus Calvert Cliffs, and a conclusion in that report regarding the ability to account for the greater differences between those two plants Calvert and Surry regarding auxiliary feedwater system matters.

Do you believe that it's an appropriate

24-10

conclusion to draw from that article that it would be inappropriate to distinguish Clinch River from, say, Calvert Cliffs because of the statement you read from that document?

BY WITNESS RUMBLE:

A. No, I would say there's a vast difference between the auxiliary feedwater system in Calvert Cliffs at the time the RSS MAP Study was done and the system as proposed for Clinch River.

The system at Calvert Cliffs was a manually initiated system with -- the valving had some single valves in it, which dominated the unavailability on demand of that system.

Clinch River is an automated system and it has a redundancy in the valving for the suction side of the auxiliary feedwater pumps.

Q. Thank you.

I think it was Dr. Rumble that indicated, and Dr. Morris, that you did not rely on a UCLA-Sandia-Brookhaven reports.

I was wondering if you could explain why?

BY WITNESS MORRIS:

A. This is partly in response to Dr. Linenberger's question. We were aware of a number of reports done early on in the 1977 time frame that estimated failure frequencies for systems at Clinch River.

We felt rather than just to place reliance on those, any one of which could have been perfectly adequate or not (we just couldn't tell), we decided we wanted to have an over-all review of all the information that would lead us to estimate accident frequencies and derive our judgments in Appendix J from that, rather than go to one single source of information.

So we have had other analyses done that were sponsored by the Staff, but we felt that it was best to look at all the information available to make these conclusions, rather than one.

Q Thank you.

Dr. Rumble was earlier asked about his basis for loss of heat sink failure frequency. Dr. Morris, did you have anything that you wanted to indicate as to what the basis was for the Staff's choice of that frequency?

BY WITNESS MORRIS:

A Well, I think the wording there was on what did we rely, and I wanted to make it clear that when we use the word "rely" and when we interpret it, we mean that if you did not have that document, that you could not make your conclusion.

You must have it in order to make the conclusion. In that sense, we don't think we relied on any one single

24-12

document. The whole body of information is the basis for our conclusions.

Mr. Rumble had a slightly different interpretation of rely. I wanted to make that clear.

Q Okay, thank you.

Dr. Rumble, you were asked about your reliance on CRBRP-1 for derivation of conditional probability for primary system failure. You indicated that you did rely on it.

I was wondering if you could explain what you meant when you said you relied on it?

BY WITNESS RUMBLE:

A. I think the question was did I rely in any way on it, and under the definition just given, I did not rely on it.

What made me think a lot about that and answer the way I did, was "rely in any way," it was part of my information base for forming that assessment.

Q But you did not rely on detailed reviews contained in that document?

BY WITNESS RUMBLE:

A. That's correct.

Q Thank you.

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BY MR. SWANSON:

Q. Dr. Rumble, you indicated that you were involved in the CRBRP-1 derivation. Could you explain what you meant when you said you were involved in that, in the early stages?

BY WITNESS RUMBLE:

A. Yes. In the early stages I was involved in the planning. I was involved in methodology, choosing and developing methodology, and also attended a week-long course on the design and operation of Clinch River at Westinghouse, and also involved in developing a list of initiators to be considered for that PRA effort.

Q. How long did this involvement last?

BY WITNESS RUMBLE:

A. I'd say two to three months. I don't know how much of my time, but over a three-month period.

Q. Do you recall that you developed any numbers or performed any calculations during this period?

BY WITNESS RUMBLE:

A. No. My recollection isn't there -- There was qualitative. There were no calculations at that time. There were some preliminary event trees done, but they were modified by other people after I left that project after three months.

Q. Is it fair then to characterize your involvement as scoping out the project?

BY WITNESS RUMBLE:

A. It's fair.

Q. Do you happen to know if any of your preliminary scope work found its way into the ultimate report, CRBRP-1?

BY WITNESS RUMBLE:

A. I think vestiges of the initiator work that I did found its way in there with modifications by other people.

Q. Now this initiator work, is this methodology specific to Clinch River, or are we talking about something more general?

BY WITNESS RUMBLE:

A. No, it was general. It was to be very complete on the initiators. That was the purpose of it.

Q. And is this initiator methodology, is this generally applicable to any power reactors, LWRs, HDGRs, as well as LMFBRs?

BY WITNESS RUMBLE:

A. Yes.

Q. And since then have you done any work for the Applicants on CRBR?

BY WITNESS RUMBLE:

A. No.

Q. Did you rely on any work you did for CRBRP-1 in the development of your testimony for this hearing or for Appendix J?

BY WITNESS RUMBLE:

A. No.

Q. Dr. Morris, your qualifications indicate that you're the section leader for the Staff's Clinch River Program Office. Did the Program Office make any attempt to determine whether a conflict of interest might exist with SAI before contracting out to have Dr. Rumble participate in the review?

BY WITNESS MORRIS:

A. Yes. [illegible] we anticipated that SAI would be involved and that [illegible] would be involved, we became aware of the previous work that had been done by SAI on the CRBRP-1.

We required in our contract with them a statement of work that they have a full disclosure of the work they did, the nature of the work, the people involved, and to give us a chance to evaluate the extent to which that could prejudice SAI in giving us sound independent advice.

Subsequent to their reply on that, in which they gave us that information, the legal and contractual people who are involved in judging the adequacy of contractual relations made a judgment that that work that they did was not of such significance that it would prevent

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them from giving us the kind of independent advice we needed.

So --

JUDGE MILLER: One more question, Mr. Swanson. Your time has expired.

MR. SWANSON: Okay.

BY MR. SWANSON:

Q I'll ask a question to anyone who wants to answer: Dr. Morris, Mr. Hulman.

Do you believe it is necessary at the LWA stage of review to do a detailed fault tree analysis of the level of, say, a detailed probabilistic risk assessment?

And please explain your answer.

BY WITNESS HULMAN:

A I don't believe that the Commission's policy statement of June 1980 ever intended such a requirement. What we have done for environmental impact statements is a matter of record on all plants that we have evaluated for either CPs or OLs since June of 1980, when that interim policy statement on accident consideration for environmental impact statements under NEPA was promulgated by the Commission.

JUDGE MILLER: They all concur, I guess.

Does that -- Fine. Thank you.

Can you keep it short?

MR. EDGAR: I have no questions.

JUDGE MILLER: Good.

Judge Linenberger.

MS. FINAMORE: I have one question.

JUDGE MILLER: What is it?

MS. FINAMORE: This relates to the LD-50-60 --

JUDGE MILLER: You've had your shot at that. Your time is up.

MR. SWANSON: It was Intervenors that brought that question up in the first place.

JUDGE MILLER: That's correct. You've --

MS. FINAMORE: It was in the testimony.

JUDGE MILLER: Well, you've had a chance to cover it. We can't keep right on.

MS. FINAMORE: But this has to do with the scope of redirect.

JUDGE MILLER: Whatever. Make an offer of proof in writing the first thing in the morning.

JUDGE LINENBERGER: I will be content with a couple of hundred questions.

(Laughter.)

BOARD EXAMINATION

BY JUDGE LINENBERGER:

Q First off, the early part of this panel's

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testimony makes several references to something that is called a formal reliability program.

I wouldn't know how to find it or avoid it, if I was trying to do either. I need some clarification. And by that, I mean the following.

As referred to in this testimony, is this formal reliability program something that the Staff anticipates that Applicants will undertake when the plant is built and operating, or built and ready for pre-operational testing, or a combination of both that involves characteristics of hardware in being as determined by observations on that hardware; or is this formal reliability program a theoretical effort that somebody will go off and run off on a model on a computer effort. Which is it? What kinds of things go into it? What kinds of things come out of it?

Not a long answer, but just kind of scope it, please.

BY WITNESS MORRIS:

A. Okay. I think it's more the former than the latter, although there may be an element of the latter. It would include, as we envision it, very systematic failure modes and effects analyses that would be done throughout all levels of the design and would involve the maintenance, the plans for how you would maintain and perform surveillance.

It would relate to how you would choose equipment, how you would test it. It would persist throughout the full procurement aspect of the time between construction permit and the OL, and it would proceed beyond the OL.

We envision this as going on, even through the life of the plant.

It would have a hardware-oriented and hard data-oriented aspect to it.

There may be some reliability studies that would involve computer codes and the like, to try to assess what was being achieved from the program.

Q. You seem then to emphasize primarily the engineering production to practice at this plant, the fabrication, assembly and operation, rather than theoretical studies based on off-the-drawingboard design inputs. Is that a fair characterization?

BY WITNESS MORRIS:

A. Yes. We believe that's where you get the best benefit out of the reliability program. The calculational aspect would be confirmatory that you had achieved the levels you were targeting.

That's the way I look at that.

Q. Who will have responsibility for formulating this reliability program?

BY WITNESS MORRIS:

A. In the program office we have a lead engineer, but we are going to be contracting to SAI to help us put together all the details for a reliability program so that we'll have that in the SER, and then we'll have an acceptable commitment in the PSAR from the Applicant.

We -- I don't know all of the details yet, but I envision that sometime we would be looking at this throughout. We'll go back again and look at it at the OL stage to see whether it has been properly implemented, and there may be even a measure to look at, to sample it and monitor it after the OL has been granted and the plant goes into operation.

Q. Okay. Now you've told me approximately what it looks like so that I can avoid falling over it. Now tell me approximately what its purpose is.

And by that I mean the following: Is this formal reliability program aimed at Clinch River as an entity in itself, or is it aimed at maximizing the derivation from Clinch River of information important to the overall LMFBR program?

BY WITNESS MORRIS:

A. We strictly think of it as aimed at Clinch River itself and to achieve the promised reliability inherent in the redundancy, diversity and independence of the Clinch River design.

It's strictly for Clinch River.

The Applicant may have other purposes that he would impose upon that reliability program for the larger purpose.

Q. But so far as the Staff, that's what you're looking for --

BY WITNESS MORRIS:

A. Strictly Clinch River reliability.

Q. Fine. That helps a lot. Just one more question.

I believe somebody mentioned that a new or updated probabilistic risk assessment program was being -- or is being or will be undertaken for Clinch River.

Say again if you haven't -- or if you have already, say it again -- what is the status of that plan? Did it or will it start, approximately when? Will it end? Who will be doing it?

BY WITNESS MORRIS:

A. It has already started. So far some of the initial event trees have been put together. We anticipate that it will end in 1984. It's a full-level PRA, and I believe -- I'm not sure exactly who the contractors are.

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Mr. Rumble was involved in a review of that. He may know the name --

BY WITNESS HULMAN:

A. May I add that it's the Applicants' responsibility, the same as the reliability program. Both of those subjects are the Applicants' responsibility, and the Staff is only concerned with the criteria and the adequacy.

Q. I appreciate that clarification, sir.

JUDGE LINENBERGER: Okay. I'll stop now.

JUDGE MILLER: Okay. I guess this panel may be excused. Thank you.

(Witnesses excused.)

JUDGE MILLER: Are you ready with your 5(b) panel?

MR. SWANSON: We would then offer into evidence Staff Exhibit 17 at this time.

JUDGE MILLER: Any objection?

MR. EDGAR: No objection.

MS. FINAMORE: Yes, objection.

JUDGE MILLER: What is your objection?

MS. FINAMORE: We have an objection to entering into evidence Question and Answer 9.

JUDGE MILLER: How many objections do you have?

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MS. FINAMORE: I have four sets of questions and answers.

JUDGE MILLER: All right. We'll hear you at a quarter of 8:00 in the morning.

We'll hear you -- We won't rule. We'll hold in abeyance the offer. We'll hear you at a quarter till 8:00 on your objections.

Next is your 5(b) panel, please.

We're holding in abeyance your offer into evidence of the testimony, Mr. Swanson, in order to give Intervenors an opportunity to state their objections and have them considered, which we will take up. You may have hopefully heard me -- at 7:45.

MR. SWANSON: My only concern is that are we going to need certain witnesses here to respond to those objections because we are -- if this panel is released, they're going to be -- Many of them may be gone.

JUDGE MILLER: Well, let them go.

MR. MIZUNO: Mr. Chairman, all these witnesses have been sworn.

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JUDGE MILLER: All of you have previously been sworn, remain under oath. Thank you very much.

You may proceed.

Whereupon,

HOMER LOWENBERG

having been previously sworn, resumed the stand and testified further as follows:

LEONARD SOFFER

having been previously sworn, resumed the stand and testified further as follows:

MOHAN C. THADANI

having been previously sworn, resumed the stand and testified further as follows:

DIRECT EXAMINATION

BY MR. MIZUNO:

Q. Gentlemen, will you please identify yourself for the record?

BY WITNESS SOFFER:

A. My name is Leonard Soffer. I am Section Leader of the Site Analysis Section of the NRC Staff.

BY WITNESS THADANI:

A. I am Mohan Thadani and I have already identified myself.

BY WITNESS LOWENBERG:

A. I am Homer Lowenberg and I the Chief

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Engineer of the Office of Nuclear Material Safety and Safeguards at NRC.

Q Gentlemen, do you have a document entitled NRC Staff Testimony of Homer Lowenberg, Leonard Soffer and Mohan C. Thadani, on Contention 5(b), before you?

BY WITNESS THADANI:

A. Yes.

BY WITNESS LOWENBERG:

A. Yes.

BY WITNESS SOFFER:

A. Yes.

MR. MIZUNO: Mr. Chairman, I would like to have that identified as Staff Exhibit No. 18.

JUDGE MILLER: It may be marked.

(Staff Exhibit No. 18 was marked for identification.)

BY MR. MIZUNO:

Q Gentlemen, do you have any corrections to make to this document at this time?

BY WITNESS SOFFER:

A. Yes. I have two corrections.

Page 9, the first line of Answer 23, the word "than" should be inserted between the words "severe" and "the", so it should read:

"In order for the releases to be more

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severe than the SST or the HCDA."

The second correction is on Page 15. There are two Question 38's erroneously marked on Page 15.

The second Question 38, should be relabeled Answer 38.

Those are my corrections.

Q Thank you.

Mr. Thadani? Do you have any corrections?

BY WITNESS THADANI:

A. No, I don't have any.

Q Mr. Lowenberg?

BY WITNESS LOWENBERG:

A. No corrections.

Q And, gentlemen, as corrected, does this represent your testimony at this proceeding?

BY WITNESS LOWENBERG:

A. Yes.

BY WITNESS SOFFER:

A. Yes, it does.

BY WITNESS THADANI:

A. Yes.

Q Is it true and correct to the best of your knowledge and belief?

BY WITNESS SOFFER:

A. Yes.

BY WITNESS LOWENBERG:

A. Yes.

BY WITNESS THADANI:

A. Yes.

MR. MIZUNO: I tender the panel for cross-examination at this time.

JUDGE MILLER: Very well.

Cross-examination. We'll allow you about twenty minutes.

MR. EDGAR: Mr. Chairman, do you want me to go first? I have one question

JUDGE MILLER: All right.

MR. EDGAR: You had asked that I go first the last time.

JUDGE MILLER: Yes. I think it would be helpful and would give Intervenors a chance to have the totality of it.

CROSS-EXAMINATION

BY MR. EDGAR:

Q. Could you turn to Page 6, Question 11, Answer 11. I'll address the question to the panel and then whoever feels best qualified to respond or more than one should respond.

You discuss your calculations of doses of K-25 and Y-12.

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My question is, would your calculations be affected by the assumption of rainfall or wet deposition and, if so, in what way?

BY WITNESS THADANI:

A. Yes, they would be affected by rainfall. If there were a rainfall, the results of dose calculations which show, the dose would be less.

If the rainfall was generally spread over the entire area, they would be less and even if the rain fell over a specific facility, for example, Y-12.

BY WITNESS SOFFER:

A. What Mr. Thadani is meaning to say is that our calculations have assumed no depletion of the cloud and, so, when the plume arrives over K-25 of Y-12, it represents the undepleted cloud.

If there were a rainfall situation in the area, the rainfall would only serve to deplete the inventory of the cloud and would reduce the dosage at the respective locations.

MR. EDGAR: Nothing further.

JUDGE MILLER: Thank you.

You may cross-examine.

MS. FINAMORE: Was there an offer -- a proffer of expertise on their areas that each witness is testifying on?

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MR. MIZUNO: Mr. Thadani is testifying as generally the person in charge of the NRC's dose calculations.

Mr. Lowenberg is the expert on K-25 and Y-12 and both Mr. Soffer and Mr. Thadani are experts who can speak to the effect of closure on ORNL.

CROSS-EXAMINATION

BY MS. FINAMORE:

Q Mr. Thadani, have you calculated what impacts to National Security might occur from long-term evacuation in Oak Ridge National Laboratory?

BY WITNESS THADANI:

A Could you repeat that question, please?

Q Have you calculated the impacts to national security or national energy supplies from long-term evacuation at Oak Ridge National Laboratory?

BY WITNESS THADANI:

A I have not calculated the impacts on national security at Y-12.

Q ORNL?

BY WITNESS THADANI:

A Or ORNL.

Q Have you calculated the long-term impact to national energy supplies from long-term evacuation of ORNL?

6-7

BY WITNESS THADANI:

A. What I have calculated is the [illegible] facilities you're talking about and if you want to find out where, as a result of those doses and as a result of any possible evacuation, what would be the impacts on national security or national energy supplies, I think you would have to address those to others.

BY WITNESS SOFFER:

A. May I supplement that?

On Page 15, our Answer 38 states that the long-term evacuation of ORNL is not likely to impact on national energy supply.

Q. Mr. Thadani, on Page 5 of your testimony, Answer 7, you mention that a fuel reprocessing plant has been proposed for the Oak Ridge area but it is no longer being considered.

Are you referring to the Exxon fuel reprocessing plant?

BY WITNESS THADANI:

(No response.)

Q. Can anyone answer that question?

BY WITNESS SOFFER:

A. No. I believe the Exxon plant was a different fuel cycle facility, a different proposed fuel reprocessing facility.

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Q Which facility are you referring to?

BY WITNESS SOFFER:

A We were referring to one that's known as the Centaur I believe.

Q Have you considered the possibility that the Applicants developing and reprocessing plant might be located in the Oak Ridge area?

BY WITNESS SOFFER:

A We have not concentrated on any of the other facilities, other than the ones that were listed but to my knowledge, none of these other facilities -- we are aware generally of the locations of these proposed facilities and the impacts would not be any larger than the impacts estimated for the K-25 plant.

Q But you haven't actually --

BY WITNESS SOFFER:

A We have not actually calculated doses for those proposed facilities. That is correct.

Q Wouldn't the DRP be located closer than K-25?

BY WITNESS SOFFER:

A I don't know.

Q Mr. Thadani, do you know what the maximum whole body dose was at the TMI II accident?

BY WITNESS THADANI:

A. It was estimated from some measured data to be say 80 millirem or somewhere around there.

Q. 80 millirem?

BY WITNESS THADANI:

A. Yes.

Q. And wasn't there a long-term evacuation at that TMI accident, or TMI area?

MR. MIZUNO: Objection. I don't understand the relevance.

JUDGE MILLER: Overruled.

Hold your objections, because I want her to maximize the time here.

WITNESS THADANI: I don't know of long-term evacuation of TMI.

WITNESS SOFFER: May I supplement that?

There was an evacuation recommended for TMI. It was not recommended on the basis of a dose of 80 millirem and, actually, the whole body dose was more like about 50 millirem, but it was recommended on the basis of a presumed threat to containment integrity from what was viewed at the time, a hydrogen build-up inside containment, which might threaten the integrity of the containment and release significantly greater quantities of radioactivity.

26-10

Q Isn't it correct to assume from that, Mr. Soffer, that the protection action guides you've mentioned of EPA were not controlling in determining whether evacuation was required at the TMI II accident?

BY WITNESS SOFFER:

A. The protective action guides have no legal force, to the best of my knowledge. They are recommendations.

We have used them here merely to show that in our judgment, there would be no need for long-term evacuation for several of the accidents considered.

Q But, in effect, long-term evacuation might be required, even though the doses do not reach the protective action guide levels?

BY WITNESS SOFFER:

A. I would not make that -- I would not use that word "required".

The actual authorities in charge might choose to evacuate at lower levels of dose or they might not, as the case might be.

Q Do you know what the whole body dose was when the U.S. Government recommended evacuation of the Bikini Islands?

BY WITNESS SOFFER:

A. No, I do not.

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Q. Does anyone?

BY WITNESS THADANI:

A. No, I don't know.

MR. MIZUNO: Continuing objection.

JUDGE MILLER: We'll give you a continuing series of objections.

BY MS. FINAMORE:

Q. Mr. Soffer, how do you distinguish between short-term dose -- short-term evacuation and long-term evacuation?

BY WITNESS SOFFER:

A. I'm not sure that there is any strict numerical quantity associated with it.

A short-term evacuation would be something that occurs perhaps over a period of hours or perhaps a few days.

A long-term evacuation would be for much longer. Many days, months. That sort of thing.

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Q Mr. Thadani, on Page 8 of your testimony -- excuse me, Answer 11, Page 6, you gave the doses from a site suitability accident at K-25 and Y-12 for whole body and thyroid.

Can you tell me what the bone surface doses would be from that accident at those two facilities?

BY WITNESS THADANI:

A. I do not recall. I don't have those numbers here.

Q Can you tell me what the bone surface dose would be for the HCDA you analyzed at the K-25 or Y-12 facilities?

BY WITNESS THADANI:

A. Again, I don't have those numbers here.

Q Aren't the bone surface doses controlling for plutonium for those two accidents?

BY WITNESS THADANI:

A. Plutonium is only one of the release elements from an accident.

Q Aren't the bone surface doses controlling for plutonium for those two accidents?

BY WITNESS THADANI:

A. Aren't the bone surface doses controlling? For what purpose?

Q For plutonium, for evacuation purposes?

BY WITNESS THADANI:

A. There's no guidance on bone surface dose for evacuation purposes.

Q. So it could be controlling for evacuation purposes?

BY WITNESS THADANI:

A. It could be controlling, yeah, but this has not been determined.

Q. Did you assume containment failure for either of your SSST or HCDA accidents?

BY WITNESS THADANI:

A. No, I did not.

Q. Which CDA class did you assume in these two analyses?

BY WITNESS THADANI:

A. It was like CDA Class 1.

Q. CDA Class 1. So wouldn't the doses be higher if you assumed CDA Classes 2, 3 or 4?

BY WITNESS THADANI:

A. Probably.

BY WITNESS SOFFER:

A. Yes, they would be, but the probability would be correspondingly much lower.

Q. Did you assume there would be venting to the environment during the SSST or CDA accidents you've

27-3

analyzed?

BY WITNESS THADANI:

A. Only in the HCDA case.

Q. What were the filter efficiencies that you assumed in these calculations?

BY WITNESS THADANI:

A. I used 99 percent efficiency for particulates and 95 for the iodines.

Q. On Page 8 of your testimony you state that the reasons for the difference between your doses and Applicants' are the same as those stated in Answer 12, which refers to the SSST; is that correct?

BY WITNESS THADANI:

A. Which question are you on?

Q. I'm on Question 18.

BY WITNESS THADANI:

A. Yes, I would say yes.

Q. And those reasons you gave in Answer 12 are the fact that Applicants used more conservative assumptions regarding atmospheric dispersion than the Staff, and a less conservative filter efficiency than the Staff. Is that correct?

BY WITNESS THADANI:

A. Only one part of that is applicable here and that is the filter efficiencies. In this case the Applicant

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also used 50 percentile dispersion factors.

Q Did they use the same plate-out period as the Staff?

BY WITNESS THADANI:

A I believe so, yes.

Q Can you explain why you had a lower number than the Applicants for the site suitability source term and a higher number than the Staff for the HCDA doses?

BY WITNESS THADANI:

A I guess our source term was somewhat higher than the Applicants'.

I just recall another reason for the differences, and that was the Applicants used 60-meter meteorology and we used 10-meter meteorology. So there was a difference in dispersion factors, too.

We used more conservative.

Q Yes, and you used those for both the SSST and the CDA accident?

BY WITNESS THADANI:

A Right.

Q Why did you get a higher number than the Applicants in one case and a lower number in the other case?

Is the difference in the source term the only reason for your --

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BY WITNESS THADANI:

A. Yes, the difference in source term and -- the difference in meteorology is on the conservative side.

The difference in source term in one case is conservative; in the other case, is not.

Q. You stated that you did not know the impact of -- excuse me.

What would you consider the impact of a long-term evacuation of the Y-12 facility?

BY WITNESS THADANI:

A. I can tell you the risk of such an evacuation is low, but I --

Q. No, the impact.

BY WITNESS THADANI:

A. The impact on national security, I don't know what goes on in Y-12 so I cannot answer that question.

MR. MIZUNO: I believe that should be answered by Mr. Lowenberg.

WITNESS LOWENBERG: I think we addressed that issue in Answer 27 on Page 11.

BY MS. FINAMORE:

Q. Yes. You stated you are unable to judge the impact. Does that mean you gave no weight to that impact in your NEPA cost/benefit analysis?

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BY WITNESS LOWENBERG:

A. That means it's a matter beyond which we had cognizance of.

Q. So you gave no weight to it in your NEPA cost/benefit analysis?

BY WITNESS LOWENBERG:

A. No, that's not true.

BY WITNESS SOFFER:

A. Not true. What we used in judging the impact on the NEPA cost/benefit analysis was the likelihood of the risk involved, which was judged to be extremely low.

Q. But doesn't risk include probability and consequences?

BY WITNESS SOFFER:

A. Yes, it does.

Q. You stated here you did not know what the consequences were?

BY WITNESS SOFFER:

A. That's right, but we judged that the risk was low, nevertheless.

Q. Based solely on the probabilities; is that correct?

BY WITNESS SOFFER:

A. Judged on the probabilities of this event, coupled with the fact that Y-12 is subject to the same kinds

27-7

of risks from external events as are many of the other facilities in the area. So we judged to be comparable.

Q So you did not consider the consequences; is that correct?

BY WITNESS SOFFER:

A Not in any specific sense, but we did factor in the risks, nonetheless.

We did not specifically calculate doses at Y-12 for CDA Classes 2, 3 and 4; nonetheless, the risk was judged to be low.

Q And you did not consider the impact of whether or not long-term evacuation would be unacceptable to the plant?

BY WITNESS SOFFER:

A In terms of national security impact, no.

Q When you say "low probability," can you give a quantification to that figure, or that statement?

BY WITNESS SOFFER:

A We have in our testimony. We stated that the -- we estimated that the impact of an accident which would produce doses significantly greater than the EPA Protective Action Guides at either ORNL or Y-12 would be on the order of about 10^{-7} per year.

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EVENING SESSION

6:00 p.m.

BY MS. FINAMORE:

Q On Page 13 of your testimony you refer to the Portsmouth facility. Isn't it true, Mr. Soffer, that the General Accounting Office has recommended that that proposed facility not be completed?

BY WITNESS SOFFER:

A I'm sorry. I'll have to defer that to Mr. Lowenberg.

BY WITNESS LOWENBERG:

A The General Accounting Office made studies for the Congress on many facilities. And in that particular case, they made that recommendation to the Congress, yes.

Q The answer is yes, you are aware that they have?

BY WITNESS LOWENBERG:

A Yes.

Q Okay. On Page 12 of your testimony, you mention the potential for switching to another gaseous diffusion plant. Do you have any idea of the cost of such switching?

BY WITNESS LOWENBERG:

A No, but it is certainly possible to do that.

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Q Are you aware of how much time it would take to switch to another gaseous diffusion plant?

BY WITNESS LOWENBERG:

A Not specifically no.

Q Have you considered those factors in your cost/benefit analysis?

BY WITNESS LOWENBERG:

A In the event that a need was overriding for energy security, clearly such decisions would have to be made. But for analysis of this nature, all we were looking at was the availability of alternative sources of supply.

Q So you didn't take it into account?

BY WITNESS LOWENBERG:

A No.

Q Mr. Thadani, on Answer 26, it states that "The probability of a severe accident at CRBR is equal to or less than that for a typical LWR."

Are you basing that answer solely on the analysis in Appendix J?

BY WITNESS THADANI:

A Yes, I am.

Q On Page 9 of your testimony, Question and Answer 24, it's stated that the probability of an accident or long-term evacuation of K-25 or Y-12 might be less than 10^{-6} per year, since the wind blows toward those facilities approximately 10 percent of the time.

When you performed your HCDA calculations, didn't you assume a 50 percent X/Q values?

BY WITNESS THADANI:

A. That was a direction dependent X/Q value with 50 percent probability, yes, for each direction in which the facility is located.

Q. And isn't a 50 percent X/Q fairly characterized as an average meteorological condition for that sector?

BY WITNESS THADANI:

A. It is, yes.

Q. And wouldn't that analysis, therefore, take into account what the weather and the wind direction would be approximately 50 percent of the time?

BY WITNESS THADANI:

A. No. If you're talking about the sector average, then it's just for that sector. You have to apply wind rows to it in order to get the ...

Q. Isn't it true that the concentrations would be less 50 percent of the time?

BY WITNESS THADANI:

A. Yes.

Q. Did you assume that the wind was blowing in the same direction during the entire course of the accident, even though the accident took place over several days?

BY WITNESS THADANI:

A. Yes, I did.

Q. Are you assuming in this answer that relevant authorities would determine whether evacuation was necessary by determining which way the wind was blowing at the time of the accident?

BY WITNESS THADANI:

A. That would be one of the factors, yes.

Q. And isn't it possible that that wind direction might change during the course of the accident?

BY WITNESS THADANI:

A. It's possible, yes.

Q. Isn't it reasonable to assume that the authorities would not give credit for the chance that the wind would blow in another direction?

BY WITNESS SOFFER:

A. It's possible, but that would not necessarily be associated with the actual doses. Furthermore, if the wind shifts direction during the course of an accident, then it is -- then the doses would be significantly less than if the wind blows in the same direction for the course of the accident.

Q. But isn't it true that the relevant authorities would not wait until the doses had actually been received before requiring or recommending an evacuation?

BY WITNESS SOFFER:

A. It's possible, yes.

Q. Wouldn't that be a prudent way in which to proceed?

BY WITNESS SOFFER:

A. Yes, it would be.

BY WITNESS THADANI:

A. If the wind was blowing in a different direction initially and then they considered the possibility of it blowing in the direction of concern, they would have to take into account what the net effect would be, rather than the total effect that we have calculated.

Q. Wouldn't they consider the effect over the entire -- or the possibility of the wind direction over the total course of the accident?

BY WITNESS SOFFER:

A. Even if you assumed that the authorities would evacuate K-25 or Y-12 regardless of wind direction, the probability goes from 10^{-7} per year to 10^{-6} per year. This is still an extremely low value, in my judgment.

JUDGE MILLER: One more question.

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BY MS. FINAMORE:

Q Mr. Thadani, for K-25 can you tell me what the difference -- relative difference in bone surface dose would be for the site suitability source term accident versus the HCDA that you've analyzed?

BY WITNESS THADANI:

A I don't have those numbers with me. They are not the numbers that would be applied for answering the contention that we're looking at.

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BY MS. FINAMORE:

Q Did you say you have the numbers here?

BY WITNESS THADANI:

A Yes, I have them here. Do you want me to tell you?

JUDGE MILLER: Yes.

MS. FINAMORE: If we could look these over and get back to them, I'd appreciate it.

JUDGE MILLER: Yes.

MS. FINAMORE: Perhaps the next day.

JUDGE MILLER: Yes, we'll get the numbers.

BY MS. FINAMORE:

Q Have you considered the possibility that all three or two of the three facilities might require evacuation during the same accident?

BY WITNESS SOFFER:

A We've considered the possibility, but I consider it to be extremely unlikely, even as I stated earlier -- even with a wind direction that would be presumed to be veering or shifting during the course of the accident.

The doses would be significantly less than if the wind sector were blowing in the same direction. Hence, for example, if the wind were blowing toward the gaseous diffusion plant in the early phases of the accident and then suddenly shifted so that it was blowing towards, say, Y-12 somewhat later in the accident, then is -- Since so much of the dose accumulates in the early parts of the accident, it's likely that in that particular example, the gaseous diffusion plant might be impacted, but Y-12 in my judgment would not.

Q Have you considered the impact upon evacuation and availability of nursing measures and other mitigating measures, if more than one facility required evacuation at one time?

BY WITNESS SOFFER:

A Could you repeat that question again?

Q Okay.

Assume, hypothetically, that more than one of the facilities you've considered requires evacuation. Mr. Thadani, have you -- I'll ask you.

JUDGE MILLER: All right. We've got this hypothetical situation where several of them are in the path of something or other. Now what's your question? -- requiring evacuation.

BY MS. FINAMORE:

Q Have you considered what impact that would have upon evacuation efficiency?

BY WITNESS SOFFER:

A We have --

Q -- in your calculation?

BY WITNESS SOFFER:

A We have not considered that situation. I would like to note that I find it so hypothetical that I do not believe it to be a credible situation, even for a very low probability.

JUDGE MILLER: Mr. Thadani, have you located your figures now from which you will be able to respond to Ms. Finamore's question?

WITNESS THADANI: I have a number for HCDA case, but I have not calculated any bone surface dose for the SSST case.

BY MS. FINAMORE:

Q Can you give that number to us, please?

BY WITNESS THADANI:

A That's 145 millirem bone surface.

Q What dose conversion factors did you use for that number?

Was it based on ICRP-30?

BY WITNESS THADANI:

A Yes.

Q One more question.

Can you explain why you did not calculate the bone surface dose for the site suitability source term accident?

29-5

BY WITNESS THADANI:

A. The -- I was addressing the contention from the point of view of need for evacuation. The guidance for that that EPA has provided is for whole body dose and thyroid dose.

Those are the only two parameters for which guidance exists.

That's the reason why I only concentrated on those two doses.

Q. Yes. But you did perform bone surface calculation for the CDA accident?

BY WITNESS THADANI:

A. It just happens to be around that -- dose calculation -- that other number.

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x3x1x

Q. Then why did you decide to perform that calculation for one accident and not the other?

BY WITNESS THADANI:

A. It's a run that calculates everything, you know. All different doses for different organs and in the other case, I have not done that.

But there is no reason for it.

BY WITNESS SOFFER:

A. If I can just add a little note to that.

For the SSST accident, it was obvious to us that the doses were so small. For example, 19 millirem to the whole body is about the value received by a chest x-ray.

Consequently, it appeared to us that calculation of the bone doses was an academic sort of a thing. It was not necessary.

Q. The bone dose or the bone surface dose?

BY WITNESS SOFFER:

A. The bone surface dose.

Q. Now, was that number for the K-25 facility?

BY WITNESS SOFFER:

A. Yes, I said 19 millirem to the whole body for the SSST accident.

JUDGE MILLER: All right. I think that about concludes the cross-examination.

Any redirect?

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MR. MIZUNO: Sir, could we have a minute to confer with the witnesses, then we have two questions on redirect.

JUDGE MILLER:All right.

MR. EDGAR: Judge Miller, do you want us to convene, the lawyers, at 7:45 for the --

JUDGE MILLER: Yes. I'm giving Ms. Finamore the opportunity at 7:45 to present her objections to, I believe it's Staff Exhibit 17 and we plan at --

Off the record.

(Discussion off the record.)

JUDGE MILLER: Okay.

Staff has two questions.

MR. MIZUNO: One question.

JUDGE MILLER: One?

MR. MIZUNO: Yes.

JUDGE MILLER: Good for you.

REDIRECT EXAMINATION

BY MR. MIZUNO:

Q Mr. Soffer, did the Staff consider the effects of closure of Y-12 on national security in the NEPA Cost/Benefit balance?

BY WITNESS SOFFER:

A. Yes, we did.

Based upon our independent analysis, we judged

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that such effects had a very low probability and that, therefore, the risk was low and that was factored into our judgment, as reflected in the FES.

MR. MIZUNO: Thank you. No more questions.

We would now like to move that NRC Staff Exhibit No. 18 be admitted.

JUDGE MILLER: All right.

Judge Hand?

JUDGE HAND: No thank you.

JUDGE MILLER: Judge Linenberger?

JUDGE LINENBERGER: No questions.

JUDGE MILLER: Are there objections to Staff Exhibit 18, Ms. Finamore?

MS. FINAMORE: No objections.

JUDGE MILLER: Objections?

MR. EDGAR: No objections.

JUDGE MILLER: All right.

Staff Exhibit 18, then, will be admitted.

(Staff Exhibit No. 18 was received in evidence and follows.)

UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

BEFORE THE ATOMIC SAFETY AND LICENSING BOARD

In the Matter of	)	
	)	
UNITED STATES DEPARTMENT OF ENERGY	)	Docket No. 50-537
PROJECT MANAGEMENT CORPORATION	)	
TENNESSEE VALLEY AUTHORITY	)	
	)	
(Clinch River Breeder Reactor Plant)	)	

NRC STAFF TESTIMONY OF HOMER LOWENBERG,
LEONARD SOFFER AND MOHAN C. THADANI ON CONTENTION 5(b)

Q.1. Mr. Lowenberg, by whom are you employed, and what is your position and the nature of your work?

A.1. Chief Engineer for the Office of Nuclear Material Safety and Safeguards, U.S. Nuclear Regulatory Commission ("NRC"). I am a graduate of Stevens Institute of Technology with degrees in mechanical and chemical engineering and am a professional engineer in the states of Pennsylvania and New York.

I have over 25 years experience in the design, construction and operation nuclear facilities for both the government and industry. Relevant experience included major responsibilities with regard to the design and construction of a number of reprocessing and fuel fabrication facilities for the U.S. government at Richland, Washington and Oak Ridge, Tennessee; for the Italian, Swedish and Indian governments; and for a division of Atlantic Richfield Co. For the past ten years I have been employed by the Atomic Energy

Commission and the NRC. I have been an assistant director and chief engineer in the licensing of commercial nuclear fuel material activities. I was the program manager for NRC's generic analysis of mixed oxide fuel use in light water reactors (GESMO); a member of the U.S. delegation to the International Fuel Cycle Evaluation for the area of fuel reprocessing and recycle: and am involved in the TMI-2 Waste Management Task Force. Further details of my background are contained in my professional qualifications statement submitted for this proceeding.

Q.2. What is the nature of your responsibilities regarding the Clinch River Breeder Reactor ("CRBR")?

A.2. I am the Office of Nuclear Materials Safety and Safeguards ("NMSS") Project Manager responsible for the preparation of the Fuel Cycle portion of the 1982 Supplement to the Final Environmental Statement ("FES") for CRBR. I directed and participated in the review of the Applicant's updated Environmental Report ("ER") related to the various steps in the CRBR fuel cycle, including: 1) fuel fabrication, 2) reprocessing, 3) waste management, 4) transportation, and 5) safeguards. I also directed the Staff's preparation of Appendix D, "Environmental Effects of the CRBR Fuel Cycle and Transportation of Radioaction Materials;" Appendix E, "Safeguards Related to the CRBR Fuel Cycle and Transportation of Radioactive Materials;" Section 7.2, "Transportation Accidents Involving Radioactive Material;" Section 7.3, "Safeguards Consideration;" Section 5.7.2.6, "Transportation of Radioactive Materials;" and Section 5.7.2.7, "Fuel Cycle Impacts" of the 1982 FES Supplement.

Q.3. Mr. Soffer, by whom are you employed, and what is your position and the nature of your work?

A.3. I am Section Leader of the Site Analysis Section, Siting Analysis Branch, Division of Engineering, Office of Nuclear Reactor Regulation, U.S. Nuclear Regulatory Commission. I am responsible for the review of the population characteristics of nuclear power reactor sites, including the exclusion area, as well as the review of nearby industrial, transportation and military facilities. A statement of my professional qualifications is attached to this testimony.

Q.4. Mr. Thadani, by whom are you employed, and what is your position and the nature of your work?

A.4. I am employed by the NRC as a Nuclear Engineer in the Accident Evaluation Branch, of the Office of Nuclear Reactor Regulation ("NRR"), of NRC. In this position, I am responsible for the reviews of applicant analyses of accidents, as reported in applicant's environmental reports ("ERs"), and the Staff's evaluation of postulated accident risks. A statement of my professional qualifications is attached to this testimony.

Q.5. What is the nature of your responsibilities regarding CRBR?

A.5. I was responsible for the Staff's analysis and evaluation of the postulated accident consequences in Appendix J of the 1982 FES Supplement.

Q.6. Messrs. Lowenberg, Soffer and Thadani, what is the subject matter of your testimony?

A.6. Our testimony addresses Contention 5(b), which states:

> Since the gaseous diffusion plant, other proposed energy fuel cycle facilities, the Y-12 plant and the Oak Ridge National Laboratory are in close proximity to the site an accident at the CRBR could result in the long term evacuation of those facilities. Long term evacuation of those facilities would result in unacceptable risks to the national security and the national energy supply.

In particular, our testimony will show that accidents up to and including the worst design basis accidents ("DBAs") will not require long-term evacuation of the Y-12 plant, the Oak Ridge National Laboratory and the Oak Ridge Gaseous Diffusion Plant ("ORGDP"), also known as the K-25 facility. While severe accidents beyond the design basis, involving a loss of containment integrity, could result in long-term evacuation of these facilities, our testimony will show that the risks of such events are low. Our conclusion is based on our assessment that: (1) the probability of the occurrence of events beyond the DBAs at CRBR are comparable to or lower than the probabilities of occurrence of such events at light water reactors ("LWRs"); and (2) the fraction of radionuclide releases to the atmosphere resulting from accidents at CRBR which are beyond the DBAs are comparable to or lower than the releases from LWRs. Our testimony will also show that there will be no negative impacts to the national security or national energy supply if there was a long term evacuation of K-25, and there will be no negative impacts to the national energy supply if there was a long-term evacuation of the Oak Ridge National Laboratory ("ORNL").

Q.7. Messrs. Soffer and Thadani, what national security and national energy supply facilities are located near the CRBR?

A.7. Existing facilities include the Oak Ridge Gaseous Diffusion Plant, also known as K-25, which is located about 2.5 miles NNW of CRBR; the Oak Ridge National Laboratory ("ORNL"), located about 4 miles ENE of CRBR; and the Y-12 facility, located approximately 8.5 miles ENE of CRBR. Two fuel cycle facilities -- the Centar centrifuge enrichment plant and a fuel reprocessing plant -- have been proposed for the Oak Ridge area, but are no longer being considered. See FES Supplement, Section 4.1. Accordingly, the possible impacts of CRBR on these two proposed facilities are not addressed in our testimony.

K-25 and Y-12 Facilities

Q.8. Mr. Thadani, have the Applicants assessed the risks to the K-25 and Y-12 facilities from accidents at CRBR?

A.8. Yes. The Applicants' analyses and calculated results were informally transmitted to the Staff in October of 1982. The Staff expects to receive the formal transmittal during the month of November.

Q.9. Did Applicants consider the Site Suitability Source Term ("SSST"), Accident and the Hypothetical Core Disruptive Accident ("HCDA") as part of their assessment of risks to the K-25 and Y-12 facilities?

A.9. Yes.

Q.10. Have the Applicants calculated the predicted doses at the K-25 and Y-12 facilities resulting from a SSST Accident at CRBR?

A.10. Yes. Applicants have calculated that doses at K-25 would be about 100 mrem to the whole body, and approximately 550 mrem to the thyroid. The doses at Y-12 were calculated to be about 6 mrem to the whole body, and about 34 mrem to the thyroid.

Q.11. Has the NRC Staff ("Staff") independently calculated doses at the K-25 and Y-12 facilities due to a SSST Accident at CRBR?

A.11. Yes. The Staff finds that doses at K-25 will be 19 mrem to the whole body, and about 320 mrem to the thyroid. The doses at Y-12 will be negligible to the whole body, and about 11 mrem to the thyroid.

Q.12. Why are the Staff's calculated doses different than the Applicants' calculated doses for the SSST Accident?

A.12. The Applicants have used somewhat more conservative assumptions regarding atmospheric dispersion than the Staff's. The Applicants have also assumed filter efficiencies at CRBR which are less conservative than the Staff's. The two differences in assumptions lead to the differences in the calculated doses.

Q.13. What is the significance of these differences?

A.13. The Staff used its own, independently-calculated SSST Accident doses to assess the need to evaucate K-25 and Y-12. Although the Staff's realistically calculated doses are somewhat different than Applicants', the differences are not significant.

Q.14. Are the Applicants' calculated doses nonetheless reasonable?

A.14. Yes.

Q.15. Messrs. Soffer and Thadani, what are the Staff's conclusions regarding the need to evacuate the K-25 and Y-12 facilities from a SSST Accident at CRBR?

A.15. The Staff finds that the doses at K-25 and Y-12 resulting from a SSST Accident at CRBR will be less than the Protective Action Guide levels ("PAG") recommended by the U.S. Environmental Protection Agency ("EPA"), which are 1 to 5 rem whole body, and 5 to 25 rem thyroid. The Staff concludes that since the calculated doses at K-25 and Y-12 from a SSST Accident are less than the PAG levels recommended by EPA, long-term evacuation of either K-25 or Y-12 is not expected to be required.

Q.16. Mr. Thadani, have the Applicants calculated the predicted doses at the K-25 and Y-12 facilities resulting from a HCDA at CRBR?

A.16. Yes. The Applicants' calculated doses at K-25 are 170 mrems to the whole body, and 7.1 rems to the thyroid. Doses at Y-12 were calculated to be approximately 25 mrem to the whole body, and approximately 1.3 rems to the thyroid.

Q.17. Has the Staff independently calculated doses at the K-25 and Y-12 facilities due to a HCDA at CRBR?

A.17. Yes. The Staff finds that the doses at K-25 will be about 3 rems to the whole body, and about 100 rems to the thyroid. The doses at Y-12 will be about 100 mrem to the whole body, and about 3 rems to the thyroid.

Q.18. Are the reasons for the difference between the Staff's calculated doses and the Applicants' calculated doses the same as those you stated in Answer 12?

A.18. Yes.

Q.19. Is there any significance to the difference between the Staff's and the Applicant's calculated HCDA doses?

A.19. No. The Staff used its own, independently calculated doses, which are more conservative than the Applicants' calculated doses.

Q.20. What are the Staff's conclusion regarding the need to evacuate the K-25 and Y-12 facilities from a HCDA at CRBR?

A.20. The Staff concludes that the K-25 facility may have to be evacuated, since the calculated doses to the whole body and the thyroid are in excess of EPA's whole body and thyroid PAGs. The Staff also concludes that the Y-12 plant will not require long-term evacuation, since the doses are below the EPA's whole body and the thyroid PAGs.

Q.21. Are there accidents more severe than the SSST Accident or HCDA that could occur at CRBR?

A.21. Yes. There are a spectrum of accidents that involve core disruptive events which may result in loss of containment integrity, either through overpressure or as a result of a failure to isolate. Such accidents could result in the release of substantially larger quantities of radioactive materials into the environment than the SSST

Accident or HCDA. These accidents are described in Appendix J of the FES Supplement for CRBR.

Q.22. Could such accidents require a long-term evacuation of either the K-25 or Y-12 facilities?

A.22. While the Staff has not calculated doses at either K-25 or Y-12 resulting from accidents more severe than HCDA or SSST Accident, the Staff concludes that such accidents may result in a long-term evacuation of the K-25 and/or Y-12 facilities.

Q.23. What is the probability of occurrence of accidents with radionuclide releases more severe than the SSST Accident or the HCDA?

A.23. In order for the releases to be more severe than the SSST or the HCDA, there would have to be successive multiple failures of highly reliable safety systems, followed by the failure of the containment to isolate, or the overpressure failure of the containment. The Staff estimates that the probability of accidents more severe than the SSST or HCDA is very small, and no more than 10^{-6} per year, as discussed in Appendix J of the FES Supplemnent.

Q.24. Is the probability of a long-term evacuation of either K-25 or Y-12 resulting from accidents more severe than HCDAs or SSST accidents therefore approximately equal to 10^{-6} per year?

A.24. No. The probability would be less, since the wind blows towards K-25 or Y-12 approximately 10 percent of the time. Hence, the probability of a release from accidents more severe than the HCDA or SSST, together with the wind blowing towards K-25 or Y-12, would be an order of magnitude smaller than the accident and release probability, or about 10^{-7} per year.

Q.25. Messrs. Soffer and Thadani, are there other factors which would also reduce the probability that a severe accident and release would require the long-term evacuation of either the K-25 or Y-12 facilities?

A.25. Yes. Since the K-25 and Y-12 facilities handle radioactive materials, their personnel are probably equipped with protective measures which would reduce the potential effects of any radionuclide releases. In addition, the shielding for habitable areas in these facilities would also be effective against external radiation exposures, and therefore may reduce the likelihood of long-term evacuation as a result of severe accidents.

Q.26. How does the estimated probability of a severe accident at CRBR requiring long term evacuation of either K-25 or Y-12 compare with the probabilities of accidents of the same magnitude occuring at LWRs?

A.26. The probability of a severe accident at CRBR is equal to or less than that for a typical LWR.

Q.27. Mr. Lowenberg, what would be the impact on the national security and national energy supply due to a long-term evacuation of the Y-12 facility?

A.27. The Y-12 facility is a research and production facility in the Department of Energy's ("DOE") military program, and does not play any role in the nuclear power reactor fuel cycle. Accordingly, long-term evacuation of the Y-12 facility would not have any impact on the national energy supply. The exact role and function of Y-12 in DOE's military weapons program is classified. Therefore, the Staff is unable to judge the impact of long-term evacuation on the national security.

Q.28. Mr. Lowenberg, what is the function of the K-25 facility, and what is its relationship to the national security and national energy supply?

A.28. The K-25 facility is one of three government-owned and contractor-operated gaseous diffusion plants ("GDPs"). GDPs are used to enrich the content of fissionable U-235 in low grade uranium, to provide uranium suitable for use in light water nuclear power plants and military applications. The U.S. need for enriched uranium is provided by these three plants. In addition to Oak Ridge, GDPs are located in Paducah, Kentucky and Portsmouth, Ohio.

Q.29. Describe the functioning of these three GDPs.

A.29. The three GDPs are operated in a cascade complex, with a combined capacity of approximately 27 million separative work units ("SWUs"). The approximate capacities for each plant are shown below:

Plant	Millions of SWU
Oak Ridge (K-25)	7.7
Paducah	11.3
Portsmouth	8.3

The K-25 facility currently functions as the middle segment of the cascade, where it receives natural and low enriched uranium feed from the Paducah GDP. The output of K-25 is used to supply low enriched material for utility fuel needs. K-25 output is also received by the Portsmouth GDP, where it is further enriched to provide highly enriched uranium for national security purposes. Presently, the K-25 facility constitutes about 30 percent of the total separative work capacity of the U.S. enrichment complex.

Q.30. Is there any flexibility in the operation of the GDPs?

A.30. Yes. The three plant complex is operating at approximately 35% of its combined capacity. Thus, there is considerable margin for increased operation of the plants. Furthermore, this complex has been and can be operated in a wide variety of modes. Some of the parameters that can be varied for different operating schemes are:

(1) power levels

(2) feed to product ratios

(3) tails assay

(4) use of enriched uranium inventories

Q.31. In addition to the three GDPs, are there any other uranium enrichment plants which are planned or under construction?

A.31. Yes. The Department of Energy ("DOE") is currently constructing a gas centrifuge enrichment plant at its Portsmouth, Ohio site. When completed the plant will have a capacity of about 13 million SWU and is planned to operate as a low enrichment facility, similar to the K-25 and Paducah facilities. The first increment of this plant is scheduled to come on-line about 1988, with full plant completion of eight units by about 1994.

Q.32. In the event that K-25 was placed out of service, what would be the impact on the nation's ability to meet its energy needs?

A.32. As discussed in Answer 29, there is considerable flexibility in the operation of the three GDP complex, so that the operations of the remaining plants could be adjusted to meet the nation's energy needs for utility-grade uranium. As I stated in Answer 28, K-25 currently constitutes 30% of the total separative work capacity of the three cascade complex. Since the complex is operating at about 35% capacity, loss of the K-25 capacity could be made up by the remaining plants under modified operating conditions. There are many ways of modifying the operational mode of the remaining two plant complex. Some of the changes that could be made are:

(1) increase power levels at the remaining plants

(2) increase tails assay from present levels of .2% U-235

(3) increase the feed of natural uranium

(4) increase the use of enriched uranium inventories.

Finally, additional separative work capacity will become available when the Portsmouth gas centrifuge enrichment plant is completed. The inherent flexibility of the GDP complex, together with the additional separative work capacity which will start to come on-line in 1988, should enable a two GDP cascade to meet the U.S. energy requirements into the 1990's.

Q.33. In the event that K-25 was placed out of service, what would be the impact on the nation's security needs for highly enriched uranium?

A.33. Essentially all U.S. national security needs for highly enriched uranium have been provided by the Portsmouth GDP. Therefore, loss of the K-25 facility should have relatively little effect on the nation's capability to fulfill its security needs for highly enriched uranium.

Oak Ridge National Laboratories

Q.36. Has the Staff calculated the predicted doses at the Oak Ridge National Laboratories ("ORNL") from a SSST Accident or HCDA at CRBR?

A.36. No. However, atmospheric dispersion factors in the northeast direction, toward ORNL, are somewhat lower than those in the north-northwest direction, toward K-25. In addition, ORNL is approximately twice as far from the CRBR site as K-25. Therefore, the ground level release dispersion factors at ORNL will probably be lower than those at K-25, and doses at ORNL would consequently be expected to be lower than the doses calculated for K-25 for both the SSST Accident, and the HCDA.

Q.37. What are the Staff's conclusions regarding the need to evacuate the ORNL following the occurence of a SSST Accident or HCDA at CRBR?

A.37. The Staff concludes, based on doses calculated for the K-25 facility, that a release due to an SSST at CRBR would not require evacuation of ORNL, but that a release due to a HCDA may require evacuation.

Q.38. Messrs. Soffer and Thadani, what would be the impact on the national security and national energy supply due to a long-term evacuation of ORNL?

A.38. The long-term evacuation of ORNL is not likely to impact the national energy supply, since it does not have any role in the fuel cycle for any energy generation mode. The Staff is unable to determine the impact of a long-term evacuation of ORNL on the national security. Such a determination can only be made by the U.S. Department of Energy.

Educational and Professional Qualifications

Homer Lowenberg
Office of Nuclear Material Safety and Safeguards
U.S. Nuclear Regulatory Commission

My name is Homer Lowenberg. I am the Chief Engineer of the Office of Nuclear Material Safety and Safeguards. I am responsible for refinements of the technological base for improving and updating the licensing process and for the performance of generic and special studies in support of national and international policies and developments in the non-reactor areas of NRC's responsibilities. I am currently responsible for NRC's environmental review of the CRBR fuel cycle. In addition, I handle activities related to the fuel cycle aspects of the GESMO proceeding and LMFBR research; also, I participate in waste management aspects of the TMI-2 clean-up and in technical review of high and low level waste management programs.

I received the degree of Mechanical Engineer from Stevens Institute of Technology with distinction in Chemical Engineering and attended the Executive Development Program of Cornell University Graduate School of Business and Public Administration.

My professional career was initiated with 5 years of plant development and start-up activities for the Hercules Powder Company in smokeless powder, rocket propellants and high explosive operations.

Then I spent 20 years in the architect-engineering field with the Kellex Corporation which subsequently became Vitro Engineering Co. I was project manager for numerous nuclear facilities including AEC's Purex, Redox and Waste Metal Recovery reprocessing plants at Richland, Washington; the Italian and Swedish Reprocessing facilities; Consolidated Edison's Indian Point Nuclear Power Plant; the Indian Plutonium Laboratory; and a wide variety of nuclear and nonnuclear projects. When Vitro Engineering was sold to Ralph Parsons Co., I was manager of its New York operations.

I was Manager of Central Engineering for Atlantic Richfield Co.'s commercial nuclear activities for 5 years including planning, design and construction of all facilities for fuel material production, fuel assembly and manufacturing, fuel reprocessing and related functions.

I joined the Atomic Energy Commission in 1971 as an assistant director in the regulatory fuels and materials licensing area and continued with NRC upon its creation in 1974. As an assistant director I was responsible for initiating the Reactor-Fuel Cycle Rule (now 10 CFR 51, Tables S-3 and S-4).

I was the program manager and chief commission witness for the GESMO proceeding on widescale mixed oxide use in LWRS; a member of the U.S. delegation to the International Fuel Cycle Evaluation Working Group 4 on Pu reprocessing and recycle and on the TMI-2 Waste Management Task Force.

I am a professional engineer in the states of New York and Pennsylvania.

I was one of the editors of the Reactor Handbook, Volume II published by the AEC on Fuel Reprocessing and have been the program leader on numerous AEC and NRC projects that have been the subject of agency reports.

LEONARD SOFFER
PROFESSIONAL QUALIFICATIONS
SITING ANALYSIS BRANCH
DIVISION OF ENGINEERING
OFFICE OF NUCLEAR REACTOR REGULATION

I am Section Leader of the Site Analysis Section, Siting Analysis Branch, Division of Engineering, Office of Nuclear Reactor Regulation, U.S. Nuclear Regulatory Commission. My duties in this position include responsibility for the review and evaluation of the population characteristics of nuclear power reactor sites as well as the evaluation of potential hazards posed by nearby man-related activities.

I received a B. S. Degree (with honors) in Physics from the City College of New York in 1952 and attended graduate school at Case Western Reserve University in Cleveland, Ohio.

Before joining the Commission, I was employed for 21 years as a Physicist and Nuclear Engineer with the National Aeronautics and Space Administration (NASA) at the Lewis Research Center in Cleveland, Ohio. In this capacity, I performed analyses on radiation shielding and nuclear safety requirements for nuclear power systems intended for lunar and space applications. I assisted in the radiation shielding design of the NASA Plum Brook reactor, served on an agency-wide study team investigating the radiological safety aspects of using radioisotopes for space power generation, and was section leader of a group responsible for research on radiation shielding and radiological safety concerns. I also monitored contracts and occasionally lectured on radiological physics and shielding to others within NASA.

I joined the Commission staff in July 1973, and have participated in the detailed review of over 20 nuclear power plants. My responsibilities in this regard have included evaluation of the demographic characteristics and nearby facilities of sites as well as the independent assessment of the likelihood and consequences of various postulated accidents. I have prepared and presented testimony at hearings on the population density and use characteristics of sites as well as the radiological consequences of accidents. In my capacity as Section Leader, Siting Analysis Branch, I am responsible for reviewing the results of similar efforts by others.

Pertinent experience has also included participation in development of a draft standard entitled "Guidelines for Estimating Present and Forecasting Future Population Distributions Surrounding Power Reactor Sites", membership in the NRC Working Group that wrote the "Report of the Siting Policy Task Force" (NUREG-0625), and membership in a Siting Mission to Greece, to assist that Government in the development of demographic criteria for nuclear power plants.

I have also lectured on accident consequence assessment at several courses sponsored by the IAEA, have attended conferences devoted to population projection methodology for small geographic areas and have had discussions with expert demographers on this subject.

I have written about 12 technical papers on various topics related to radiological safety aspects of nuclear reactors. I am a member of the American Nuclear Society and the Population Association of America, which is the professional society of U. S. demographers.

PROFESSIONAL QUALIFICATIONS

OF

MOHAN C. THADANI

I am employed as a Nuclear Engineer in the Accident Evaluation Branch, Division of Systems Integration, Office of Nuclear Reactor Regulation. My responsibilities include the reviews and the analyses of designs and operations of nuclear power plant systems to determine the acceptability of the plant safety and the environmental impacts.

I graduated from the University of Bombay in 1955, with a Bachelor of Science (Honors) degree in Chemistry and Physics. I received a post-graduate diploma in Chemical Engineering from the University of London. Subsequently, in 1964 I received a Master of Science degree in Chemical Engineering from the University of Tennessee. In 1957, I joined the Nuclear Power Division of Head Wrightson and Company in Stockton-On-Tees, England. I was assigned to the thermal and hydraulic design and analysis of the Bradwell Nuclear Power Station in England.

In 1959, I joined the Foster Wheeler Limited of London, England. I was assigned to the research department on the design and testing of heat exchange components of the Pressurized Water Reactors for the British submarines.

From 1964 to 1970, I worked for the aerospace companies, Northrup Space Laboratories, Grumman Aerospace Corporation, and Fairchild Industries. I performed thermodynamics and reliability analyses for the Apollo Saturn Launch Vehicles, NERVA nuclear rocket systems, Lunar Module, Earth Orbital Shuttle Systems, and several satellite systems.

In 1971, I joined NUS Corporation as a senior engineer responsible for preparation of safety and environmental evaluations for nuclear power plant systems. While at NUS, I attained progressively increasing responsibilities, being promoted to the positions of section leader, and senior staff consultant. I was assigned as a project manager for the preparation of Safety Analysis Reports and Environmental Reports for Construction Permit and Operating License Applications for Nuclear Power Plants.

In 1978, I joined Teknekron, Incorporated, as a Senior Scientist and served as a Principal Investigator for analyses and evaluations to guide and support the development of Nuclear Regulatory Commission's proposed rule 10 CFR 60 concerning the safety of the geologic isolation of high level nuclear wastes.

In April 1980, I joined the Nuclear Regulatory Commission as a Nuclear Engineer in the Environmental Evaluation Branch, Division of Operating Reactors, Office of Nuclear Reactor Regulation. Following a reorganization of the Office of Nuclear Reactor Regulation, I was assigned to my present position as a Nuclear Engineer in the Accident Evaluation Branch, Division of Systems Integration.

JUDGE MILLER: We will meet in the morning at 7:45 to give you the opportunity to make the objections that you want.

That is on Staff Exhibit 17, isn't it, that you wish to be heard?

MS. FINAMORE: Yes.

JUDGE MILLER: I think that's the Staff's panel testimony.

Okay.

MR. MIZUNO: And Staff Exhibit No. 18 will be incorporated into the transcript, as if read?

JUDGE MILLER: It will be better than that. It will be given numbers and it will be right there just as though they opened their little lips and said, "I do".

That's all.

(Whereupon, the hearing in the above-entitled matter was recessed at 6:15 P.M. to reconvene at 7:45 A.M., Wednesday, December 15, 1982, in the same place.)

NUCLEAR REGULATORY COMMISSION

This is to certify that the attached proceedings before the

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in the matter of: TENNESSEE VALLEY AUTHORITY (CLINCH RIVER BREEDER REACTOR)

Date of Proceeding: December 14, 1982

Docket Number: 50-537

Place of Proceeding: Oak Ridge, Tennessee

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

Mary L. Bagby

Official Reporter (Typed)

Mary L. Bagby

Official Reporter (Signature)