ORIGINAL

UNITED STATES
NUCLEAR REGULATORY COMMISSION

IN THE MATTER OF: DOCKET NO:

PERRY NUCLEAR POWER PLANT, UNITS 1 & 2 50-440/50-441

THE CLEVELAND ELECTRIC ILLUMINATING CO., ET AL

LOCATION: PERRY, OHIO PAGES: 3433 to 3644

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UNITED STATES OF AMERICA

NUCLEAR REGULATORY COMMISSION

BEFORE THE ATOMIC SAFETY AND LICENSING BOARD

In the matter of:	:	
	:	
PERRY NUCLEAR POWER PLANT, Units 1 and 2	:	Docket Numbers 50-440 50-441
THE CLEVELAND ELECTRIC ILLUMINATING COMPANY, et al	:	

Perry Town Hall
Center Road & Main Street
Perry, Ohio 44081

Thursday, May 2, 1985

The hearing in the above-entitled matter was convened at 9:00 a.m., JAMES P. GLEASON, presiding.

BEFORE:

JAMES P. GLEASON, Chairman
Nuclear Regulatory Commission
Atomic Safety and Licensing Board

JERRY R. KLINE, Member
Nuclear Regulatory Commission
Atomic Safety and Licensing Board

GLENN O. BRIGHT, Member
Nuclear Regulatory Commission
Atomic Safety and Licensing Board

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APPEARANCES:

On Behalf of the Applicant, Cleveland Electric Illuminating Company, et al:

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and
HARRY H. GLASSPIEGEL, Esquire
SHAW, PITTMAN, POTTS & TROWBRIDGE
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On Behalf of the Intervenor, Ohio Citizens for Responsible Energy:

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On Behalf of the NRC:

COLLEEN WOODHEAD, Esquire
Office of Executive Legal Director
Nuclear Regulatory Commission
Washington, D. C. 20555

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C O N T E N T S

E X H I B I T S

PROCEEDINGS

(9:00 a.m.)

JUDGE GLEASON: All right.

Whereupon,

EILEEN M. BUZZELLI,

RICHARD D. RICHARDSON,

KEVIN W. HOLTZCLAW,

ROGER W. ALLEY,

BERNARD LEWIS,

BELA KARLOVITZ,

- and -

G. MARTIN FULS,

resumed the stand as witnesses called by and on behalf of the Applicants and, having previously been duly sworn by Judge Gleason, were further examined and testified as follows:

JUDGE GLEASON: I believe you had a preliminary matter, Mr. Glasspiegel?

MR. GLASSPIEGEL: Thank you, Mr. Chairman. Yesterday during the hearing a matter came up concerning the PNPP drywell electrical penetrations at transcript 3418 to 3419, and I believe, Ms. Buzzelli, you have some clarifying testimony to give relating to some answers you gave yesterday.

WITNESS BUZZELLI: Yes. Yesterday I talked about I believe electrical penetrations in the drywell in containment were similar, but to clarify that and also clarify my response to the question whether the Perry drywell electrical penetration was similar to the description provided in the document which is identified as the BWR Systems Training Manual, at page 4.1-4.

That description of the drywell electrical penetration is similar to the Perry electrical drywell penetrations, except that Perry does not have just a single fitting for sealant on the outside of the drywell wall.

There is an air and water tight header box that is filled with a ceramic blanket and a sealant material that is qualified to the drywell environment.

In addition, there is a welded multi-cable transit camble spreader on the outside face for positioning the cables.

MR. GLASSPIEGEL: We appreciate the opportunity to make that clarification. Thank you.

JUDGE GLEASON: Ms. Hiatt?

XXX CROSS EXAMINATION

BY MS. HIATT: (Continuing)

Q I believe yesterday we were talking about station blackout accidents, and you indicated that hydrogen would accumulate in containment without being burned off in such a situation, did you not?

A I indicated yesterday that for the unlikely station blackout that had progressed for a considerable period of time, past the point in time -- let's clarify -- past the point in time in which the reactor core insulation cooling system would have provided makeup to the vessel.

Sustained station blackout would allow hydrogen to accumulate if the igniter system is not powered during that extended severe accident type of an event.

Q Now, if we assumed that a 75 percent metal water reaction has occurred, wouldn't the concentration of hydrogen in the containment, assuming it is completely mixed, be around 28 percent, by volume?

A Approximately that concentration.

Q Isn't that a denotable mixture?

A I will have to let Dr. Lewis explain that.

A (Witness Lewis) That depends. It depends on how much steam. It depends on the source of ignition, and some of the other features in the ignition process.

Q Assume there is not much steam in the atmosphere. It is in the detonable range?

JUDGE GLEASON: That is a question, Dr. Lewis.

WITNESS LEWIS: That depends on how much air is present and how much hydrogen is present.

BY MS. HIATT: (Continuing)

Q Well, in this they are talking about a concentration of 28 percent hydrogen in air.

A (Witness Lewis) Oh, in air.
Q In air, yes.
A It is a detonable mixture under the right circumstances.
Q Now, if the AC power is restored at that point, and the distributed igniter system is actuated, have you not introduced an ignition source into a detonable atmosphere?
A No.
Q You have not?
A No.
Q Are you saying that the igniters are not an ignition source in a detonable atmosphere?
A That is right. Well, they are an ignition source, but not an ignition to detonation. You can't get detonation from a thermal ignition source.
Q You could not ignite the detonation?
A You could not initiate a detonation.
Q Even at detonable concentrations?
A That is right.
Q What is the basis for your statement, sir?
A Fifty years of experience.
Q Can you cite any experiments which prove that?
A Yes.
Q Would you please do so?
A Beg your pardon?

Q Would you please cite some specific experiments to show this.

A I can't immediately recall the exact publication, but I can say this. If you have say, a glow plug, and you ignite a mixture which is flammable, it might be a mixture which is able to sustain a detonation.

But the frame that is formed around the ignition source is a frame without convolutions, and no opportunity to accelerate.

If you can't accelerate a deflagration, then you can't get a detonation. I know in the minutes of a meeting between Sandia representatives and Professor Lee of Montrael. Professor Lee admits, as you know, that you cannot -- it is most unlikely to get a detonation with a glow plug source in an open space.

Q It would get very high over-pressures even from a deflagration at those concentrations though, would you not?

A Oh, yes. That is another matter.

Q Do you know what pressures you might get?

A What concentration are you talking about, 28 percent?

Q 28, yes.

A Those pressures could be starting with atmospheric pressure, could be about 100 pounds; 100 to 110 pounds. The loss could be as low as 50 pounds.

Q You are talking about heat loss?

A Heat loss, yes.

Q Right. Okay. Now, if we had such a situation, station blackout situation, upon recovery of AC power, would the operators in any way rely upon measurements of hydrogen concentration in the containment atmosphere in deciding to actuate the distributor igniter system?

A (Witness Buzzelli) Yes, they would. There would be guidance provided to the operator to have him determine the concentration prior to inititiating the igniter system.

Q Would you base the measurements of hydrogen concentration, containment atmosphere, on results from the hydrogen analyzer?

A No, that would not be the mechanism for the operators determination of hydrogen concentrations in a postulated station blackout event.

Q What system would be used?

A Post-accident sampling system.

Q Is that dependent upon AC power?

A No, it is not.

Q What methods does it use to measure hydrogen concentration?

A The grab sample technique. I don't have the details on the exact procedures the operator would use.

Q Is containment venting or purging to be used if the use of the distributor igniter system is impossible or inadvisable?

A The concept of venting is factored into the generic guideline discussions for situations, including hydrogen and other situations in which containment over-pressure is a concern.

End 1.
MS fols.

Sim 2-1

Q So it might be used?

A It is the subject of discussion in the development of this specific emergency procedure guidelines for hydrogen control as well as the overall containment overpressure concern from other accident sequences.

Q Now when you vent the containment, you have essentially created a leak, haven't you?

A The concept of venting is to control the overpressure.

A (Witness Richardson) It is more than a controlled release. There is guidance provided in the emergency procedure guidelines by the BWR Owners Group to vent under certain circumstances. We first evaluate the potential radiological release that may result.

Q Now for the Perry design just where would you vent containment atmosphere to?

A (Witness Buzzelli) The exact vent path has not been established. It is under review and evaluation at this time for the Perry plant.

JUDGE GLEASON: By whom?

WITNESS BUZZELLI: By our engineering staff and that of Gilbert and General Electric. Discussions are underway to establish what that vent path might be fore the overpressure concerns of the containment.

BY MS. HIATT:

Sim 2-1

Q Do you know what the flow rate would be of this venting system?

A No, I do not.

A (Witness Richardson) It would depend on the vent path that is finally selected.

Q Now in your analyses of containment response, do you not assume that containment sprays are available and will be actuated during or prior to hydrogen ignition?

A (Witness Buzzelli) Yes.

A (Witness Richardson) Yes. In the preliminary evaluation the containment sprays were assumed to be actuated after the first hydrogen burn when the operator would see an increase in temperature and pressure.

Q Now the containment spray system is a sub-system of the residual heat removal system, correct?

A Correct.

Q And another function of the heat removal system is low-pressure coolant injection?

A That is correct.

Q And low-pressure coolant injection is also an ECCS sub-system?

A Correct.

Q And to get into a degraded core accident with hydrogen production you must have the ECCS unavailable or degraded in some manner, correct?

Sim 2-3

A To postulate the degraded event that we have analyzed, then you must assume a delayed injection by some means. That specific means a non-mechanistic scenario, and that specific means has not been established. It is just assumed that it occurs somehow.

Q Now both containment spray and low-pressure coolant injection are dependent upon the same RHR pumps?

A Yes.

Q And they might also share some common valves or piping?

A They share some common piping.

Q And they also share AC power controls and wiring?

A They share some common electrical power supplies.

Q So it really isn't conservative to assume that containment sprays are available in a degraded core accident, is it?

A We feel that it is acceptable to make that assumption in that since the scenario is non-mechanistic it is not identified what the exact failures are. It is just assumed that there are failures which would result in a delayed injection into the core. It is reasonable to assume that one of those failures may be a failure of the injection valve for one of the A or B LPCI injection systems which would still allow the containment spray.

Q Isn't it true that containment spray operation

Sim 2-4

is a permissive for operating the drywell purge compressors?

A To my knowledge, it is not at the Perry plant. I know it is not at the Grand Gulf Nuclear Station and, to my knowledge, it is not at the Perry Nuclear Power Plant.

Q Ms. Buzzelli, do you agree with that?

A (Witness Buzzelli) I am not aware of such an interlock at the Perry plant.

Q I am handing you a part of the final safety analysis report for the Perry plant. Do you recognize this?

A I do.

Q Specifically Figure 73-5, RHR system function control design. On sheet 5 of 5 on this diagram does it not state here that there is a permissive to start hydrogen mixing system?

A (Witness Richardson) This figure is out of the final safety analysis report, which is a copy of a General Electric elementary diagram for the -- I assume this is the RHR system. It shows a permissive coming out of the logic to go to some other instrumentation and controls. As it shows here, it says "Permissive to start hydrogen mixing system by others." This is not the important document for identifying whether that permissive has been picked up in the plant design.

There are several permissives which are

Sim 2-5

provided by General Electric in the logic that they place in the plans, and those permissives are auxiliary relays which can then be used, if necessary, in other logic circuits such as the combustible gas control system. The document that would be important for establishing that would be the actual logics and control circuits for the combustible gas control system.

Q So are you saying that your final safety analysis report does not completely describe the design of the Perry plant?

A The final safety analysis report, that relay, to my knowledge, would probably be in the circuits. Whether that contact is picked up in the other circuits is not shown and it is not necessary that it be shown in that diagram.

Q But you don't believe that feature has been incorporated at Perry?

A To my knowledge, no.

Q If we assume ---

A I would like to add that I know in the case of Grand Gulf, which I am a little bit more familiar with in terms of in particular the instrumentation and control, since I have looked at many of the diagrams and circuits, that same permissive is provided in the GE instrumentation and control from the RHR system, and the relay was not picked up by the architect/engineer because it was not necessary.

Sim 2-6

Q If we assume that sprays are available in a degraded core accident, will they automatically actuate a containment pressure of 9 psig?

A Excuse me, did you say -- what was the first assumption? I missed that.

Q If we assume the sprays are available in a degraded core accident, they will automatically actuate at a containment pressure of 9 psig; is that true?

A They will actuate at approximately 9 psig. I don't know what the exact setpoint is. It is nominally approximately 9 pounds.

Q Isn't it true that containment spray takes precedence over other RHR functions with the exception of low-pressure coolant injection for the first 10 minutes of an accident?

A That is true.

Q Will both trains of containment spray continue to operate as long as containment pressure exceeds 9 psig?

A If the pressure is above 9 psig and stays there and the operator does not take manual control of the system then the system would continue to operate in the spray mode.

end Sim
Sue fols

#3-1-SueT

Q And if the containment pressure were to fall below 9 psig, operator action would be necessary to realign the A or B loop of RHR to another function such as pool cooling, correct?

A (Witness Richardson) I think that's true. It depends on whether that contact is a seal end or not. I think that that is a seal end contact which would require the operator to realign the system.

Q Isn't it true that the operator cannot manually override containment spray as long as the containment pressure exceeds 9 psig?

A I would have the check the schematics to verify that. I do not think that that is the case, but I would have to check the schematics.

Q Ms. Buzzelli, do you know?

A (Witness Buzzelli) I don't know without checking the schematics on that.

Q Do any of your draft emergency procedure guidelines instruct operators to activate containment spray upon high containment temperature regardless of core cooling?

A (Witness Richardson) I'm sorry. Would you restate the question?

Q Do any of your draft emergency procedure guidelines instruct operators to activate containment spray upon high containment temperature regardless of core cooling?

#3-2-SueT

A (Witness Buzzelli) The emergency procedure guidelines on containment temperature control, I believe is the specific guideline, direct the operator to focus all of his efforts on restoring core cooling. In the event the containment temperature is increasing, he is able to cycle the system. That is, put the water to containment sprays to bring that pressure down and then restore it back to core cooling.

It is not an either/or situation. It's direction to the operator to protect the containment, bring that pressure down and once again restore core cooling.

Q Mr. Richardson, did you make a presentation to the Nuclear Regulatory Commission on behalf of the Hydrogen Control Owners' Group on June 29th, 1983?

A (Witness Richardson) If you have a document that shows that, I guess I did. I would like to see it. I made a number of presentations to the NRC, and I can't remember the dates.

(Ms. Hiatt is showing the witness the document.)

Q Yes.

A Yes, I was there, and I did make certain portions of the presentation. There were other people also making presentations.

Q This is a handout of materials that you gave the NRC and others in attendance?

A It appears to be. I don't remember all of the

#3-3-SueT

handouts that were given, but it does appear to be information that was provided.

I know some of this information was provided. I can't attest that all of it was. I don't remember.

Q Doesn't this page concern the emergency procedure guideline for hydrogen control?

A That -- this document, this handout was a description of some draft information that the Hydrogen Control Owners' Group had submitted to the BWR Owners' Group in an attempt to initiate discussions and provide some basic guidelines that we felt should be considered for incorporation into the emergency procedure guideline.

And this was some very preliminary information that has been used to prepare those documents.

Q I call your attention to the part under Operator Actions. Could you read this last part into the record here?

A Yes. It says, "Initiate containment spray on high high containment temperature regardless if adequate core cooling is assured."

Again, I restate that this is some initial thinking that was provided to the BWR Owners' Group who has the primary responsibility for developing these guidelines. And whether or not that statement will be in the final guidelines, I am not sure.

Q Could you identify what high high containment

#3-4-SueT

temperature would be?

A At that time, we had no value for that. It was a concept which was to take certain actions based on some high temperature which was to be established, and then a -- later establish a high high temperature at which point you would take further actions if you could not reduce the temperature down. It's more of a concept than a specific value.

Q Now, these high containment temperatures, are these the ones resulting from hydrogen combustion?

A There already are in the guidelines are some steps for actuating containment sprays based on temperature if adequate core cooling is assured. And that presently is 185 degrees.

I'm sorry, what was your --

Q The high temperatures in containment you are talking about, these would be resulting from hydrogen combustion, correct?

A As I was getting ready to say, there already are some steps in there for actuating containment sprays on high temperatures, 185 degrees. And these tests are intended to provide some additional guidance if necessary to the operator for actuating the sprays on high temperature.

The -- my latest understanding of the guideline is that there would be no additional steps to actuate sprays above the existing temperature of 185 degrees. That is again

#3-5-SueT

the guideline currently, to cover other events.

Q Now, when the residual heat removal system is used in the containment spray mode, isn't it true the suppression pool cooling is greatly diminished as compared to that available when you have an RHR loop devoted to pool cooling?

A First of all, there are two systems that can provide either containment spray or suppression pool cooling. The RHR-A and the RHR-B.

So, if the other RHR system is available, it can be aligned in the suppression pool cooling mode. In addition, if the spray system is on line spraying, the water from the suppression pool is directed through the heat exchange even before it's sprayed. So, there is some pool cooling by the water eventually getting back down to the suppression pool.

Q But if we assume that there are no RHR loops devoted to pool cooling, and we have containment spray, there isn't as much heat removal from the pool in the spray mode, is there?

A That's true.

Q So, as decay heat is added to the pool its temperature will rise?

A That's a true statement.

Q So, even if the pressures resulting from hydrogen burning do not directly fail the containment, if the containment spray is kept operating the pool cooling is effectively

#3-6-SueT

disabled, isn't it?

A I would not agree that it is effectively disabled, no; in that, as I said, you are removing the water from the suppression pool through the heat exchange and spraying it. And the problem, even though the cooling in the heat removal may be diminished, you know, the problem with the elevated suppression pool temperature may be to increase the pressure in the containment.

However, the spray would be adequate to handle any pressure which may increase.

END #3

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Q Now, isn't it true that when you do not have an RHR loop devoted to pool cooling, you do not have the mixing in the pool which you would ordinarily have?

A (Witness Richardson) You have RHR loops in the pool cooling mode?

Q Correct.

A You would not have the circulation of water and the mixing that would normally occur when the loop is in the pool cooling mode.

Q Isn't it true that most of the containment spray will not reach the pool, but it will be impeded by the operating floor of other structures, and floors within the plant?

A Well, all of the water that is sprayed in the top of the containment will eventually get down to the pool. Other than some small amount which may be dropped in some lines or something, but that is minimal.

It might not arrive there in a very small drop or spray or mist, but it is going to eventually get bzck down to the pool.

Q Isn't it true that the reactor core isolation cooling system has a maximum water temperature it can pump of 140 degrees F?

A The 140 degrees F is a guideline provided by the vendor on not allowing AC operation above that temperature, because the lube oil cooler which obtains its cooling from the flow of water through the system.

I know in a lot of plants, such as Grand Gulf, I am not quite sure if the same evaluation has been done with Perry, but evaluations have been done to show that that operation of the RCIC system can be extended much beyond that.

A (Witness Holtzclaw) In addition, there has been some work done recently to define what the actual capability of RCIC turbines and pump systems to operate well beyond 140 degrees, and it has been established that those pumps can operate without impairing the lube oil cooling to temperatures of well in excess of 140 degree value.

Q Exactly what are those temperatures?

A I don't recall the exact numbers, but there has been an estimate by some of the turbine manufacturers that lube oil cooling would not be impaired for operation in excess of 180 degrees F.

Q The high pressure core spray likewise has the maximum temperature of 212 degrees F?

A (Witness Richardson) To my knowledge the limit that you are referring to is a design limit, and it is based on a very conservative nps, net positive suction head calculations.

The system typically has much more capability than that. Particularly in this event where both calculations are done assuming a very hot pool with no pressurization in the containment, and in this condition, if you did have some pressurization, that would add to the pressure and suction on the pump.

Q And when the water in the condenser storage tank is exhausted, HPSI and RCIC take suction from the pool, correct?

A Correct.

Q Does the BWR Owners Group generic emergency procedure guideline establish any curves for pool water temperature and operability of these various pumps?

A Generic guidelines have several actions taken on pool temperature. I can't recollect that there is one on there for operation of those systems.

A (Witness Holtzclaw) There is some work that has been ongoing by the BWR Owners Group, looking at suppression pool temperature limits, primarily to reduce the conservatisms that are currently identified in things like final safety analysis report, that place fairly conservative limit on suppression pool temperature.

There is an activity that has been ongoing for the last year in the BWR Owners Group. They recently submitted a report to the NRC to relax some of the suppression pool temperature limits.

I believe that there is an activity that will be ongoing to best define what the actual limiting condition is based on things like pump performance, and it is expected that there will be a significant relaxation in suppression pool temperature limit requirements.

As of right now, the NRC Staff is reviewing the most recent Owners Group documentation to relax some of the suppression pool temperature limits.

Q Is this work based upon calculations, or are there actual tests of equipment involved there?

A I believe that a good deal of the work is based on analysis of what the actual suppression pool temperature would be in a number of scenarios.

I am not aware of the test support for that document.

Q Mr. Richardson, I am handing you a document dated December 22, 1982, from BWR Owners Group to Nuclear Regulatory Commission, concerning a draft of the generic emergency procedure guidelines.

Are you familiar with this document?

(Witness peruses document.)

A (Witness Richardson) Not familiar with this actual letter that submitted these guidelines. I am generally familiar with the guidelines.

Q Now in the caution section, are there not codes concerning the net positive suction head requirements for pumps taking suction from the suppression pool?

A (Pause.) The caution in the front of this document provides the operator a caution on hearing NPSH requirements for pumps taking suction from the suppression pool.

This caution is in the front, and you can actually see -- to actually see how it was implemented, you would have to go back through the document here and see where that caution is picked up.

Q Well, looking at these graphs, can it not mean that for the residual people who are in the system, when the containment pressure is 10 psig, if you get above a 248 degrees F, the pumps will gravitate?

A According to this curve, and again, this -- I do not know the basis for this curve and what plant this was calculated on, the calculation has to be plant specific.

And these guidelines, they generally take a plant, which may be a BWR-3 or 4, and they evaluate the piping of that particular plant, and provide a curve which is some general guidance, and that curve has to be -- if the guidance provided to the specific plant from the Owners Group, that has to be taken; and the actual net positive suction head occurs with that plant, and for the actual installation in that plant has to be developed.

So, this is a general curve, and this curve does show that for the RHR pump, it shows a curve based on flow to the pump for a given suppression pool temperature.

And it has the -- for the 10 psig curve, it is on the order of -- it appears to be 248 or so at low flows.

Q So, if you are trying to take hotter water than that, the pump will gravitate? Is that the basic idea of these theories?

A Again, it depends on the -- that is the basic idea of these curves. It depends, -- if you say hotter water, you would have to evaluate the pressure, because the calculations must also include in the pressure that exists in both the pool and --

Q And for the curves for the low pressure core spray pump, that would indicate about 245 degrees F at 10 psig would be the limit?

A This curve that is in this document shows, as you have stated, approximately 245 pre-cool temperature at 10 psig.

Q Do you know if this is generally applicable to the BWR-6?

A The concept is applicable. The exact curves, I would have to evaluate the actual mpsh calculations of a given plant, because it depends on the routing of the pipe and the head of water that exists above the suctional pump in the suppression pool.

Q Ms. Buzzelli, are you familiar with any Perry-specific curves like that?

A (Witness Buzzelli) I am not aware that our plant specific curves have been developed as yet.

A (Witness Richardson) It may not have been clear before when I was talking about it, but as I was saying to the Board, there are limits that are placed in the guidelines for suppression pool temperature where there are steps actually in the guidelines to tell the operator actions to take.

That is different from the cautions that you are asking here. This is a caution for the operator to be concerned about potential for cavitation due to net possitive suction head requirements, and there is a distinction there. To my knowledge there are not specific steps taken. There are only cautions that may be in here.

Q Isn't it true that at Perry the reactor core isolation cooling system, by-pressure core spray system, low pressure core spray system, and residual heat removal system take suction from areas of the pool within the safety relief valve discharge quencher zone?

A Can you define what you mean by, 'safety relief valve quencher zone?'

Q Well, maybe I will do this. I hand you a document, a letter dated May 29, 1984, from Murray R. Edleman to Mr. B. J. Youngblood, of the NRC, correct?

A Yes.

Q And it concerns a piping design review of the Perry

Plant?

A (Witness Buzzelli) It does. The subject of that letter does concern a piping design review.

Q Now, did you emply CYGNA Energy Services to conduct this piping design review?

A CYGNA Energy Services was the consultant utilized in the piping design.

Q And attached to the letter is an observation record which they made as a result of their review of the pipes?

A It was a SYGNA observation record. It describes their observation, specific review item, as part of that program.

Q Doesn't this observation state that the location of HPCS, LPCI, RCIC and RHR suunction strainers are within the SRV discharge quencher zones?

A The description of the specific finding was on the HPCS suppression pool suction strainer is not located outside the safety relief valve discharge zone is the description of one of the three findings in this observation document.

The resolution comments indicate that the observation has no impact on designer safety, and for that particular item that General Electric had approved the location of the suction strainers for the HPCS, high pressure core spray, low pressure fuel injection, reactor core isolation cooling, residual heat removal, suction strainers, and that approval was based on the pump manufacturer's certification on the acceptability of that configuration for the pump operation.

Q Wasn't the approval based on the quantity of ingested air that is acceptable for pump operation?

A The vendor certified -- the approval was based on the pump vendor's certification that the quantity of ingested air (40 percent maximum in 1.5 seconds) is acceptable for the pump operation.

Q And you don't know if temperature was evaluated in the disposition of this item?

A I cannot tell if temperature was included based on this observation.

Q Couldn't this possibly be a misprint? Should that be LPCS by any chance?

(Witness peruses document.)

JUDGE GLEASON: Let's identify where you are referring to, if you please.

MS. HIATT: It is the last page of this document. Observation Record Review. The paragraph small letter 'a.' The sentence: General Electric approved the location of the HPCS, LPCI, RCIC, and RHR.

Do you know that that should be LPCS and not LPCI?

A That may be a typo in this document. As I stated before, the original finding was focused on the high pressure core spray system, and the discussion herein focuses on the high pressure core spray.

I think the comment here is extended beyond the scope of the original finding. I don't know without looking further if the supporting documents are identified therein.

Q Well, the low pressure injection does not have a separate suction strainer from RHR?

A (Witness Richardson) Each of the RHR systems, A, B, and C, do only have one suction from the suppression pool.

However, it is hard to tell what the author intended there. He could have been referring to the C System, which is only a LPCI mode, and is often referred to only as LPCI as opposed to RHR.

Q Do you know if the low pressure core spray is also -- has a suction strainer located within the SRV quencher discharge zone?

A (Witness Buzzelli) I don't know.

MS. HIATT: I would like this document to be marked for identification as OCRE Exhibit --

JUDGE GLEASON: The document will be marked as OCRA Exhibit No. 14.

MS. HIATT: I believe that would be 15.

JUDGE GLEASON: 15? I am sorry, you are right. It will be Exhibit No. 15.

XXX INDEX

(Above mentioned document is marked OCRE Exhibit No. 15, for identification.)

JUDGE GLEASON: Is there objections to its admission?

MR. GLASSPIEGEL: I need a moment to try to check to see if this appears to be the complete document. Just one moment, please.

JUDGE GLEASON: Do you have a copy, Ms. Woodhead?

MS. WOODHEAD: Yes, I do. I object on the grounds of relevance. I don't understand where this line of questioning is going.

MR. GLASSPIEGEL: Mr. Chairman, first I would agree with Ms. Woodhead's objection, and further, I understand that this was a transmittal letter, transmitting a report that was in excess of an inch thick.

(VOICE) This is the document, Harry.

(Document passed to Mr. Glasspiegel.)

MR. GLASSPIEGEL: I am holding the backup document, and you can see it is rather thick.

So, I think there is some additional potential at least for prejudice here. I am not recommending that we put two inches of documentation in the record. I think the better approach is that Ms. Hiatt has asked the questions she wants to ask.

I think the record is relatively clear on which portions of the letter she has asked about any my preference would be not to have the document in the record.

End 4.
MS fols.

Sim 5-1

(Pause.)

JUDGE GLEASON: Well, whether the document is in any way inadequate as a summary, or the letter is inadequate as a summary as to what is in that document, I will let you handle on rehabilitation, and its relevancy I don't really want to argue at this point. So the objections are denied and the letter will be admitted into the record.

MR. GLASSPIEGEL: I am sorry, which exhibit number was that?

JUDGE GLEASON: 15.

MR. GLASSPIEGEL: Thank you.

(OCRE Exhibit No. 15, previously marked for identification, was admitted into the record.)

(OCRE Exhibit No. 15 follows:)

OCRA Ex. 15

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VICE PRESIDENT
NUCLEAR

May 29, 1984
PY-CEI/NRR-0117 L

(82)

Mr. B. J. Youngblood, Chief
Licensing Branch No. 1
Division of Licensing
U. S. Nuclear Regulatory Commission
Washington, DC 20555

Perry Nuclear Power Plant, Units 1 & 2
Docket Nos. 50-440; 50-441
Piping Design Review

Dear Mr. Youngblood:

This letter is to provide you with a copy of the final report on the Piping Design Review program. This program was discussed with the NRC staff on March 12, 1984 and in our April 5, 1984 letter (PY-CEI/NRR-0103 L).

The piping design review program was undertaken as one element of the overall Design Verification effort. This final report consists of two parts. Part I describes the overall program, CEI's review of the consultant's (Cygna Energy Services) observations and our evaluation of generic implications. Part II is the final report of the consultant's detailed review of selected piping systems. (Volumes 1 and 2).

Based on this combined review effort, and the resulting programs that are underway and being tracked to resolve the observations and generic concerns, CEI believes that the mechanical design adequacy at the Perry Nuclear Power Plant is assured.

We hope that this information is helpful in the development of any initiatives you may plan. If you have any questions please contact us.

Very truly yours,

A. Kaplan for M. Edelman

Murray R. Edelman
Vice President
Nuclear Group

MRE:njc

Limited Dist

Attachments

B001
1/1

cc: Jay Silberg, Esq.
John Stefano
Max Gildner

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PDR ADOCK 05000440
A PDR

CYGNA

Observation Record

Observation No.	ME-02-03	Revision No.	0
Checklist No.	ME-02 HPCS Item No. 2	Sheet	1 of 2
Originated By	R. W. Hum	Date	12/1/83
Reviewed By	RJ Weingart	Date	12/9/83

1.0 Description

The location and arrangement of some equipment and piping is inconsistent with General Electric and NRC Criteria. Specifically:

a. The HPCS suppression pool suction strainer is not located outside the safety relief valve discharge zone.

b. Valve F023 is located approximately 14 ft. from the containment penetration. It should be located as close as practical to the penetration. Normally a distance of 5 ft. or less is achievable.

c. The length of straight pipe after a valve and prior to flow orifice N007 does not meet the 43 ft. requirement.

2.0 Requirement

a. General Electric Specification 22A3131, Section 4.2.4.6, states that the HPCS suction strainer shall be located away from safety relief valve discharge zones.

b. Both General Electric Specification 22A3131, Section 4.2.3.13 and 10CFR50 Appendix A Criterion 56 require that outside containment isolation valves, such as F023, be located as close to the containment penetration as practical.

c. Per General Electric Specification 21A9505BV, Rev. 1, Section 4.3.1.1 there should be 43 ft. of straight pipe between the outlet of a valve and the inlet of the flow measuring orifice.

3.0 Reference Documents

3.1 Design Specification HPCS, 22A3131, Rev. 5

3.2 General Design Criteria, 10CFR50 Appendix A

3.3 Flow Orifice Assembly HPCS, 21A9505BV

Cygna

Observation Record

Observation No.	ME-02-03	Revision No.	0
Checklist No.	ME-02 HPCS, Item No. 2	Sheet	2 of 2
Originated By	R. W. Hess	Date	12/1/83
Reviewed By	[signature]	Date	12/9/83

3.4 Drawings

3.4.1	HPCS Plans and Sections	D-304-701
3.4.2	HPCS Sections	D-304-702
3.4.3	HPCS Reactor Building El. 620'-6" and 574'-10"	D-304-703
3.4.4	MSSR Piping Inside Reactor Building El. 574'-10" and 599'-9"	D-304-026
3.4.5	Discharge Quencher	767E676 I.C.D
3.4.6	Quencher Arrangement Design Envelope	B-301-734, Rev. J

4.0 Potential Design Impact

a. The location of the HPCS suction strainer within the quencher discharge zone could cause air or steam entrainment in the HPCS pump suction line.

b. The location of F023 away from the containment penetration provides a greater length of nonisolatable piping which could lead to a breach of containment if it failed.

c. The accuracy of flow orifice N007 could be affected by its proximity to the valve located upstream.

5.0 Probable Cause

Design oversight and lack of documentation of design variances.

Attachments

A. Observation Record Review

CYGNA

Observation Record Review
Attachment A

Observation No. ME-02-03	Checklist No. ME-02	Revision No.	0
OFR No.		Sheet 1 of	1

	Yes	No
Closed	X	

Extent 1 of 3 Systems with nonconformance to GE Equipment arrangement requirements

Comments

Based on the following GAI and GE data and documentation, this Observation does not have any impact on design or safety.

a. General Electric approved the location of the HPCS, LPCI, RCIC and RHR suction strainers within the SRV discharge quencher zones in Field Deviation Disposition Request No. KL1-301 approved on 6/6/83. This approval was based on the pump vendor certification that the quantity of ingested air (40% maximum in 1.5 seconds) is acceptable for pump operation.

b. GAI has stated, based upon their review of the piping arrangment, that due to the proximity of other piping and the valve operator size, F023 cannot be located any closer to the containment penetration.

c. GAI has stated that the current piping arrangement will provide the 1% accuracy specified for flow element E22-FE-N007. GE concurrence with the existing piping arrangement was requested by GAI in letter PY-GAI/GEN-2931, dated 12/30/83.

Approvals

Originator	R. W. Hess	Date	1/13/84
Project Engineer	[signature]	Date	1/13/84
Project Manager	[signature]	Date	1/16/84
CEI Representative	[signature]	Date	1/20/84

Cleveland Electric Illuminating; 83102
Perry Nuclear Power Plant Piping Design Review

BY MS. HIATT:

Q Isn't it true that with diminished pool mixing, that the water drawn by these systems from the zone of the safety relief valve discharge quenchers would be hotter than the bulk pool temperature?

MR. GLASSPIEGEL: I will object on the basis that I don't believe Ms. Hiatt has laid a foundation for the premise.

JUDGE GLEASON: Let's find out where she is going with it.

Answer the question if you can, please.

WITNESS BUZZELLI: It is not likely based on the configuration of the safety relief discharge lines, and locations of the suction strainers and the overall volume of the pool.

BY MS. HIATT:

Q You do admit that there would be diminished pool mixing if you did not have an RHR loop in pool cooling?

A (Witness Richardson) Diminished is certainly relative. If you have an RHR system in pool cooling, you sustain a significant amount of additional mixing with the pool. However, during these events with safety relief valves lifting and discharging there is a consideratable amount of mixing and aggitation of the pool water. So diminished is certainly relative.

Sim 5-3

Q Wouldn't the water in the vicinity of the safety relief valve quencher be hotter because of the steam heat addition?

A Typically as you discharge the water into the pool the area right immediately outside the quencher would be hotter than other areas of the pool.

To just follow up on that, if I am not mistaken, the suctions of the ECCS systems are lower than the actual discharge heighter of the quencher, which means they would be drawing water from an area which is typically cooler.

Q How much lower are they?

A How much lower?

Q Yes.

A I don't remember the exact figure.

Q Have you evaluated suppression pool response with both A and B RHR loops used in the containment spray mode?

A (Witness Buzzelli) Can you repeat the question? My immediate answer is no, not as part of the preliminary evaluation of the hydrogen control system. If you ask me is that evlauation part of our preliminary analysis of the hydrogen control system, the answer is no.

Q Well, has General Electric performed an evaluation generally for the Mark III of the suppression pool temperature response with A and B RHR loops used in

Sim 5-4

containment spray?

A (Witness Holtzclaw) As part of the consideration of the operation of the hydrogen control system, I don't believe such an evaluation has been done. Typically I think for design basis accident evaluations there is an evaluation of suppression pool temperature.

Q And did that evaluation consider that one of the RHR loops was used in the pool cooling?

A I have to admit that I am just not familiar with those evaluations and I can't say for sure.

Q Isn't it true that at least one RHR loop must be devoted to pool cooling to prevent containment over-pressure from lack of steam condensation and pool surface evaporation?

MR. GLASSPIEGEL: I am sorry. For my benefit I would appreciate it if the reporter would read the question back.

(The pending question was read by the reporter.)

JUDGE GLEASON: Go ahead.

WITNESS RICHARDSON: I am not aware of the specific analysis that you are talking about, but it sounds like you may be referring to considerations for design basis events to assure that certain limits are maintained in accordance with the design basis anlaysis. Such calculations have not been done for the degraded core event for

Sim 5-5

the hydrogen event where the containment pressure may get to higher levels as demonstrated by the ultimate capacity of the containment.

BY MS. HIATT:

Q Are you familiar with the RSMAP study of the Grand Gulf plant?

A (Witness Richardson) I am familiar with it.

Q And isn't that a study of the beyond basis accidents?

A RSMAP stands for Reactor Safety Study Management Applications Program, and it was a study to extrapolate the results of the reactor safety study to a more modern plant such as Grand Gulf, and it is a study of events which lead to severely melted cores.

Q Do you consider this a valid study?

A There are some inconsistencies and there are some errors in some of the descriptions in there relative to the plant design and there are some features that are not accounted for because it was a simplified study. Beyond that, it is a valid study.

Q I am handing you a document numbered NUREG CR-1659, Volume IV entitled "Reactor Safety Study Methodology Applications Program, Grand Gulf No. 1 BWR Power Plant" by the Sandia National Laboratory.

I would call your attention to Page A1-11.

Sim 5-6

MS. WOODHEAD: Mr. Chairman -- oh, I am sorry.

MS. HIATT: Would you please read the first sentence of this paragraph into the record.

MS. WOODHEAD: Mr. Chairman, I think the witness has identified this document as being related only to a full core melt, and I think the purpose of our hearing is to discuss the hydrogen control system in the event of a degraded core at the Perry plant.

If this document is, as Ms. Hiatt and the witness have identified it, being related only to full core melt, it is totally irrelevant to the purose of this hearing, and I see no point in going forward with dicussions of design basis accident.

JUDGE GLEASON: What is your response to that?

MS. HIATT: Well, I think there is a fine line between the degraded core accident and the severe core meltdown. If you do not have certain systems available such as decay heat removal, you might accelerate the degraded core accident into a severe core accident meltdown.

The specific part of this document we are referring to, we are not really talking about severe core accidents. We are talking about the ability of systems within the BWR-6 Mark III and their performance in beyond design basis accident situations. So I think it is applicable.

Sim 5-7

JUDGE KLINE: Ms. Hiatt, the Board is concerned that you appear to be beyond the requirements of the rule as to hydrogen. I mean we are not clear as to where we are going on the question of hydrogen control, and I guess we need a little more explanation as to why this is relevant.

MS. HIATT: The object of my questioning is to determine whether or not the necessity to remove the heat of hydrogen combustion from the containment atmosphere will degrade the decay heat removal processes which would normally be operating in the plant and thus might aggravate the course of a degraded core accident.

JUDGE KLINE: I mean even if one granted that scenario to be true, and I am not saying that it is, but even so, of what relevance is it to hydrogen control?

The question that we have before us is the ability to control hydrogen to 75 percent of the metal water reaction. So even granted that the accident might progress beyond that, why is it relevant to the question?

MS. HIATT: I think we might have to go back to the rule and look at that. I think there was a statement therein that the hydrogen control systems should not in themselves aggravate the course of an accident. I can find it, if you want.

JUDGE KLINE: Yes, why don't you try.

Sim 5-8

(Pause.)

MS. HIATT: In the Federal Register notice, page 3500 under the heading "Hydrogen Control Systems," it is near the bottom of the page.

"The system that is proposed and approved must safety accommodate large amounts of hydrogen and operation of the system either intentionally or inadvertently must not further aggravate the course of an accident or endanger the plant during normal operations."

That is basically what I am getting at here is whether or not the measures necessary to control the large amounts of hydrogen will perhaps inadvertently also degrade decay heat removal.

MR. GLASSPIEGEL: I would like to respond to that if I could.

JUDGE GLEASON: Wait just a minute, please.

MR. GLASSPIEGEL: Okay.

(Pause.)

(Board conferring.)

JUDGE GLEASON: Mr. Glasspiegel, we are ready for your argument.

MR. GLASSPIEGEL: Well, I have some reservations about the statutory interpretation that Ms. Hiatt is proposing without conceding any arguments about the context of the statement she is referring to. I think we should

Sim 5-9

just let the question in and move on.

JUDGE GLEASON: I do, too.

WITNESS RICHARDSON: Would you restate the question, please?

BY MS. HIATT:

Q All right. We were on page A1-11 of the RSMAP study. Would you please read this first sentence into the record.

A (Witness Richardson) I would like to first say that I am reading from a section of the document, Section 2.2.5 which is entitled "Event I - Residual Heat Removal." That event for these sequences that are considered in this document is not included in one of the dominant accident sequences that results in a failure of the containment or hydrogen combustion as identified in Table Figure 6-1 of the report.

And the basis for that is that they are discussing long-term loss or degradation of suppression pool cooling and loss of decay heat removal which is a consideration in severely melted cores and severe accident considerations and in risk studies where they are considering other modes of failure of the containment beyond hydrogen burning such as long-term decay heat removal, and that is what this section describes, that particular event.

The specific paragraph that you have asked

Sim 5-10

me to read starts out "In addition to this, successful RHR depends on either RHRS loop A or B operating in the suppression pool cooling mode. This means that one flow path from the suppression pool through a heat exchanger and back to the suppression pool must be established. The steam condensing mode of the RHRS was not considered for LOCAs. This is due to the fact that successful operation of the steam condensing mode requires RCIC system operation and the RCICS will not be available long-term due to low steam pressures."

MS. HIATT: That is enough I think.

BY MS. HIATT:

Q Do you agree with the first two sentences there?

MR. GLASSPIEGEL: I will object to any further questions. I think the witness has clearly stated that this isn't relevant to the issue.

end Sim
Sue fols

#6-1-SueT

JUDGE GLEASON: She has already laid a foundation for getting this question answered. Your objection is denied.

Answer the question.

WITNESS RICHARDSON: I agree with that statement only in the context that it was made for this event which was evaluated for an event which did not result in hydrogen burning in containment failure.

BY MS. HIATT: (Continuing)

Q But doesn't this section specifically talk about various systems and not specific accident scenarios?

Isn't that what this section of the document is about?

MR. GLASSPIEGEL: Objection.

JUDGE GLEASON: Objection denied.

WITNESS RICHARDSON: This section discusses events and potential failure modes for given events. And it makes some simplifying -- the study made some simplifying assumptions for given events in order to simplify the risk study.

It did not evaluate the actual capability of the system and what is really required before you get a potential loss of suppression pool cooling. You have to -- you can only take this section in context with the events that are being considered.

BY MS. HIATT: (Continuing)

Q Mr. Richardson, what do you believe is the accident

#6-2-SueT

scenario that that specific paragraph was talking about?

A That particular paragraph is -- and I'm not looking at the document now, but Event I had to do with loss of RHR, which is an event and not a scenario. It's an event that is considered for risk studies, and it's one of several events.

And, so to answer your question, it's not a scenario.

Q And this particular event could be postulated in a number of accident scenarios; isn't that true?

A The event can be postulated in a number of scenarios, and it's important in what the event is relative to the scenario.

In that particular case, it's more concerned with long term decay heat removal, as I've stated, and containment failures from other means besides hydrogen and generation and combustion.

Q Well, don't you in any event need long term decay heat removal to maintain the core in a safe condition?

A You do need long term decay heat removal to maintain the core in a safe condition, that's true in design basis considerations as well as degraded cooling.

Q Do you know John M. Humphrey? Have you ever heard of him?

A I have heard of him and met the man.

Q He is a former General Electric engineer, correct?

A That's correct.

#6-3-SueT

Q And his speciality at GE was containment design, correct?

A He was a containment -- I mean, at the time he left, he was the Lead System Engineer for the containment systems. I'm not sure if that qualifies him as a specialty. He may have worked in other areas that I'm not aware of.

Q And he specifically worked on the MARK III containment design, didn't he?

A To my knowledge, yes.

Q Are you aware that Mr. Humphrey prepared a Discussion Report on MARK III Containment Interface Issues?

A I have heard of such a report.

Q Have you ever seen it?

A No, I have not.

Q Has anyone here seen it?

A (Witness Buzzelli) I may have seen the report, but I'm not familiar with details of its contents.

Q Do you think Mr. Humphrey is a reputable engineer?

A (Witness Richardson) It depends on what you mean by reputable. I mean, I --

JUDGE GLEASON: Let's not quibble over little things. You know what reputable means.

WITNESS RICHARDSON: He appears to be a reputable engineer.

BY MS. HIATT: (Continuing)

#6-4-SueT

Q Do you think that is work is valid?

A (Witness Richardson) Yes.

Q I am handing you Page 3.3-25 of his Discussion Report. Could you please read this paragraph into the record?

JUDGE GLEASON: Now, this is a Discussion Report on what?

MS. HIATT: On MARK III Containment Interface Issues.

JUDGE GLEASON: And is there a date on it?

MS. HIATT: June 30th, 1983, prepared for the U. S. Nuclear Regulatory Commission, Final Report.

JUDGE GLEASON: All right.

MR. GLASSPIEGEL: Mr. Chairman, this came up in the last two days, and I just have a problem if I understand the Chair's rulings up until now.

The answers given were that the witnesses -- I think Ms. Buzzelli said she was generally familiar with the document but didn't know its contents. There were questions about whether Mr. Humphrey was reputable, whether his -- Mr. Richardson had reason to question whether his work was valid.

Those questions aren't really helpful to the record. It's well known that Mr. Humphrey has raised some issues which the witnesses may agree or disagree with.

Now, to start reading paragraphs into the record I

#6-5-SueT

think is a little dangerous. If Ms. Hiatt wants to read a paragraph into the record and ask the witnesses if they agree or disagree with the finding, I think that's one thing. We handled it that way in the past.

JUDGE GLEASON: Go ahead, Ms. Hiatt. You read it and see if he agrees with it. I think it's much easier if they read it themselves, because then they can concentrate on it.

But if you can listen better than you can read, then let her read it. Go ahead.

MS. HIATT: All right.

JUDGE GLEASON: How would you prefer to go?

MR. GLASSPIEGEL: I would rather go this way.

JUDGE GLEASON: No, I'm asking your witnesses.

WITNESS RICHARDSON: If I'm going to have to respond to questions, then I am going to need the document in front of me, now or later.

BY MS. HIATT: (Continuing)

Q Do you want to read this, then?

A (Witness Richardson) This document, which is a Discussion Report on MARK III Containment Interface Issues, Page 3.3-25, states: "Containment spray operation has two potential effects on the suppression pool temperature response. The additional head required to pump the RHR flow through the spray headers at the top of the containment results

#6-6-SueT

in a reduced RHR flow rate and roughly a fifteen percent reduction in the RHR "K" value for suppression pool cooling. Spray operation also terminates the direct RHR discharge flow into the suppression pool which is designed to provide pool mixing. Some of the spray will land in the suppression pool and provide localized vertical pool mixing. However, most of the spray will land in the upper pool or on containment floors. This flow will likely find its way back to the pool via the upper pool dump lines or the containment sumps and should also provide some localized vertical mixing. However the net effect of containment spray operation is likely to be a significant reduction in suppression pool mixing effectiveness which will potentially result in increased suppression pool stratification."

Q Okay. Are those true statements?

A I would have to take -- taking it from the beginning, it says that "The additional head required to pump the RHR flow through the spray headers at the top of the containment results in a reduced RHR flow rate and roughly a fifteen percent reduction in the RHR "K" value for suppression pool cooling." Taking that in pieces, it is true that because you are pumping through a higher part of the containment, there is a higher head of water and therefore this can be a lower flow. Whether or not there is a fifteen percent reduction in the RHR "K" value, I would have to evaluate that myself.

#6-7-SueT

The next part says, "Spray operation also terminates the direct RHR discharge flow into the suppression pool..." that portion is certainly true.

"...which is designed to provide pool mixing." The design does facilitate pool mixing, but as I stated before there is considerable agitation in the pool such that the reduction due to, you know, the suppression pool discharge not being available, is not too significant.

The next sentence says, "Some of the spray will land in the suppression pool and provide localized vertical pool mixing." That is certainly true. "However, most of the spray will land in the upper pool or on containment floors." There is nothing wrong with that statement.

"This flow will likely find its way back to the pool via the upper pool dump lines or the containment sumps and should also provide some localized vertical mixing." As I had said before, except for some very small amounts of water which are trapped in some pockets or something, almost all the water will go down because a significant amount of water -- you are talking on the order of 5600 gallons per minute, that's a significant amount of water dropping on to the suppression pool whether it's being dropped from the spray or from the droplets after it has landed on some other larger equipment.

He mentions localized vertical mixing. That's going to be occurring all the way around, and I would not

#6-8-SueT

necessarily agree that it's loccalized.

"However the net effect of containment spray..." Moving on further, "However, the net effect of containment spray operation is likely to be a significant reduction in suppression pool mixing effectiveness which will potentially result in increased suppression pool stratification." I would take exception to the term "significant reduction." As I've stated, there may be a reduction in pool mixing effectiveness. I do not think it will be that significant, and I also do not feel that it is pertinent to the hydrogen control evaluation.

Q Have you personally evaluated these effects in that report?

A I personally have not evaluated these effects it discusses here. When I was at Mississippi Power and Light we evaluated some of the Humphrey issues. I personally did not; some of the people from my organization as well as our architect engineer and General Electric worked, under my direction, to evaluate some of these issues.

At the time we evaluated them and felt that these were not significant issues.

Q How do you define significant?

A That they were second or third order effects relative to the results of the analysis.

Q But they are real effects?

#6-9-SueT

A There are some effects.

JUDGE GLEASON: This might be a good time for us to take a break.

(Whereupon, the hearing is recessed at 10:25 a.m., to reconvene at 10:42 a.m., this same day.)

JUDGE GLEASON: All right. I think we can go back on the record, please.

CROSS EXAMINATION

BY MS. HIATT: (Continuing)

Q Mr. Richardson, in October of 1982, did you and Mr. Sam Hobbs of Mississippi Power and Light present a paper entitled "A Utility Perspective on Hydrogen Control" at the Second International Conference on the Impact of Hydrogen on Water Reactor Safety?

A May I see the paper, please?

Q I'm handing you a book entitled "Proceedings of the Second International Conference on the Impact of Hydrogen on Water Reactor Safety" designated NUREG CP-0038.

And the paper in question is on Page 283.

(The witness is looking at the document.)

A This paper was -- that you gave me says "A Utility Perspective on Hydrogen Control" by John D. Richardson and Sam H. Hobbs. Yes, it was co-authored, but Mr. Hobbs presented it.

Q But you were responsible in some degree for it?

#6-10-SueT

A That's true.

Q Would you please read this paragraph on Page 291 into the record?

A Reading from a paragraph on Page 291, "One of the most interesting cases studied involves the drywell break case and the resulting differential pressures between the containment and the drywell. In this case, which occurs after the core has been recovered, the drywell is inerted with a mixture of hydrogen and steam, and air is being added to the drywell atmosphere from the containment atmosphere by the purge compressors. Eventually the concentration of oxygen is sufficient to support a large burn in the drywell. Due to this burn, the pressure increases dramatically and a substantial amount of the hydrogen rich drywell atmosphere is forced into the containment through the suppression pool. There is a burn in the wetwell, but the large volume of hydrogen being forced through the suppression pool causes a substantial volume of hydrogen to be swept into the main containment atmosphere where there is a global burn. This burn causes a relatively high pressure in the containment which forces the suppression pool tc depress rapidly. Simultaneously, the hot water vapor in the drywell is being condensed by the flow of water from the break location which causes a low pressure to occur in the drywell at the same time that the high pressure is occuring in the containment. The combined negative

#6-11-SueT

"differential pressure transient causes the violent overflow of the suppression pool into the drywell. This overflow further condenses water in the drywell..."

MR. SILBERG: I'm sorry. Water vapor.

WITNESS RICHARDSON: "...water vapor in the drywell..." Let me restate that sentence.

"This overflow further condenses water vapor in the drywell atmosphere which increases the net effect to some extent. This analysis is still being finalized. Based on the results, the effects of the violent pool overflow will be evaluated to determine what adverse effects there are on essential equipment which is needed for long term accident recovery."

BY MS. HIATT: (Continuing)

Q Now, were these analyses a result of CLASIX 3 sensitivity studies?

A These analyses were a result of CLASIX 3 studies. If you are referring to a specific set of studies, I would have to know which ones you are talking to, in that there were a number of sensitivity studies conducted.

These particular cases were evaluated with some very conservative assumptions beyond those which were expected to occur in our use in the base case CLASIX 3 analysis.

Q What have you done to evaluate the effects on drywell equipment, components and structures from violent

#6-12-SueT

overflow of suppression pool?

A Again, this -- are you referring to Grand Gulf or are you referring to Perry?

Q Well, either one. Have you done any evaluations of the effects?

A Yes. As you see, this said that this analysis is still being finalized. And as I stated this was a very conservative analysis beyond the base case, those conditions which existed -- which are considered to exist or will exist in a postulated case.

And MP&L did evaluate the potential consequences and found that there were no adverse consequences for this reference here.

And, as you can see in the Perry case, the differential pressures that are shown in the preliminary evaluation in Appendix A -- if you like, I will give you a figure --

Q Well, why don't I stop --

A -- a significant figure, less than the design basis case.

Q -- you right here. The studies referred to in your paper are not -- you are not using the same conditions as were postulated in the Appendix A preliminary evaluation, correct?

A That's correct.

Q All right.

#6-13-SueT

A These studies here were done -- some studies were done by Mississippi Power and Light to evaluate more conservative assumptions.

MR. GLASSPIEGEL: Ms. Hiatt, your question wasn't limited to Grand Gulf, and I would like to let the witness if he wants to finish the statement that he was interrupted.

JUDGE GLEASON: It's up to Ms. Hiatt.

MR. GLASSPIEGEL: Well, she cut him off.

JUDGE GLEASON: She is entitled to cut him off. If she wants to stop him, he has to ask if he can amplify the statement.

WITNESS RICHARDSON: May I amplify the statement that I was making?

MS. HIATT: I think you can cover it on redirect, Mr. Glasspiegel.

BY MS. HIATT: (Continauing)

Q Wouldn't you be worried about recirculation pumps piping, any control rod drive piping, perhaps the reactor pressure vessel being impacted by water or suffering thermal shock perhaps leading to breakage resulting from this violent overflow of the suppression pool?

A No.

Q You wouldn't?

A Is that a question?

Q Yes. You wouldn't be?

#6-14-SueT

A No, I would not.

Q You have specifically evaluated those effects?

A We have evaluated the differential pressures in the preliminary evaluation, and they have been shown to be less than the differential pressures in the design basis case.

And the design basis case evaluates the potential consequences of any reverse or falling pool flow.

Q Okay. This preliminary evaluation you are talking about, is that the preliminary analysis that has been designated Applicants' Exhibit 8-1?

Is that what you are talking about?

A I don't remember the exact exhibit number.

Q But that's what you are talking about?

A Yes, that's what I'm talking about.

Q Mr. Richardson, does the Hydrogen Control Owners' Group have a program plan for solving the hydrogen control issue?

A Yes, it does.

Q And isn't it true that Task 10 of that plan is entitled "Evaluation of Drywell Response to Degraded Core Accidents?"

A I have to look at the plan that you are referencing to see if that's the exact task.

There is a task for evaluating drywell response. I don't remember if that's the exact task, though.

#6-15-SueT

MS. WOODHEAD: Mr. Chairman, could I ask if we are getting into the final analysis required of the Owners' Group which is not the subject of this hearing?

JUDGE GLEASON: I think you have already asked that, Ms. Woodhead.

MS. WOODHEAD: Pardon?

JUDGE GLEASON: I think you have asked it.

(Laughter.)

MS. WOODHEAD: May I have an answer?

JUDGE GLEASON: Ms. Hiatt?

MS. HIATT: Well, I think it is an undetermined question of law as to what constitutes an appropriate preliminary analysis and what can be left to a final analysis. I don't think that has been determined.

JUDGE GLEASON: So the answer is maybe yes and maybe no.

MS. WOODHEAD: I believe Ms. Hiatt is objecting to the scope of this hearing. It's well defined by the Applicant as to what its definition of preliminary analysis is, because --

JUDGE GLEASON: Well, he has one definition.

MS. WOODHEAD: Well, we have it before us.

JUDGE GLEASON: And the Staff has a definition.

MS. WOODHEAD: That's correct. We also have --

JUDGE GLEASON: I gather that the Intervenor may

#6-16-SueT

not agree with that. She is entitled to pursue it. I made comment on this earlier, a day or so ago, as to where we stand -- where this procedure stands with respect to that ruling.

And so she is entitled to pursue as to what should be contained in the preliminary analysis. And that is what she is doing, if I understand it correctly.

MR. GLASSPIEGEL: Mr. Chairman, I don't want my silence to be misinterpreted.

JUDGE GLEASON: You are never misinterpreted.

(Laughter.)

MR. GLASSPIEGEL: I'm not arguing with the Chair. I want to be on record as saying that if we -- if Ms. Hiatt attempts to get into a detailed cross-examination on matters that are covered by the final analysis, matters that are not completed, then I would agree with Ms. Woodhead that that is outside the scope of the hearing. The rule does specifically say that the final analysis --

JUDGE GLEASON: I don't think that that is what Ms. Woodhead said. I think she said -- her question was in the area of final analysis. And Ms. Hiatt doesn't necessarily agree with that.

So, proceed, Ms. Hiatt.

MS. HIATT: Thank you.

JUDGE GLEASON: All right.

END #6

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BY MS. HIATT: (Continuing)

Q I am handing you a document that I believe pertains to the Perry plant.

(Witness peruses document.)

A (Witness Richardson) This does appear to plan --

JUDGE GLEASON: Mr. Richardson, we have a hard time hearing you at times. I know the reporters are having a hard time. You will have to speak up just a little louder, please.

WITNESS RICHARDSON: This does appear to be the program as updated.

BY MS. HIATT: (Continuing)

Q And does does include the Task 10 series of drywall type of introductions.

A (Witness Richardson) Task 10 is an evaluation of drywall response to degraded core accidents. It is a further evaluation for the long term programming. The drywall response had already been evaluated in a preliminary evaluation.

This is to evaluate additional questions and some long term issues.

Q Section 10.21 is entitled Evaluate Potential for Pool Swell Loading From Hydrogen Combustion.

A That is correct. I would like to state that this document is very comprehensive in an integrated program which includes a task for generic long term hydrogen control program as well as task that may have been completed for even specific utilities, and it is placed it there to account for any possible task which may be necessary for all the owners.

This task is, as I stated, mainly potential for pool swell loading -- potential for pool swell loading from hydrogen combustion, which is a consideration that has been evaluated in the case of preliminary evaluation for Perry Nuclear Power Plant.

Q Would you read this section into the record, starting right there?

(Pointing)

A I am reading from page 4-119 of the Task 10-21, and the section I have been asked to read starts out: An immediate and large deflagration in the wetwell could produce a large containment to drywell differential pressure. This pressure may result in forcing a jet of water from the area between the drywell wall and weir wall upward into the drywell. With sufficient velocity, this jet of water may produce loads on structures or affect safety relaed equipment above the weir area. The possibility for occurrence of this negative pool swell will be investigated.

Q Isn't the present status of this part that it hasn't even been started yet?

A You have to understand the basis for this document.

In referring to this statement in this document, that is dependent on -- it is stated that way because it is a generic task. It is made that way to emcompass all of the owner groups, since it is a generic program.

The standpoint of Perry Nuclear Power Plant, the preliminary evaluation, we have evaluated the differential pressures that result from the case we studied, and those differential pressures were less than the design basis case.

In the long term program, if there are any other issues that because of further analysis which arise and could impact that consideration, we would evaluate that further. That is why that task is stated that way.

Q Now, the cases studied in the preliminary analysis are not the same cases that -- case we do to this concern, correct?

A I would not agree with that statement. The drywell brake case studied in the preliminary evaluation is the case that is of concern.

Q But don't you assume some different parameters to -- in the paper that you presented at the International Conference on Impact of Hydrogen, didn't you say this is considered different considerations from the cases studied in the preliminary evaluation?

A I stated that the assumptions that were made in the analysis that were referenced on my paper and the proceedings on the second national conference were different than the base case. They were conservative assumptions made beyond the assumptions that are made in the base case, and the assumptions made in the base case were those which are assumed to exist, and are conservative.

Q And the Perry Preliminary Evaluation evaluated the base case, correct?

A The Perry -- events analyzed in the Perry Preliminary Evaluation are the base case assumptions which are conservative for the events being analyzed.

Q Now, your analyses assumed that hydrogen is released to the wetwell through the suppression pool, correct?

A That is correct.

Q And for a small break LOCA in the drywell, the hydrogen would first be released to the drywell, correct?

Q Initially it would be released directly to the drywell.

JUDGE GLEASON: You are talking about Perry now?

MS. HIATT: Yes.

JUDGE GLEASON: All right.

BY MS. HIATT: (Continuing)

A (Continuing) After a certain period of time, however, half will be going to the drywell, as far as the analysis is concerned. Half would be going through the drywell and half would be going through the suppression pool via the safety release valves.

Q And you are also assuming that steam and hydrogen pressurization along with the operation of the drywell purged compressors will pressurize the drywell such that the first row of LOCA events is uncovered, and the hydrogen within the drywell would then bubble out through the pool?

A That is true.

Q Now, there are two trains of drywell compressors with a capacity of 546 standard cubic feet per minute?

A There are two trains graded at approximately 500 cubic feet per minute.

Q Now, according to Table 5.4-2 of your preliminary analysis, isn't the maximum allowable drywell leakage 5,843 standard cubic feet per minute, at 2.5 psig?

A Is that table 5.4-2?

Q Yes.

A Would you restate the value you gave?

Q 5,843 standard cubic feet per minute, at 2.5 psig.

A This table gives -- commonly called the capability of the design value for allowable leak rate that was used in design basis analysis.

That is the maximum allowable for design basis analysis, and it is not necessarily what will occur or what it is tested for.

Q So, does that correspond to the drywell leakage pool area of 1.68 square feet?

A It does not state here what the basis for that number is. A over root K for Perry is 1.68, to my knowledge.

Q You don't know if that leak rate in cubic feet per minute corresponds to that specific area?

A I would have to review the FSAR discussion to see if that value is derived from that, A over root K.

Q Would you happen to know that, Ms. Buzzelli?

A (Witness Buzzelli) I don't know if that is the exact number for that 1.68 design allowable test.

Q Well, let me ask this: Would this number correspond to the 1.68 rather than the .168?

A That would be correct.

Q Now, isn't the figure in this table over five times capacity of both drywell purged compressors?

A (Witness Richardson) This figure here is over five times capacity.

Q So, it is possible the hydrogen may leak out to the drywell wall rather than flowing through the pool?

A Given -- as I said, the value here is for design purposes, and it is not anticipated that that will be the actual leakage, and if you have leakage through the drywell wall then hydrogen could go through the drywell wall.

Q Now, the tech spec allowable, wouldn't that be about one-tenth of the figure given here?

A Tech spec allowable is typically ten percent.

Q So, you wouldn't have to do anything about the leakage until it approached that number, correct? Under the technical specifications?

MR. GLASSPIEGEL: Are we still talking about 5,843?

MS. HIATT: Well, we would be talking about ten percent of that for the tech spec allowable, I believe. He can confirm my conclusions.

WITNESS RICHARDSON: The technical specifications requires that you periodically test drywell for leakage, and that value is typically, as I stated, ten percent of the capability, and you are not required for tech specs to take any action if the leakage is less than the tech spec allowable.

BY MS. HIATT: (Continuing)

Q At what pressures do you periodically test the drywell for leakage?

A (Witness Richardson) I would have to look at the technical specifications to see the exact pressure in that. Some of those values may vary from plant-to-plant, and I don't remember what the exact value is in the case of Perry.

It is on the order of approximately three pounds.

Q Now, if hydrogen were to leak out through the drywell wall, wouldn't that change the transport and combustion characteristics in containment?

A No.

Q It would not?

A No. It would not change the combustion that is analyzed in the preliminary evaluation.

Q Wouldn't it change the concentrations of hydrogen in certain compartments as a function of time?

A There may be some changes in the concentrations. However, the overall effect would -- it would not change the conclusions.

Q Have you evaluated the effect?

A No.

Q Do you plan to include any drywell leakings in any experimental studies, such as the quarter scale facility?

A No.

A (Witness Buzzelli) I would like to add that the drywell bypass leakage concern is being dealt with in the long term program as part of the hydrogen control owners group program plan, so it is not specifically just an experimental test.

JUDGE KLINE: Could we clarify right here as to whether these assumptions -- of whether this discussion is under the assumption that the hydrogen control system is functioning or not functioning?

MS. HIATT: My assumptions were that the system is functioning, and the concern about the bypass leakage is -- hasn't been analyzed versus their analysis, which it seems it is all released through the pool into the bottom of the wetwell.

JUDGE KLINE: But it matters whether -- I mean it matters as to the amount of hydrogen being transported whether the system is functioning or not, doesn't it?

MS. HIATT: I am not an expert witness.

JUDGE KLINE: All I want to know is what the assumption is. Is the igniter system working or not working as we trace the pathways of hydrogen through the system?

MS. HIATT: My assumption was that things are functioning. The igniter system is functioning.

JUDGE KLINE: That is all we need to know.

BY MS. HIATT: (Continuing)

Q Ms. Buzzelli, at page 6 of the preliminary analysis, it is stated that the spray shields are provided for igniters assemblies in areas where they may be exposed to containment sprays, is that correct?

A (Witness Buzzelli) That is correct.

Q Does that mean that some igniter assemblies do not have spray shields?

A This statement is intended to convey that spray shields are provided to protect the igniters against containment sprays.

Most all of our locations are such that the spray shield is installed on the igniters. I can't think of a specific example where the spray shield is not included.

Q Case 8 of the preliminary analysis there is a discussion of igniter locations in the drywell taking full advantage of existing steel as protection against jet impingement.

Could you describe just how such assemblies are placed so that they are protected by existing steel?

A The locations are selected to take advantage, as the statement indicates, of existing steel. We postulate a pipe break, the jet impingement load is the direct steam jet from that pipe break. If the igniter is located with an intervening structural steel member it is protected from that jet impingement load.

You look at the code of that jet from your jet impingement studies, and locate the igniters accordingly.

Q So you would be postulating specific pipe breaks in drywell for your jet impingement studies, is that it?

A (Witness Richardson) For the design basis accidents, there are certain type break locations postulated, and the jet code is analyzed for safety-related equipment.

Q Isn't it true that many of the igniter assemblies are located close to ceilings or under other obstructions?

A There are some igniters located on the ceilings.

You said near obstructions?

Q Under.

A Under obstructions.

Q Aren't more of them under such conditions?

A I haven't taken a count. I would have to evaluate whether there was more.

Q Less?

A There are many igniters in open areas. I don't know what the split is. I would have to count them.

A (Witness Buzzelli) The igniters are located in areas where hydrogen may potentially accumulate, and in an enclosed or ceiling area, you would have -- such as a steam tunnel -- you would have igniters under there, so that as the hydrogen mixed into that region, we would have ignition at low concentrations.

Q I am handing you a document entitled Perry Nuclear Plant, Units-1 and 2, Interim Report on the Hydrogen Control System, a draft document.

Specifically pertaining to Table 2.2-1 on Igniter locations. Have you seen this before?

A Yes. This is a portion of an early draft report on the hydrogen control system, which identified preliminary igniter locations throughout the containment and drywell. Noted specific igniter number, its elevation, relative location in containment, and a description of the location.

This document, entitled Interim Report -- it is actually superseded by the preliminary evaluation which has been marked Applicants Exhibit 8-1.

Q Are most of the igniter locations in this table similar or idential to those in the preliminary analysis?

A As I stated, the preliminary analysis supersedes this listing on this early draft report.

JUDGE GLEASON: That is not her question. That is not her question. She is saying are they identical? Are they both the same?

WITNESS BUZZELLI: The answer is, no. The actual locations are superseded --

JUDGE GLEASON: I know they are superseded, but are they different? Are they different?

WITNESS BUZZELLI: They are different. I don't know that they are all different. Many are different. Preliminary spotting locations for the igniters, the finalized as-built construction is requested in the preliminary evaluation.

BY MS. HIATT: (Continuing)

Q So, your preliminary evaluation does not include the location description that is given herein, does it?

A (Witness Buzzelli) No, it is -- a description is provided through the drawings included in preliminary evaluations, which located the igniters more representatively than to say inside face of drywell. A more accurate representation is provided by the drawings in the preliminary evaluation.

Q Isn't it a little hard to tell from those drawings whether you are on the underside of a support ring for a crane, for example?

A Preliminary evaluation has both drawings and a listing with the elevation and azimuth of the igniters. The reproductions may be difficult to read, but the drawings themselves give you a more accurate representation of the relative location of the igniter adjacent equipment and major supporting structures.

End 7.
MS fols.

Sim 8-1

Q Wouldn't it be true to say that the locations and location descriptions given in this document are not significantly different for the most part from the locations in the preliminary analysis?

A (Witness Buzzelli) I would have to say that in some cases, and perhaps in many cases they are significantly different than the preliminary -- the very early draft listing you are referring to.

JUDGE GLEASON: She has already testified that they are substantially different.

BY MS. HIATT:

Q Now you can tell from the specific location dimensions given whether or not these are similar to or identical to those within the preliminary analysis, correct?

A (Witness Buzzelli) Can you repeat that question? I am not sure I understood what you were asking.

Q You could tell, couldn't you, from the specific location dimensions given for elevation, dimensions of containment asmuth, whether or not these locations for these igniter numbers are the same or different from those given in the preliminary analysis?

A One could do a comparison of that listing to the listing and drawings in the preliminary evaluation and ascertain exactly which igniters have changed.

Q I would ask that this document be marked for

Sim 8-2

identification as OCRE Exhibit 16.

JUDGE GLEASON: This will be designated as OCRE Exhibit 16, and is there objection for its admission?

MR. GLASSPIEGEL: Yes, absolutely. The witnesses have testified that this is not a current description of locations. Ms. Buzzelli has testified that there are substantial differences. She has testified there are two ways in the preliminary evaluation to determine more precisely whether igniters are adjacent to structures, and I would object to putting that document in the record for those reasons.

JUDGE GLEASON: Ms. Woodhead, do you have any objection?

MS. WOODHEAD: I object for the same reason. It doesn't reflect the as-built plan.

JUDGE GLEASON: Ms. Hiatt, what is the purpose of putting it in?

MS. HIATT: I think it gives a better idea of just how these igniter assemblies are located in the plant than does the preliminary analysis, and for reasons that will be apparent later, the location of the igniters is important.

I agree that they may not all be identical ---

JUDGE GLEASON: You don't have to say anything more than that.

The objection is denied and the exhibit will

Sim 8-3

be admitted into the record.

(The document referred to was marked OCRE Exhibit No. 16 for identification and admitted into the record.)

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JUDGE GLEASON: Could we have a date? Is there a date for this interim report?

MR. GLASSPIEGEL: Did I get a copy, Ms. Hiatt? Excuse me. I don't have a copy, Mr. Chairman.

(Pause.)

JUDGE GLEASON: Do you have a date of this?

MS. HIATT: I am not sure I ever saw a date appearing on it. They might know better than I do.

JUDGE GLEASON: Does anybody have a date?

WITNESS BUZZELLI: I don't have a date for this document. It was a draft document.

MR. GLASSPIEGEL: I don't have a copy, Mr. Chairman.

(A copy was provided by Judge Gleason to Counsel Glasspiegel.)

JUDGE GLEASON: All right, let's proceed, please.

MR. GLASSPIEGEL: Mr. Chairman, may I inquire of the Chair. Is Ms. Hiatt to be permitted to ask questions for the record about the location of the matters using the document that has just been admitted?

JUDGE GLEASON: Yes, sir.

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(OCRE Exhibit No. 16 follows:)

PERRY NUCLEAR POWER PLANT

UNITS 1 & 2

INTERIM REPORT ON THE

HYDROGEN CONTROL SYSTEM

DRAFT

DOCKET NUMBERS

50-440, 50-441

/ = change from Prelim

Table 2.2-1
Igniter Locations

	IGNITER #	ELEVATION	AZIMUTH	DIMENSION TO OF CONTAINMENT	SUPPORTING MEMBER	REFERENCE DRAWING #	LOCATION DESCRIPTION
312	01	592'-0"	1°	33'-0"	Concrete	E-002-002	Inside face of weir wall
311	02	592'-0"	52°	33'-0"	Concrete	E-002-002	Inside face of weir wall
311	03	591'-9"	104°	33'-0"	Concrete	E-002-002	Inside face of weir wall
311	04	591'-9"	148°-30'	33'-0"	Concrete	E-002-002	Inside face of weir wall
312	05	592'-0"	208°	33'-0"	Concrete	E-002-002	Inside face of weir wall
312	06	592'-0"	260°	33'-0"	Concrete	E-002-002	Inside face of weir wall
312	07	591'-6"	310°-15'	33'-0"	Concrete	E-002-002	Inside face of weir wall
331	08	629'-6"	7°	36'-6"	Concrete	D-411-137	Inside face of drywell wall
331	09	632'-6"	41°-30'	41'-6"	Concrete	D-411-137	Inside face of drywell wall
331	10	632'-6"	87°-30'	36'-6"	Concrete	D-411-137	Inside face of drywell wall
331	11	630'-7"	137°	36'-6"	Concrete	D-411-137	Inside face of drywell wall
332	12	630'-7"	182°	36'-6"	Concrete	D-411-137	Inside face of drywell wall
332	13	630'-7"	221°	36'-6"	Concrete	D-411-137	Inside face of drywell wall
332	14	630'-7"	273°	36'-6"	Concrete	D-411-137	Inside face of drywell wall
332	15	630'-7"	320°	36'-6"	Concrete	D-411-137	Inside face of drywell wall
352	16	660'-7"	0°	30'-0"	Concrete	D-411-137	Inside face drywell top slab
351	17	659'-9"	57°	35'-0"	Concrete	D-411-137	Inside face drywell top slab
351	18	660'-7"	114°	30'-0"	Concrete	D-411-137	Inside face drywell top slab

	IGNITER #	ELEVATION	AZIMUTH	DIMENSION TO OF CONTAINMENT	SUPPORTING MEMBER	REFERENCE DRAWING #	LOCATION DESCRIPTION
351	19	660'-7"	171°	30'-0"	concrete	D-411-137	Inside face drywell top slab
352	20	660'-7"	228°	30'-0"	concrete	D-411-137	Inside face drywell top slab
352	21	660'-7"	280°	30'-0"	concrete	D-411-137	Inside face drywell top slab
352	22	660'-7"	320°	30'-0"	concrete	D-411-137	Inside face drywell top slab
321	23	624'-6"	54°	57'-0"	Beam "A"	D-511-023	Inside face drywell top slab
321	24	624'-6"	89°	57'-6"	Beam "A"	D-511-023	HCU floor
321	25	624'-6"	121°-30'	57'-6"	Beam "A"	D-511-023	HCU floor
321	26	624'-6"	161°-30'	50'-6"	Beam "A"	D-511-023	HCU floor
322	27	624'-6"	194°	57'-0"	Beam "A"	D-511-022	HCU floor
322	28	624'-6"	234°	57'-0"	Beam "A"	D-511-022	HCU floor
322	29	624'-6"	271°	57'-0"	Beam "A"	D-511-022	HCU floor
322	30	624'-6"	324°	57'-0"	Beam "A"	D-511-022	HCU floor
332	31	637'-0"	0°	41'-6"	Concrete	D-411-141	Outside surface of drywell wall steam tunnel room
331	32	641'-0"	151°	43'-6"	Concrete	D-411-214	Underside of floor slab for refueling pool
332	33	641'-0"	185°	43'-6"	Concrete	D-411-214	Underside of floor slab for refueling pool
332	34	640'-0"	324°	50'-6"	W16x100	D-511-861	I beam below grating at 640'-0"
331	35	642'-0"	60°	51'-0"	W16x100	D-511-062	I beam below grating at 642'-0"
331	36	642'-0"	117°	52'-6"	W16x50	D-511-062	I beam below grating at 642'-0"

	IGNITER #	ELEVATION	AZIMUTH	DIMENSION TO OF CONTAINMENT	SUPPORTING MEMBER	REFERENCE DRAWING #	LOCATION DESCRIPTION
332	37	640'-0"	227°-15'	50'-6"	W16x100	D-511-061	I beam below grating at 642'-0"
332	38	642'-0"	261°	55'-0"	W30x211	D-511-026	I beam below grating at 642'-0"
342	39	650'-9"	286°-30'	41'-6"	Concrete	D-411-141	Outside surface drywell wall
342	40	648'-2"	0°	51'-0"	Concrete	D-411-141	Ceiling of steam tunnel
341	41	652'-2"	42°	50'-6"	W16x100	D-511-026	I beam below grating at 652'2"
341	42	651'-3"	89°	50'-5"	Concrete	D-411-214	Room ceiling
341	43	651'-8"	103°	49'-0"	Concrete	D-411-214	Room ceiling
351	44	660'-3"	82°	48'-6"	Concrete	D-411-217	Room ceiling
351	45	660'-3"	100°	48'-6"	Concrete	D-411-217	Room ceiling
351	46	662'-4"	54°	54'-0"	W14x257	D-511-028	I beam below grating at 664'-7"
351	47	665'-0"	112°	56'-0"	Concrete	D-411-221	Outside wall of room
351	48	664'-7"	147°	53'-0"	W12x30	D-511-028	I beam below grating at 664'-7"
352	49	664'-7"	218°	51'-6"	W21x111	D-511-027	I beam below grating at 664'-7"
352	50	664'-7"	251°	50'-2"	W14x193	D-511-027	I beam below grating at 664'-7"
352	51	661'-10"	289°	49'-6"	W21x111	D-511-027	I beam below grating at 664'-7"
352	52	661'-10"	324°	50'-6"	W21x111	D-511-027	I beam below grating at 664'-7"
362	53	669'-6"	0°	55'-0"	Concrete	D-411-214	Room wall
362	54	684'-9"	355°	52'-6"	Concrete	D-511-315 D-411-214	Room ceiling
361	55	686'-0"	75°	48'-0"	Concrete	D-411-221	Room ceiling

	IGNITER #	ELEVATION	AZIMUTH	DIMENSION TO OF CONTAINMENT	SUPPORTING MEMBER	REFERENCE DRAWING #	LOCATION DESCRIPTION
361	56	686'-0"	85°	47'-0"	Concrete	D-411-221	Room ceiling
361	57	686'-0"	95°	47'-0"	Concrete	D-411-221	Room ceiling
361	58	686'-0"	105°	48'-0"	Concrete	D-411-221	Room ceiling
361	59	686'-0"	75°	35'-0"	Concrete	D-411-221	Room ceiling
361	60	686'-0"	105°	35'-0"	Concrete	D-411-221	Room ceiling
361	61	689'-6"	45°	48'-0"	W30x132	D-511-025	I beam below grating at 689'-6"
361	62	689'-6"	133°-15'	41'-0"	W8x24	D-511-025	I beam below grating at 689'-6"
362	63	685'-3"	229°	48'-0"	W36x150	D-511-024	I beam below grating at 689'-6"
362	64	689'-10"	252°	43'-6"	W21x62	D-511-024	I beam below grating at 689'-6"
362	65	689'-10"	289°	43'-0"	W21x62	D-511-024	I beam below grating at 689'-6"
362	66	689'-5"	311°	48'-6"	W36x150	D-511-024	I beam below grating at 689'-6"
666	67	715'-6"	358°-51'	58'-9"	Steel	E-002-002	Underside of support ring for crane
666	68	715'-6"	27°-8'	58'-9"	Steel	E-002-002	Underside of support ring for crane
666	69	715'-6"	61°-47'	58'-9"	Steel	E-002-002	Underside of support ring for crane
666	70	715'-6"	87°-32'	58'-9"	Steel	E-002-002	Underside of support ring for crane
666	71	715'-6"	119°-27'	58'-9"	Steel	E-002-002	Underside of support ring for crane
666	72	715'-6"	150°-33'	58'-9"	Steel	E-002-002	Underside of support ring for crane

	IGNITER #	ELEVATION	AZIMUTH	DIMENSION TO OF CONTAINMENT	SUPPORTING MEMBER	REFERENCE DRAWING #	LOCATION DESCRIPTION
666	73	715'-6"	178°-46'	58'-9"	Steel	E-002-002	Underside of support ring for crane
666	74	715'-6"	209°-27'	58'-9"	Steel	E-002-002	Underside of support ring for crane
666	75	715'-6"	240°-35'	58'-9"	Steel	E-002-002	Underside of support ring for crane
666	76	715'-6"	267°-9'	58'-9"	Steel	E-002-002	Underside of support ring for crane
666	77	715'-6"	300°-26'	58'-9"	Steel	E-002-002	Underside of support ring for crane
666	78	715'-6"	331°-38'	58'-9"	Steel	E-002-002	Underside of support ring for crane
666	79	745'-6"	0°	48'-0"	Steel	E-002-002	Containment vessel
666	80	745'-6"	34°	48'-0"	Steel	E-002-002	Containment vessel
666	81	745'-6"	72°	48'-0"	Steel	E-002-002	Containment vessel
666	82	745'-6"	102°	48'-0"	Steel	E-002-002	Containment vessel
666	83	745'-6"	143°	48'-0"	Steel	E-002-002	Containment vessel
666	84	745'-6"	180°	48'-0"	Steel	E-002-002	Containment vessel
666	85	745'-6"	216°	48'-0"	Steel	E-002-002	Containment vessel
666	86	745'-6"	252°	48'-0"	Steel	E-002-002	Containment vessel
666	87	745'-6"	287°	48'-0"	Steel	E-002-002	Containment vessel
666	88	745'-6"	324°	48'-0"	Steel	E-002-002	Containment vessel
666	89	757'-0"	0°	1'-0"	Steel	E-002-002	Containment vessel
666	90	757'-0"	180°	1'-0"	Steel	E-002-002	Containment vessel
670	91	647'-0"	166°	59'-0"	Concrete	D-411-211	Room ceiling

	IGNITER #	ELEVATION	AZIMUTH	DIMENSION TO OF CONTAINMENT	SUPPORTING MEMBER	REFERENCE DRAWING #	LOCATION DESCRIPTION
670	92	645'-0"	172°	58'-0"	Concrete	D-411-211	Room wall
321	93	613'-4"	6°	44'-0"	Concrete	D-411-140	Room ceiling
321	94	613'-4"	13°	43'-6"	Concrete	D-411-140	Room ceiling
322	95	613'-4"	347°	43'-6"	Concrete	D-411-140	Room ceiling
322	96	613'-4"	354°	44'-0"	Concrete	D-411-140	Room ceiling
322	97	642'-0"	289°	50'-6"	W30x211	D-511-026	I beam below grating at 642'-0"
362	98	685'-6"	342°	53'-0"	Concrete	D-511-315	Room ceiling inside jet shield
361	99	685'-6"	17°	53'-0"	Concrete	D-511-315	Room ceiling inside jet shield
	100	686'-0"	75°	25'-0"	Concrete	D-411-221	Room ceiling
	101	686'-0"	105°	25'-0"	Concrete	D-411-221	Room ceiling
	102	670'-0"	351°	12'-6"	NEW		
	103	670'-0"	3°	12'-6"			

320/C/6/nb

Sim 8-4

MR. GLASSPIEGEL: Is there going to be any request to have her -- how is the record going to ---

JUDGE GLEASON: She has indicated she is going to make it relevant.

MR. GLASSPIEGEL: Well, I didn't quite hear her say that. What I heard her say was that locations are important and the applicants don't dispute that. And she has also stated that from Ms. Hiatt's standpoint, and I might add that she is not the expert testifying here, she believes it is easier to determine locations from this document than from using the currently applicable locations. But I don't frankly see how that is going to happen.

JUDGE GLEASON: Well, I don't think that is the sole purpose. I presume it is not the sole purpose. I presume the purpose is that the issue of location or the issue of the changing of the locations is relevant to this proceeding as to the effectiveness of the system. Is that ---

MS. HIATT: Yes, basically. I had not intended to ask any further questions on it. I think the document, along with the preliminary analysis, relatively speaks for itself.

The point I was making is that the igniter location is important, and I think that exhibit identifies that a little more clearly than do the drawings and tables in the preliminary analysis.

JUDGE GLEASON: Well, on that basis I just can't admit it into the record. I thought there was going to be some follow-up to demonstrate the importance of the location of these in the system.

MR. GLASSPIEGEL: Mr. Chairman, also Mr. Silberg just pointed out looking at the document that there are a number of notations and marks and I don't know whether they are ---

MS. HIATT: Those were my marks and they can be excluded.

MR. GLASSPIEGEL: Well, the record -- is Ms. Hiatt plans to use this document in her proposed findings, she is perfectly entitled to do that. However, the record needs to be clear on which hard markings are her's. I am just looking at this document for the first time and I assume that on page 1 where there are hand markings they are Ms. Hiatt's. On page 2 where there are hand notations ---

JUDGE GLEASON: You have my document. So I don't know what you are talking about.

(Laughter.)

MR. GLASSPIEGEL: Anyway, there are hand markings on each of the pages and I think -- Susan, are you saying tbat all of the hand markings on this document are your markings?

MS. HIATT: That is correct, and I am not

Sim 8-6

offering those for evidence. I also think that if they are really objectionable you could find an unmarked copy for the record.

MR. GLASSPIEGEL: That is not my point at all. I am just saying that if this document is to be used for findings, the record needs to understand which are your markings and which are somebody else's markings. That is my only point.

MS. HIATT: Well, all of the markings therein that were not obviously typewritten in are my markings and are excluded for the purposes of the record.

(Board conferrring.)

JUDGE GLEASON: The Board has decided that this exhibit will be admitted into the record, and if you have some follow-up questions with respect to it, please proceed, Mr. Glasspiegel.

MR. GLASSPIEGEL: Excuse me one minute.

JUDGE GLEASON: All right.

(Pause.)

JUDGE GLEASON: I frankly have to state that I really have a real question in my mind as to why you would want to keep this material out of the record.

MR. GLASSPIEGEL: Well, I don't know why she is using it. Let me make a couple of ---

JUDGE GLEASON: Well, would you agree as a

Sim 8-7

general proposition that the location of these plugs is a relevant matter for this proceeding?

MR. GLASSPIEGEL: Yes, sir, but I would like to explain what my concerns are.

JUDGE GLEASON: All right. Go ahead.

MR. GLASSPIEGEL: I haven't had a chance to study the document and I don't know all of the background. My understanding is from just conferring with people in the audience that just because a particular igniter may be located at the same azimuth in the same elevation, doesn't necessarily mean that it it is in the same location.

Therefore, one of my concerns is that Ms. Hiatt hypothetically might in her findings say that the document that she has just introduced speaking about one igniter has the same azimuth in the same elevation as the azimuths and elevations given in the preliminary analysis and therefore the characterization that is in the exhibit that was just submitted is an accurate characterization.

My understanding is that is not necessarily going to be the case.

Now, secondly, I understood her to answer your quetion that she was not concerned about changes of the location from the preliminary document to the final, but she was worried about location. And as I have just answered a moment ago, certainly the issue of location is relevant

Sim 8-8

to the proceeding, but my ultimate point is that if the issue of location is relevant to the proceeding, then the parties ought to be using the current and applicable descriptions of locations, and I am concerned that that will not be done in the findings.

JUDGE GLEASON: It is so obvious to me that I really must be overlooking something that you are going to have to point out to me. If location is important, certainly changes in location are important.

MR. GLASSPIEGEL: Well, Ms. Hiatt didn't say she was going to say it for that purpose.

JUDGE GLEASON: Well, I don't know what she is going to use it for.

MR. GLASSPIEGEL: Well, could she please tell us at this point how she is going to use it?

JUDGE GLEASON: She doesn't have to.

MR. GLASSPIEGEL: Well, I didn't say she had to. I am asking her to.

MS. HIATT: You will find out in my findings.

MR. GLASSPIEGEL: Okay.

JUDGE GLEASON: Let's move on. The exhibit will be admitted into the record.

BY MS. HIATT:

Q Isn't it true that the spray shield and the placement of igniter assemblies underneath ceilings would inhibit upward flame propagation?

A (Witness Buzzelli) I would like to have Dr. Lewis address that.

A (Witness Lewis) No.

Q Now if an igniter is placed right under a ceiling, where is the flame going to travel? It doesn't have far to go upward, does it?

A The flame will propagate from the igniting source, which is the glow plug. If the concentration is in the right ball park, the flame will move downward, sideways and upward, and no closeness to a wall, ceiling or shield is going to change that phenomenon. The flame is going to propagate everywhere.

Q And the criterion for downward propagation is what, sir?

A That it should be of the order of eight and a half percent or a little higher, eight to eight and a half to ten.

Q Dr. Lewis, do you know Barry Shot?

A I don't know him personally.

Q Do you know of him?

A I know his name.

Q Do you know that he is with the Los Alamos Scientific Laboratory?

A I didn't know, but I understand he is.

Sim 8-10

Q Do you consider him to be a combustion expert?

A I don't know him.

Q Mr. Karlovitz, do you know?

A (Witness Karlovitz) I don't know about him, only one reference or one statement.

Q Are you aware of the experiments conducted at the Nevada test site?

MR. GLASSPIEGEL: Which experiments, Ms. Hiatt?

MS. HIATT: They were large-scale hydrogen combustion experiments conducted in a spherical vessel I believe.

WITNESS LEWIS: A large spherical vessel, yes. Well, I have not seen the report, but I have been told of the contents.

BY MS. HIATT:

Q Do you know if those tests used the igniter assembly with spray shield that is used in the Perry plant?

A (Witness Lewis) I don't know.

Q Do you know how the igniters were placed in that experiment?

A I don't know.

A (Witness Richardson) The igniter placement in that assembly had nothing to do with trying to replicate anything in the Perry plant. As a matter of fact, that test was more oriented to large dry containments for PWR's.

Sim 8-11

Q Now the volume of that vessel was 75,000 cubic feet?

A (Witness Lewis) Well, if you will give me the diameter, I can agree or not.

(Laughter.)

MS. HIATT: I am not sure I have it.

(Pause.)

JUDGE GLEASON: If the others of you know the answer, it would help us get along with they would just volunteer the answer.

WITNESS LEWIS: You would have to calculate it. It is very easy.

JUDGE GLEASON: I understand. Do you know, Mr. Richardson?

WITNESS RICHARDSON: I don't remember the exact volume.

(Discussion off the record.)

MS. HIATT: I am afraid I don't really have dimensions.

JUDGE GLEASON: Well, I think we can proceed.

BY MS. HIATT:

Q Didn't the Nevada test site results show that for concentrations of hydrogen greater than about 7.7 percent combustion is virtually complete?

A (Witness Lewis) I believe that was the case.

Sim 8-12

Q And didn't the Nevada test site results show that when combustion is complete the maximum pressures and temperatures are only about 10 to 15 percent below the adiobatic theoretical values?

A I am not sure of that. I haven't read the report.

Q I am handing you a page marked "Preliminary Results For Premixed Combustion Tests." Does this look familiar in any way as the Nevada test site results?

A I have never seen that.

Q Has Dr. Xarlovitz seen that?

A (Witness Karlovitz) No, I have never seen that.

Q Isn't it true that for many of the lean premixed combustion tests at the Nevada test site combustion could not be induced except by using fans, sprays or different igniters?

A I didn't hear the part of your sentence dealing with the operations of the fans.

Q I will re-read it.

Isn't it true that for many of the lean premixed combustion tests at the Nevada test site combustion could not be induced except by using fans, sprays or different igniters?

A How lean?

Q It was my understanding that it was maybe in the

Sim 8-13

six percent range?

MR. GLASSPIEGEL: Could I have just a clarification. Ms. Hiatt said she had a document in front of you. There is a reference to different igniters. Does the context say different than what?

MS. HIATT: I believe it may have been a location or additional igniters. The document from which I obtained that is a draft Sandia document designated NUREG CR-4138, "Data Analysis For Premixed Combustion Tests Performed At The Nevada Test Site," if you would like to look at it.

MR. GLASSPIEGEL: No. I just had a very specific question. You were at a sentence and it was hard to tell out of context what the reference to different igniters meant. There was a reference to different igniters and I am just asking different than what?

MS. HIATT: I will read the statement from the document and see if that will help.

It states that "Note for some of the initially lean hydrogen combustion tests local conditions around the ignition sources were not immediately conducive for combustion. In these instances different igniters might be triggered or spray systems and/or fans might be again operated to facilitate combustion."

That is all the information I have.

Sim 8-14

WITNESS LEWIS: May I answer the question?

MS. HIATT: Yes.

WITNESS LEWIS: It is perfectly obvious that you don't get combustion from a comparable ignition source if you don't have a premixed mixture. It is outside of the flammable range or otherwise the igniter would ignite it, I mean would propagate it.

BY MS. HIATT:

Q Well, the tests were intended to be premixed; isn't that true?

A (Witness Lewis) They were what?

Q They were intended to be premixed combustion tests?

A They were intended to be premixed, but what I am saying is they didn't ignite the mixture around the igniters. It was not an ignitable mixture. Therefore, in certain places in that large sphere there were mixtures that were not within the flammable range. It is not surprising at all.

Q Dr. Lewis, do you believe that a flame speed of six feet per second is conservative for use in the CLASIXS analysis?

A Yes, I do.

Q And is one of the experimental bases for that conclusion the Lawrence Livermore igniter tests?

Sim 8-15

A No.

Q You were not relying on that whatsoever?

A No. We have an independent way of determining the flame speed.

Q And what was that method?

A Well, we know what the laminar speed is of propagation, and by laminar I mean an unperturbed flame propagation, unperturbed by turbulence, and that was of the order of a little more than one foot per second. The introduction of turbulence would increase that to about three and a half to four, and under certain circumstances maybe even to five. It depends on tube diameters and so on, and that is conservative against six assumed in the CLASIXS.

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Sue fols

#9-1-SueT

Q This is based on experimental data that you have performed, sir?

A Well, it's in the literature open to the world.

Q What was the size of the vessels in which these experiments were conducted?

A Various sizes.

MR. GLASSPIEGEL: Excuse me, which experiments are we talking about, Susan?

MS. HIATT: The experiments that Dr. Lewis has referenced.

MR. GLASSPIEGEL: He talked about information being available in the general literature. I didn't hear him talk about specific experiments.

BY MS. HIATT: (Continuing)

Q Are you aware that the Sandia National Laboratory has conducted an extensive program on hydrogen combustion?

A I believe that's true.

Q Are you aware that one of the vessels which was used is known as the variable geometry experimental system, an upright cylindrical tank with a volume of about 176 cubic feet?

A I am not aware of that vessel.

Q Do you know Dr. John H. S. Lee?

A Yes, I do.

Q And he works at McGill?

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A McGill in Montreal, Canada.

Q And isn't he true that he has conducted research on flame acceleration?

A Yes.

Q And hasn't his research found that at concentrations of eight volume percent of hydrogen, speeds of twenty meters per second have occurred due to acceleration of flames by obstacles?

A Under those conditions, yes.

Q Now, Dr. Lewis, on Page 31 of your prefiled testimony, you refer to a detonable range of hydrogen/air mixtures.

Would you define what that range is, sir?

A Well, the term detonable range appears in the last sentence on Page 31.

Q Yes. And what is that detonable range, is what I'm asking, sir? What concentrations of hydrogen are you talking about?

A Well, the upper range. The upper range is on the order of 60 percent, 59/60 percent. And the lower range can vary between about 14 and 18 percent. I believe that the value of 18 is not quite low enough. It's based on all determinations.

And the value of 14 percent would be a competent lower limit for detonation. That would be a mixture that can support and continue to propogate the detonation range.

#9-3-SueT

If it is under 14 percent or thereabouts, the way -- if you overdrive by high explosives, you will get an apparent detonation which will then die out to a deflagration flame.

Q Are you aware that Dr. Lee's research has produced a detonation, a mixture of thirteen point eight percent hydrogen and air?

A Yes. I am aware of that. And that has all been done with high explosive charges. We don't have high explosive charges in the containment.

JUDGE KLINE: Do you mean the high explosive initiates the --

WITNESS LEWIS: Petrol. Petrol or TNT are that strength of explosives. As a matter of fact, the thirteen point eight is postulated to require 50,000 grams or over a hundred pounds of TNT to continue the detonation into a -- from a tube that is twenty-eight feet in diameter out into an open space containing the same mixture composition.

This is manifestly -- first of all, it is interesting for Dr. Lee to find this, because he is seeking to determine basic principles for the relation between detonation cells and critical diameter for propagation into a larger space. It has no application whatsoever to the conditions that are under consideration in this case.

BY MS. HIATT: (Continuing)

Q Are you aware that Dr. Lee and his colleagues

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presented a paper on Direct Initiation of the Spherical Detonation by a Hot Turbulent Gas Jet at the Seventeenth International Symposium on Combustion?

A There is such a paper. Yes.

Q Is this a copy of the paper, sir?

A Yes, it is.

Q I would direct your attention to the comment at the end of the paper by E. T. McHale. Do you know Mr. McHale?

A Oh, yes. Yes.

Q Would you please read that comment into the record?

A May I read it first?

Q Oh, go ahead.

A It is small print.

(Laughter.)

Yes. May I comment on this?

JUDGE GLEASON: Why don't you read it into the record?

MS. HIATT: Sure.

JUDGE GLEASON: Let her read it --

WITNESS LEWIS: May I comment on this?

JUDGE GLEASON: Let her read it in the record and then you comment on it.

WITNESS LEWIS: Oh, all right.

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MS. HIATT: Comments by E. T. McHale, Atlantic Research Corporation, U.S.A. "It is of interest to add a historical comment in connection with this work. Dr. Gene von Elbe predicted approximately five years ago that detonation of unconfined fuel/air mixtures could be initiated by injection of certain reactive chemicals. Approximately two and one half years ago, we obtained such detonations for the first time in unconfined two-phase mixtures of hydrocarbon droplets in air and several reactive coordinated agents have been found to be suitable initiators."

BY MS. HIATT: (Continuing)

Q Are you familiar with that, sir?

A Yes. Dr. von Elbe was a colleague of mine for fifty years.

Q What would be the mechanism by which reactive chemicals would initiate a detonation?

A Yes. Now, these would be reactive chemicals containing very important atoms and radicals. Radicals are a combination of two or three atoms in a single molecule. They have a deficiency of one or more atom so that they are highly reactive. We call them reactive species and chain reactions.

Well, what they injected was a material that would make a profuse concentration of these reactive species. They are not inert, because they react with the fuel and the air

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mixture and cause a highly sensitive mixture to be formed by virtue of their presence. And you can go over into deflagration and detonation.

It has nothing to do with inert in terms of ordinary inert gases like nitrogen, carbon dioxide, et cetera. These are very special chemicals which has nothing to do with any situation here.

Q Wouldn't ionizing radiation have the same effect?

A Well, the mere fact that a molecule has had an electron removed from it and, therefore, becomes a positive ion doesn't imply that it is a reactive radical.

For example, if you had hydrogen molecules with an electron removed, it would be a hydrogen H2 positive charge. That is not reactive.

Q Well, doesn't ionizing radiation create radicals? I mean, can it do that?

A Yes, it can. It depends on the concentration that it makes in its reaction -- in its effect on molecules that it ionizes.

Q Are you aware that at the Fifth Symposium on Combustion a paper was presented on the Effect of Atomic Radiation on the Combustion of Hydrocarbon/Air Mixtures?

A Yes.

(Ms. Hiatt is showing the witness a document.)

Yes, I'm aware of this paper.

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Q Doesn't the paper conclude that the presence of ionizing radiation will promote accelerated combustion effectiveness and increase the reaction rates?

A Yes. But because the piece of paper was published in 1928 at the Wisconsin University Combustion Meeting, at that time not very much was known, and a lot was guessed at, with respect to ionizing radiation having an effect on initiating flames and initiating detonations.

Q And --

MR. SILBERG: Wait, wait.

WITNESS LEWIS: I would continue a moment.

BY MS. HIATT: (Continuing)

Q All right. I'm sorry.

A I've made a note on this paper. Beta radiation. And beta radiation is nothing but a high speed electron. And he also used, not hydrogen but, propane and air as a form of a mixture.

And the result of this radiation, the flame speed was not altered. The blowoff of the flame, which is a special phenomena as to whether a flame can remain stabilized on, say, a burner, that blowoff was not effected.

So, therefore, he concluded there is no significant change due to radiation of low source energy. When you work with higher sources energy in a constant area combustor, he measured in this tube, in this flow tube, an increase in the

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pressure drop. This merely meant that in his tube he was having problems develop and consequently the flame speed increased and he got a pressure drop of some dimension. And that's it.

It's common to get a pressure drop if you increase the speed.

MR. GLASSPIEGEL: May we have a five minute break, Mr. Chairman?

JUDGE GLEASON: Yes. In fact, it's seven to 12. Why don't we -- is it all right to go to lunch? Or, is this an appropriate place?

MS. HIATT: Yes.

JUDGE GLEASON: All right. Let's be back at 1:15.

(Whereupon, the hearing is recessed at 11:53 a.m., to reconvene at 1:15 p.m., this same day.)

SueT

UNITED STATES OF AMERICA

NUCLEAR REGULATORY COMMISSION

BEFORE THE ATOMIC SAFETY AND LICENSING BOARD

------------------------------X

In the matter of: :

:

PERRY NUCLEAR POWER PLANT, : Docket Numbers
Units 1 and 2 : 50-440
: 50-441
THE CLEVELAND ELECTRIC :
ILLUMINATING COMPANY, et al. :

------------------------------X

Perry Town Hall
Center Road & Main Street
Perry, Ohio 44081

Thursday, May 2, 1985

The hearing in the above-entitled matter was resumed at 1:15 p.m., JAMES P. GLEASON, presiding.

BEFORE:

JAMES P. GLEASON, Chairman
Nuclear Regulatory Commission
Atomic Safety and Licensing Board

JERRY R. KLINE, Member
Nuclear Regulatory Commission
Atomic Safety and Licensing Board

GLENN O. BRIGHT, Member
Nuclear Regulatory Commission
Atomic Safety and Licensing Board

SueT

APPEARANCES:

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Washington, D. C. 20555

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CONTENTS

AFTERNOON SESSION

LAYIN DOCUMENTS

(None)

EXHIBITS

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A F T E R N O O N   P R O C E E D I N G S

(1:15 p.m.)

JUDGE GLEASON: All right. If we could proceed, please.

Ms. Hiatt.

Whereupon,

EILEEN M. BUZZELLI,

RICHARD D. RICHARDSON,

KEVIN W. HOLTZCLAW,

ROGER W. ALLEY,

BERNARD LEWIS,

BELA KARLOVITZ,

- and -

G. MARTIN FULS

resumed the stand as witnesses called by and on behalf of the Applicant and, having previously been duly sworn by Judge Gleason, were further examined and testified as follows:

CROSS EXAMINATION

BY MS. HIATT:

Q If we consider the conditions in the drywell for a small break loss of coolant in drywell degraded core accident, initially the drywell air will be driven out of the drywell by steam; is that correct?

A (Witness Fuls) Yes.

(Witness Richardson) Yes.

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Q As the metal-water reaction proceeds, the drywell atmosphere will consist of steam and hydrogen, correct?

A (Witness Fuls) Yes.

(Witness Richardson) Yes.

Q And the drywell purge compressors will admit air from the containment which contains oxygen to the drywell, right?

A (Witness Fuls) That's correct.

Q Now, let's consider specifically your conditions portrayed in Appendix A to the preliminary analysis for the drywell break case.

In Figure 22 at a time of fifty-five hundred seconds, the drywell temperature is 230 degrees Fahrenheit; is that correct?

A What figure was that, please?

Q Figure 22, Appendix A.

A What was the question?

Q At time equals fifty-five hundred seconds the drywell temperature is about 230 degrees Fahrenheit; is that correct?

A That's about correct, yes.

Q And from Figure 25, is the drywell pressure about 26 psia at T equals fifty-five hundred seconds?

A That's correct.

Q And from Figure 29, is the drywell oxygen concentration

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about two percent at T equals fifty-five hundred seconds?

A That's correct.

Q And from Figure 32, is the drywell nitrogen concentration about eight percent at T equals fifty-five hundred seconds?

A That's correct.

Q And from Figure 35, is the drywell hydrogen concentration about thirteen percent at T equals fifty-five hundred seconds?

A That's correct.

Q And from Figure 38, is the drywell steam concentration about seventy-five percent at T equals fifty-five hundred seconds?

A Well, it might be a little bit higher than that. But I will grant you that close.

Q Okay. Now, that is not a flammable mixture, is it?

A No, it's not.

Q Now, let's suppose that at T equals fifty-five hundred seconds we get vessel reflood such that cold water will flow out in the break into the drywell; now, would that situation result in any rapid condensation of steam in the drywell?

A Well, it depends upon how you characterize rapid. It will be a tendency to condensate and be a function of the

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heat transfer characteristics between the spray and the atmosphere.

Q This is a copy of the Perry Final Safety Analysis Report, correct, Ms. Buzzelli?

A (Witness Buzzelli) It is.

Q I'm asking you.

A It is. Yes.

Q Would you please read this statement, Page 6.2-22, starting at that sentence?

(The witness is looking at the document.)

Q Would you please read that into the record?

A From FSAR, Page 6.2-22, under, called Evaluation of Drywell Negative Differential Pressure, "Following the blowdown phase of a LOCA air initially contained in the drywell has been purged to the containment and the drywell is full of steam. During this period the ECCS is injecting cooling water from the suppression pool into the reactor pressure vessel. When the reactor pressure vessel is flooded to the level of the break water begins spilling into the drywell condensing the steam and causing rapid depressurization of the drywell. A bounding calculation of the peak drywell negative differential pressure is based upon the following conservative assumptions..."

Q That's enough. You don't have to --

A (Witness Fuls) I disagree. There is --

#9-13-SueT

JUDGE GLEASON: Nobody has asked her a question to agree or disagree with. All she was asked to do was to read that statement.

BY MS. HIATT: (Continuing)

Q And that's a true statement of your Final Safety Analysis Report?

A (Witness Buzzelli) That is a true, first two and a half sentences of the part you asked me to read. There is more information contained in the balance of that same paragraph if you would like me to read it into the record.

Q No. I just wanted that sentence. That's all.

MR. GLASSPIEGEL: Mr. Chairman, I understand we had this discussion before, but the witness was asked to read something and was stopped in the middle of a sentence.

I can come back on redirect and we can finish the sentence or finish the sentence now. It would be much more helpful for the record if we just finished sentences.

JUDGE GLEASON: Do you intend to -- I don't know what the question is. As I recall, she was just asked to read something in the record.

MR. GLASSPIEGEL: The witness tried to finish the sentence and was cut off.

JUDGE GLEASON: Well, she could go on and read the rest of the material, but there is no question that relates to it. What is your question? Was there a question?

#9-14-SueT

MS. HIATT: I asked her if those were true statements, and I believe she agreed.

MR. GLASSPIEGEL: And my point, Your Honor, you don't have the benefit of the sentence in front of you but she was asked whether a part of a sentence is a true statement. That creates a misleading record.

JUDGE GLEASON: How do you want to proceed, Ms. Hiatt? Do you want her to pick up reading the rest of it, following it up on reidrect, or should she do it now?

MS. HIATT: Well, they have the option of redirect on their witnesses.

JUDGE GLEASON: All right. Just wait. It doesn't have much value the way it is now.

BY MS. HIATT: (Continuing)

Q All right. Now, from the conditions which we took from the preliminary analysis, Appendix A, we can calculate the vital concentrations of nitrogen, oxygen and hydrogen if we assume that all the steam is condensed and neglecting further air addition from vacuum breaker operation during depressurization; is that correct?

A (Witness Fuls) It's probably valid that you could do that.

Q Would you care to perform that calculation?

A Now?

Q Yeah.

#9-15-SueT

MR. GLASSPIEGEL: Well, I object. There is no basis to ask a witness to perform a calculation in the middle of a hearing.

JUDGE GLEASON: Is it a complicated calculation?

WITNESS FULS: All I can give you is an estimate of what the answer would be. It is involved. There is heat transfer, there is rate to heat transfer. There is temperature changes.

JUDGE GLEASON: You would have to accept an estimate.

MS. HIATT: Well, I was -- maybe we can simplify it a little further than that, if we could just consider the ideal gas while we are assuming all the steam will be condensed. Let's just -- you know, we are back to -- just make a few basic assumptions and maybe we get a ballpark figure.

That's what we are looking for.

MR. GLASSPIEGEL: Well, Ms. Hiatt can make all the assumptions she wants to. But if she wants the witness to make estimates or calculations, then that is up to the witness as to whether they can do that reliably in the middle of a hearing.

JUDGE GLEASON: Well, that's what I asked him, and can you do that on an estimated basis?

WITNESS FULS: I believe so. What you are asking -- would you ask the question again, please?

END #9
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BY MS. HIATT: (Continuing)

A All right. We will assume that all the steam is condensed. We will neglect further air addition from the vacuum breaker operation during depressurization. I think maybe the temperature, we can perhaps assume possibly -- we can assume -- I can make some assumptions, but why don't we calculate the final concentrations of nitrogen, oxygen, and hydrogen, following the condensation of all the steam.

A (Witness Fuls) Well, taking your assumptions at face value, and assuming that the steam somehow gets out of there, not granting that it can get out, you would be taking about 75 percent of the partial pressures out of there, and so you would have 13 percent, I think, was the number that you used for the initial hydrogen concentration, and multiply that by an order of by about four, so you would be in the range, based on your assumption, of about fifty-two percent hydrogen.

The same thing would apply to the oxygen. I forgotten the number. I believe you said it was -- it would be about eight percent orders of magnitude.

Q With no steam, we are assuming?

A That is correct. But you would also have a concomitant decrease in the pressure by a factor of -- instead of 24 psia, you would be down to like 6 psia. A very rarified atmosphere.

Q Is that a combustible mixture?

A Yes.

Q Is it a detonable mixture?

A No.

Q Go ahead.

A You have sufficient hydrogen, but you have a deficit of oxygen when you get into the detonable region.

Q Could you predict -- lets say the adiabatic isochoric theoretical pressure rise from the combustion of that mixture?

A I will defer to one of my colleagues.

A (Witness Lewis) You want the pressure that would arise from the conbustion of this?

Q Correct.

A All right. First of all, I can tell you that the oxygen is 8 percent.

Q Pardon sir? I am having trouble hearing you.

A Oxygen is 8 percent.

Q Yes, sir.

A Nitrogen is 35 percent, and hydrogen is 57 percent.

Q I believe it was 52. Is that what you said.

A 57.

Q I thought you said 52, Dr. Fuls?

A (Witness Fels) I said 52.

A (Witness Lewis) But I have done it accurately.

JUDGE GLEASON: You are impeaching your own witness.

WITNESS LEWIS: Well, this is an estimate he made, you see.

This, obviously, is a very rich mixture. You see you are on the downward slope, and that can't be done off the top of your head. I will venture a guess that the pressure would be -- it is very close to the limit of detonation, if you can get the light ignition.

So, the pressure would be of the order of 50 pounds -- 50 to 55 pounds.

Starting from atmospheric pressure. This is a Delta-T of 50 to 55 pounds.

A (Witness Fuls) She was talking about 6 psia, so --

A (Witness Lewis) Oh. You mean reduced pressures?

Q The intial pressure.

A Oh, well, I didn't hear that. 23 psia.

Q Okay. Now, isn't it true in actuality in that situation, Dr. Fuls, you would expect more oxygen to be into the drywell due to the action of the vacuum breakers during depressurization?

A (Witness Fuls) I would expect that there would be more oxygen, but I also expect a tremendous amount of steam to be residual in the -- at the same time.

Q Now, the Marsh Code was used to calculate steam and hydrogen releases as input to your containment response analysis, correct?

A That is correct.

Q Do you know what version of the Marsh Code was used?

A I understand it was version 1.1.

Q And is that something the NRC informed you, or --

A Yes. They did the calculation.

Q I am handing you a document that has been purported to be a listing of input values for the Marsh Code that was used as input. Is that what it looks like to you?

A That is what it looks like, yes.

Q This listing consists mainly of unidentified numerical values, correct?

A That is correct. Without the manual it would be virtually impossible to tell what the numbers mean.

Q But you do think this is -- these are input variables into the Marsh Code?

MR. GLASSPIEGEL: Ms. Hiatt, from where did you get the document? Rather than playing guessing games, why don't we find out where the document comes from?

MS. HIATT: We got it from you. You supplied this during discovery.

MR. GLASSPIEGEL: That is fine. Let's have an identification of it, that is all. There is no date or title or anything.

MS. HIATT: It says on the top: Listing of Input Data for Case 1, Grand Gulf Degraded Core of Hydrogen.

It was provided in response to my Interrogatory 13-65.

MR. GLASSPIEGEL: Well, our version has the top portion cut off, I think, but I appreciate having the identification where it came from given.

JUDGE GLEASON: Proceed, Ms. Hiatt.

BY MS. HIATT: (Continuing)

Q If you have the March Manual, could you identify to which input variables these numbers correspond?

And the manual we are referring to is NUREG CR 1711.

A (Witness Fuls) I don't remember the CR number.

Q Is this a copy of the March manual document?

A That appears to be the same one that I used.

Q Could identify where the input variables for which these numbers correspond?

A You mean in the manual, in the back of the manual?

Q Could you identify the input variables to which they correspond?

MS. WOODHEAD: Ms. Hiatt, we think these are misidentified.

MS. HIATT: That is what I thought, too. But --

MS. WOODHEAD: Well, I think we need to have an accurate identification of the document before you use it.

JUDGE GLEASON: Who can identify it correctly?

MS. WOODHEAD: Mr. Notafrancesco produced the document.

JUDGE GLEASON: Is the author here? Identify it.

MR. NOTAFRANCESCO: This is input to IMPEL Delta-T 28 Code.

WITNESS FULS: To the best of my knowledge, this was what was sent to me by Battelle Memorial Institute, through the NRC, as being the input to the March program used in production of the base run used in this analysis.

JUDGE GLEASON: Can you corroborate that, Mr. Notafrancesco?

MR. NOTAFRANCESCO: I definitely think the input is --

JUDGE GLEASON: It is not from the March Code?

MR. NOTAFRANCESCO: The results of March are used as input for the IMPEL codes.

MS. HIATT: Well, let them look at it a little longer.

JUDGE GLEASON: All right.

JUDGE GLEASON: Can you respond to her question. Can you identify that?

MR. FULS: No, I -- all I can tell you is that this, to the best of my knowledge, this was transmitted to me by a devious route, and purported to be the import to the

March program used to generate the Grand Gulf result.

JUDGE GLEASON: Mr. Richardson?

WITNESS RICHARDSON: I think I can clarify a little bit, in that the input into the CLASIX Code that was necessary was derived from the March Code, and it -- at the time Battelle National Laboratories had conducted the RUSMAP Study, which Ms. Hiatt had identified earlier, and had used March for the Grand Gulf plant.

They had done that work for the Nuclear Regulatory Commission, and when we initially did the studies for CLASIX we requested, through the NRC, that the output of March be provided for use in the studies of the hydrogen generation event, and for use in the CLASIX.

So, the output of the March Code came from Battelle and the NRC to Mississippi Power and Light, and was sent to Dr. Fuls.

Dr. Fuls, I think, says that that was attached to the output information from March as the input that went in.

The important parameter was the output of March, and that is what we were interested in. That was just sent as additional information.

JUDGE GLEASON: Now, can you corroborate that? What he just said.

MR. NOTAFRANCESCO: I am not sure of all the details.

JUDGE GLEASON: All right.

BY MS. HIATT: (Continuing)

Q Mr. Fuls, you still believe that this is an input listing for the March Code?

A (Witness Fuls) Not according to this manual, no, it is not.

Q Okay. Now, isn't it true that the CLASIX 3 Code -- for purposes of the CLASIX 3 Code, the hydrogen steam output values of March are linearly interpolated between the data points?

A That is correct.

Q Now, the CLASIX 3 Code is a proprietary code, is it?

A That is correct.

Q And that is not widely availa ble, or available at all in the public domain?

A That is the meaning of proprietary.

Q Has the CLASIX 3 Code been validated by comparison with experimental data?

A It certainly has.

Q Could you describe that?

A There were innumerous comparisons with information from Penwall and other small volume tests and recently there were some comparisons made with the NTS test, which as you know, is a large volume test.

Q Now, by comparisons, you mean comparisons of the actual results achieved from the Code and any comparisons for input value, such as burn parameters?

A We use the data available from the test, such as initial conditions. Hydrogen concentrations. Whatever information was available on the initial conditions, and the analysis was performed with the CLASIXs, and the output compared with the test data.

Q Are you talking about CLASIX, or CLASIX 3?

A CLASIX 3.

Q Now, there have been comparisons made between CLASIX and other response codes which model hydrogen combustion, correct?

A Only one available, and that is the Coco Class 9 from Westinghouse, which is also a proprietary code.

Q Now, isn't it true that Sandia National Laboratory made a comparison between March and CLASIX and Hector?

A Yes, that is true.

Q And that comparis[illegible] is documented in a document Number NUREG CR 2530? F[illegible] Review of the Grand Gulf Hydrogen Igniter System?

A I have read [illegible] some time, and I don't remember all of the det[illegible]. Tha[illegible] may be true.

Q Do you recall whether [illegible]arch and Hector predicted higher pressures and temperaturs from hydrogen combustion than did CLASIX 3?

A I recall statements to that effect; I can't say from my own recollection.

Q Now, you performed a number of sensitivity studies on the CLASIX 3 Code, correct?

A Yes, I did.

Q And these sensitivity studies addressed wetwell spray carryover as a parameter?

A That is true.

Q And did you find that increasing the wetwell spray carryover resulted in an increase in temperature?

A An increase in temperature in the wetwell, yes.

Q I call your attention to Table 9 of Appendix A to the preliminary analysis. You used for the Perry CLASIX 3 analysis a welwell spray carryover fraction of .4669?

A That is correct.

Q I will direct your attention to Figure 2.4-12 of the preliminary analysis. According to this figure, after 6 -- 89 foot six inch elevation at Perry, the cross sectional floor area of the containment is 2,778 square feet?

A That is what the figure says, yes.

Q Doesn't that correspond to about 25 percent of the total cross sectional area of the containment?

A Offhand, I don't know.

Q You don't know.

A That is correct. I don't know the full cross sectional area.

Q Now, the containment spray headers are up above that elevation, correct?

A Yes. Considerably above it.

Q So, wouldn't we only expect about 25 percent of the spray to directly enter the wetwell?

A If your numbers are correct, yes.

Q Okay. Did your carryover fraction of .4469 also include sheet flow of water?

A It was based on sheet flow, yes.

Q And you made an assumption that sheet flow is one half as effective as droplet flow and heat transfer?

A That is correct.

Q Do you have an experimental basis for that assumption?

A No, I do not.

Q So, it is certainly possible that spray effectiveness in the wetwall would be less than what you assumed?

A It is also possible it could be considerably more.

Q If we assume that it is less, wouldn't the hydrogen burn temperatures be greater than was calculated?

A In the wetwell, if the spray were less, the peak temperature would be higher -- would be expected to be higher.

Q So, the CLASIX 3 analysis models -- you go on.

A There is one consideration. I would tend to expect them to be higher, but the magnitude would not be directly proportional, because the spray and the spray carry-over tend to reduce the temperature in the wetwell.

Therefore, because of the lower temperature, it requires more pounds of hydrogen to equal eight percent. So, there may be some offsetting conditions there.

You are burning more pounds. Initiating at a lower temperature. You have -- there is some offsetting characteristics there. But offhand, I would say they would be expected to be higher peak temperatures.

Q Okay. Now, the CLASIX 3 analysis will model only deflagrations, and not diffusion flame, correct?

A That is correct.

Q Mr. Richardson, at one point on your scale test you referred to in your testimony demonstrated that continuous diffusion flames exist in the wetwell for hydrogen releases greater than .4 to .5 pounds per second, is that true?

A (Witness Richardson) Feel that there was a threshold, and the threshold was in the vicinity of 0.4 to .5 pounds mass per second. And above that threshold, diffusion flame would occur.

End 10.
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Sim 11-1

Q Isn't it true that the fusion flames pose a thermal threat to equipment survivability and containment integrity in the wetwell region?

A (Witness Richardson) Part of the Hydrogen Control Owners Group program is to evaluate thermal environment from the fusion flames by cnoducting a large-scale test, a quarter-scale test to determine what that thermal environment is, and I feel confident that the results of that test would show that the thermal environment is not a threat to the equipment.

Q On June 29th, 1983 did not the Hydrogen Control Owners Group and the NRC conduct a meeting to discuss the results of the 1/20th scale tests?

A If you have a document that shows that. I don't remember the dates of all the meetings.

(Pause while the witness reviews a document.)

Yes, there was a meeting.

Q And at that meeting did you not make a statement that standing diffusion standing diffusion flames will result in unacceptable loading to equipment for a 75 metal-water reaction?

A I can't remember if I made that exact statement. If I made the statement, it would have been with certain conditions which stated for certain release rates of hydrogen which could not exist for a 75 percent metal-water reaction.

Q Let me direct your attention to one of the viewgraphs here. Did you present this one at that meeting, the conclusions?

A I probably did. I can't remember.

Q Why don't you just read that into the record.

A The slide is a slide that says conclusions, and the particular bullet or section says resulting thermal loading to equipment is unacceptable for 75 percent metal-water reaction. However, that statement is somewhat out of context because this is a slide, and it was a very brief statement.

It has a very big qualifier on it which is for the release rates used in the 20th scale facility, which are not capable again for a 75 percent metal-water reaction, then the thermal loading might impair the equipment.

We did say, and if you read further, it does say that it is likely acceptable for a realistic source term, and that is exactly the point I am making.

Q Didn't you perform an analysis based on the 1/20th scale test results, which would indicate that the transformer in the igniter assembly would reach a temperature of 900 degrees Fahrenheit?

A There was some analysis conducted evaluating the 20th scale data. I am not which analysis you are talking about. There were some very gross preliminary analyses

Sim 11-3

done prior to the time I left Mississippi Power and Light and there were some better analyses conducted after the time I left MPL. If you could tell me which ones you are referring to.

Q Let me show you this. This is a document dated July 15th, 1983, a memorandum for A. Schwencer from M. D. Houston, Project Manger for Grand Gulf, subject, Summary of the BWR Hydrogen Control Owners Group Meeting on June 29th, 1983, and it summarizes the main points in the HCOG presentation.

You might look that over.

Have you ever seen it before?

(Pause.)

A I don't remember reading it before.

Q Does it accurately summarize the presentation that you made?

A Just reading this, and I haven't read the whole document ---

Q Well, if you would like to, take your time.

(Pause.)

JUDGE GLEASON: If I understand correctly, this purports to be a summary of a HCOG meeting. Did you ever seen this summary before?

WITNESS RICHARDSON: This was not a summary by the HCOG. It is the meetings minutes internal to the

Sim 11-4

NRC.

JUDGE GLEASON: All right.

WITNESS RICHARDSON: Someone in the HCOG may have had it, but right after this date I left MP&L.

JUDGE GLEASON: All right.

(Pause.)

JUDGE GLEASON: We are spending an inordinate amount of time on a three-page document to get a simply statement as to whether it is an accurate summary or not.

WITNESS RICHARDSON: It does summarize the meeting. It has some facts in it that I am not sure were the actual facts presented. I can't tell from just what is here.

MS. HIATT: Well, let me read this statement to you.

"The transformer on the hydrogen igniter assembly was identified as a critical item on the basis that it is qualified to 400 degrees Fahrenheit and was calculated to reach a temperature of approximately 900 degrees Fahrenheit.

Is that an accurate characterization of the material you presented at that meeting?

WITNESS RICHARDSON: Yes. I don't remember the exact temperature that was presented. It is a characterization of the fact that if you take the release

Sim 11-5

rate that was used in the facility, which we discussed at that meeting that it was not possible for a 75 percent metal-water reaction, but if you took the release rates that were evaluated in the 20th scale testing and carried them out for extended periods of time, the temperatures would continue to increase until the point where the hydrogen igniter would reach very high temperatures and fail.

If you take any elevated temperature out long enough, the temperature is going to increase. That analysis was to take the temperature, to take the component past failure to see what the peak temperature was.

BY MS. HIATT:

Q Do you recall whether the 1/20th scale tests indicated that a maximum gas temperature below the HCU floor was around 1200 degrees Fahrenheit?

A (Witness Richardson) I don't remember the number for the maximum gas temperature.

(Pause.)

Q Didn't your evaluation of the 1/20th scale test facility indicate that at the HCU floor the temperatures would be in the range of 500 to 700 degrees Fahrenheit?

A Yes, and I am not sure which evaluation you are referring to. There were several evaluations, you know, conducted, some with some preliminary data and there were some done for the meeting and then there were some that

Sim 11-6

were conducted after the meeting which were better predictions using better data. So I really do need to know which time frame.

Q Well, this figure is part of what you presented at the meeting, or you and your colleagues presented?

JUDGE GLEASON: What document is that?

MS. HIATT: This is the document, the HCOG/NRC meeting in Bethesda, Maryland on June 29th, 1983.

(Pause.)

WITNESS RICHARDSON: This is a chart showing some data taken from the 20th scale testing which, as we had stated in the presentation, was very conservative temperatures. It would be much higher than expected because the scaling relationships were off. The scaling relationships, once you go beyond about one in ten, break down and you start getting very conservative temperatures. So these values do appear to be what was presented there from the 20th scale data.

BY MS. HIATT:

Q And they range around 500 to 700 degrees at the HCM floor?

A (Witness Richardson) It looks like five to six hundred, something like that, 625, or something like that.

Q Now at normal pool water level, the top of the

Sim 11-7

pool surface is at 593 feet elevation approximately?

A I think that is correct.

A (Witness Buzzelli) That is correct.

Q Now the drywell equipment hatch and the lower personnel airlock are located on the 599 elevation?

A Could you repeat the question?

Q The drywell equipment hatch and the lower personnel airlock in the containment are located at the 599 elevation; is that true?

A I believe that is correct.

Q And both of these use polymeric seals as leakage barriers?

A (Witness Richardson) Both of those use seals. I don't know if it is that type. I would have to check that material.

Q Well, a polymer is a very general class of materials. There are polymeric seals, right?

A (Witness Buzzelli) They both have sealing arrangements in the hatch and in the airlock that you referred to.

Q Isn't it a concern that standing diffusion flames persisting for a length of time could degrade the seals in both the drywell equipment hatch and the lower personnel airlock?

A (Witness Richardson) Those hatches are

Sim 11-8

included on the equipment survivability list in the preliminary evaluation and they will be evaluated for the thermal environments which could exist from standing diffusion flames as a result of the quarter-scale testing.

Q And it is a goal of that quarter-scale facility to generally define the thermal environment to which equipment will be subjected from the diffusion flames?

A It is an objective of that testing to define the thermal environment which may result from standing diffusion flames and to use that thermal environment for evaluating the equipment response.

Q Do you intend to put actual items of equipment in that facility to test them?

A No.

Q Is your methodology there to measure heat fluses and estrapolate them to full scale and then use those inputs to analytical models of equipment thermal response?

A The methodlogies use more than just heat fluxes. We are measuring several parameters, heat fluxes, gas velocities, temperatures, several things. We are going to use the information measured and we have an extensive network of instrumentation in the facility. We are going to use that information to define what the full-scale thermal environment would be and use that

Sim 11-9

thermal environment in computer models of the equipment to determine what the equipment response is.

In addition, we have placed what we call a complex calorimeter, which is an instrumented device, a well instrumented device of a complex geometry where we will measure the temperature response of this complex calorimeter, not only on the outside, but also internal to the device and use the thermal environment which is measured and apply it in the same manner to the computer models of that device and compare the analysis to the tested results in order to validate the methodology.

Q Dr. Lewis, did you Mr. Karlovitz perform a study of hydrogen control at the Grand Gulf Nuclear Station in 1981?

A (Witness Lewis) Of the test program.

Q I am just asking did you perform or write a report on the study of hydrogen control for the Grand Gulf Nuclear Station around 1981?

A I think so, yes.

Q And in your evaluation didn't you recommend that full-scale testing of diffusion flames above the suppression pool be conducted?

A (Witness Karlovitz) May I answer this question, please?

Q Sure.

Sim 11-10

A When we recognized that above the water level out come bubbling hydrogen and formed diffusion flames, we realized that these diffusion flames differed in geometry essentially from diffusion flames known from experiments. The usual diffusion flames are formed by fuel gas come out at a pretty high velocity from a tube blowing into air, entering air and forming a diffusion flame.

Here we have hydrogen bubbling out at a relatively slow velocity over a large area. So we will have a large cross-section area of slow-moving hydrogen flow entering air . For this case we could not find experimental data and proposed that experiments should be carried out to be able to measure and determine the dimensions of particularly the height of these diffusion flames.

Then while this was a joy. to discover a situation in flames which has not been fully explored in experiments, we wanted to do this, then we realized that the hydrogen flow rate from a single sparger would be only about half a pound per second, which could be handled in a large laboratory.

Therefore, we proposed why don't we make a square tower built of concrete blocks or so with water and a single sparger in full scale because it can be done in full scale without a great effort, and then all considerations of scaling can be omitted.

Sim 11-11

Then came around ERPI and other people involved and they said yes, there is another problem, too. Hydrogen comes up, but air has to come down.

Previously we compared an area on which air can flow down and found it plenty large to bring in air. So it did not seem so important, but our other people insisted because we have different stairways and platforms and so on in this angular shell, and it would be a nice thing to make an experiment, not a single sparger, but on the entire ring.

Now when we get to the entire ring, then the dimensions get out of the scale of a laboratory and then you have to go to a lower scale model.

So there is no contradiction between our original recommendation to make full-scale tests. We did not say you have to make a full-scale test. We said it is possible to carry it out and now it is obvious that you have to make scaled down model.

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#12-1-SueT

Q Is this document a copy of the recommendation?

A (Witness Karlovitz) This is an attachment to that report, yes.

MS. HIATT: I would ask that this be admitted as OCRE exhibit.

JUDGE GLEASON: All right, the document will be designated as OCRE Exhibit Number 17.

MR. GLASSPIEGEL: May I have a copy to share with my witnesses?

(The document referred to is marked as OCRE Exhibit Number 17 for identification.)

INDEXX

MR. GLASSPIEGEL: We don't have any objection.

JUDGE GLEASON: Any objections?

MS. WOODHEAD: No.

JUDGE GLEASON: All right. The exhibit will be admitted as OCRE Exhibit 17.

(The document previously marked as OCRE Exhibit Number 17 for identification is admitted in evidence as OCRE Exhibit Number 17.)

INDEXX

(The document, OCRE Exhibit Number 17 follows.)

OCRE #17.

ATTACHMENT A

Experimental Study of H_2 Diffusion Flames Burning Above a Pool of Water

While the general character of H_2 diffusion flames burning above a pool of water with restricted air supply can be predicted there is considerable uncertainty regarding the height of such flames. An experimental study of these flames is proposed which will allow the measurement of flame height and temperature, and observation of ignition by glow plugs and of flame stability.

The maximum H_2 flow rate through a single sparger is .5 lb/sec. Thus it is possible to do the experiment at full scale and avoid the scaling problem.

The experimental arrangement would consist of a 20' x 20' x 50' high concrete structure open at the top and containing an 18 foot deep pool of water. A single full scale sparger would be arranged in a position similar to that in the wetwell with three horizontal vent holes representing the connection between the drywell and wetwell (Figure A-1).

Glow plug igniters will be placed at locations corresponding to those in the wetwell. Observation windows and sampling ports will be arranged in the side walls for measurement of flame height, temperature and H_2 distribution along the flame.

In order to measure the transient ignition pressure the top of the structure may be closed temporarily with a cover containing an appropriate vent opening.

The experimental system described above will also be suitable to study the effect of splashing water and water sprays on the igniters and on the flame. Also tests of equipment survivability will be possible.

For safety the tests should be carried out at an open site with remote controls.

C5rg12

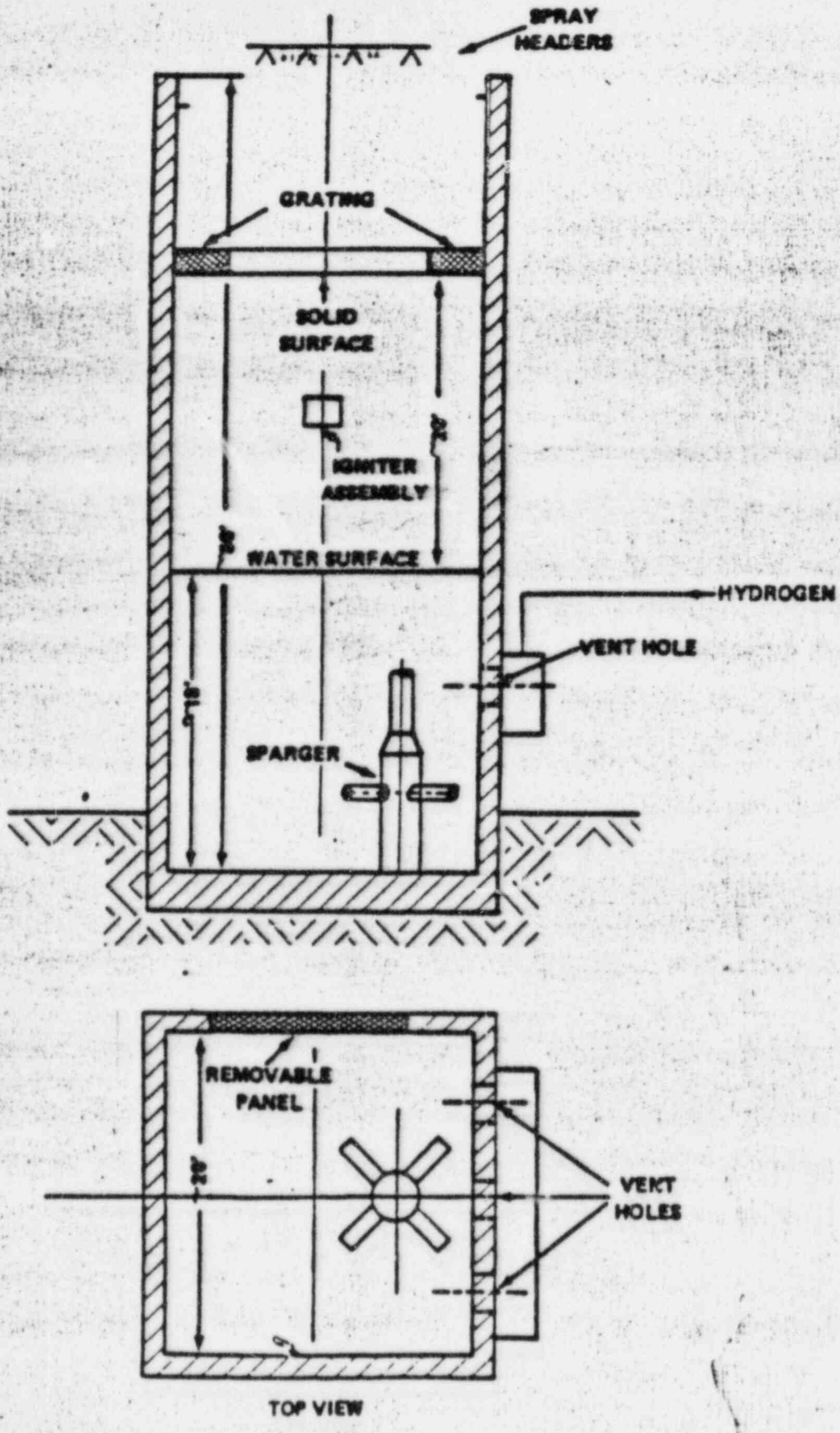

FIGURE A-1
WETWELL TEST CHAMBER

#12-2-SueT

MR. GLASSPIEGEL: Do you plan to ask any questions, Susan, on the document?

MS. HIATT: I think I might have a couple, yes.

BY MS. HIATT: (Continuing)

Q The second paragraph of the document --

A Yes.

Q -- makes reference to doing the experiment at full scale and avoiding the scaling problem.

A Yes.

Q Would you please elaborate on what problems there are with scaling?

A In engineering experiments, one is frequently faced with the necessity to carry out not full scale but reduced scale experiments. You cannot put a 747 into a 747 into a wind tunnel full scale. And there are innumerable such cases.

Now, the scaling law is different for different physical phenomena. It's different for turbine generation in a stream where you have to use the Reynolds number similarity. If this is fulfilled, then the model is dynamically similar to the full scale case and gives reliable results. This has been used for many, many years.

In diffusion flame case, we are faced with a buoyancy phenomenon. The hot gases move up and this movement produces the turbulence which brings in the air to the flame.

Here, the modeling has to be done by the Froud number. And it turns out that if you go from a full scale situation to a reduced scale situation, and your problem is not a single phenomenon but several involved, you cannot scale everything properly. You have to select the most important phenomenon and scale that properly and show that the other phenomena, for example, Reynolds number similarity, also would be negligible. The error would be negligible.

That's what we've done here when we went from full scale down to the one-twentieth order, one quarter scale.

Q The document also states that for the experimental system you had proposed that tests of equipment survivability would be possible.

Did you envision actual placement of items in the specific --

A Yes. In the full scale model, you could put in actual boxes and models and whatever you want to use. Sure.

Q Would you consider that approach preferable to measuring heat fluxes and other parameters in a scaled facility?

A No. Here we are faced with two separate problems. Our original problem would have allowed full scale testing. But extended problem brought in by EPRI and other people does not allow a full scale testing.

Q Let me ask this. Would you generally consider it preferable to test an actual piece of equipment than to

#12-4-SueT

measure heat fluxes and other parameters and do an analytical calculation of its thermal response?

A It depends what is the situation, what are you forced to do, what can you do, and what can you not do.

Modeling is used in the technique all the time for very different purposes.

Q Mr. Richardson, isn't it true that the hydrogen release histories to be used in the quarter scale test facility are to be developed from the BWR heatup code?

A (Witness Richardson) That's correct. Except for one release history which we have proposed, which is to simulate a low release rate from a possible prolonged degraded core which possibly may get to seventy-five percent metal-water reaction.

Q Is that BWR heatup code a public domain code?

A The BWR heatup code was developed in the Industry Degraded Core Rulemaking Group, and it has been further developed from that point through the Hydrogen Control Owners' Group utilizing the Elect: ic Power Research Institute, EPRI.

The code -- I'm not sure if the code is public domain or not. I think we did submit the BWR heatup code users' manual to the NRC and it was, to my knowledge, not a proprietary document.

Q Has this code been verified by comparison with experimental data?

- #12-5-SueT

A There were some experimental data that was evaluated in order to evaluate some of the correlations and equations, but as you know it was no BWR with a degraded core that could be used as a model to evaluate the whole core in an experiment.

It has been verified against hand calculations and problems that are well known and well founded, and that experimental data as available on fuel and reactor interactions has been used.

Q This code has undergone some limited NRC review; isn't that true?

A It has undergone some NRC review.

Q Didn't the NRC's review uncover some faults with the code?

A I wôuld disagree that they uncovered faults. I would say that there are some questions the NRC raised and some issues they identified for the Owners' Group to take under advisement and study further.

I think it involves a question as to whether additional conservatisms should be added to account for any uncertainties that might be in the code.

Q Isn't a feature of this code an irreversible termination of zirconium oxidation, at a core known temperature greater than that specified by the input variable TOXOFF?

A That's correct.

#12-6-SueT

Q Has that been shown through experimental data?

A There are -- there is some experimental data that has been shown to substantiate the phenomena. The best data that has been provided was an evaluation by a gentleman during an NRC meeting from EG&G in Idaho, and his presentation showed that such oxidation -- oxidation is reduced above temperatures on the order of magnitude assumed by the Owners' Group if the localized oxidation fractions are less than on the order of point six eight, which the Owners' Group has evaluated the use of that in the BWR heatup code and shown that the assumptions made is consistent with that data.

Q Do you intend to conduct hydrogen combustion tests in the quarter scale facility using a quantity of hydrogen equivalent to that produced from a seventy-five percent metal-water reaction?

MS. WOODHEAD: Objection. Mr. Chairman, we've had about fifteen questions now on the final analysis which is still under development by the Owners' Group and NRC. And it clearly is beyond the scope of this contention.

JUDGE GLEASON: It is and it isn't. We have gone through this argument once before. And I made a ruling with respect to it.

And that same ruling applies. Your objection is denied. Please answer the question.

WITNESS RICHARDSON: Would you repeat the question?

#12-7-SueT

BY MS. HIATT: (Continuing)

Q Okay. Do you intend to conduct hydrogen combustion tests in the quarter scale facility using a quantity of hydrogen equivalent to that released from a seventy-five percent metal-water reaction?

A At the present time, it is our intent to test a -- to conduct tests with a hydrogen release rate which would be consistent with a release rate from a degraded core which may reach seventy-five percent metal-water reaction.

Q Let me ask this. For tests in which you intend to produce diffusion flames, will the hydrogen release history there be equivalent to a seventy-five percent metal-water reaction?

A No. The rates which will sustain diffusion flame will not allow you to reach seventy-five percent metal-water reaction.

The oxidation rate is so high in generating that types of hydrogen generation that it would drive you into a very rapid and very high core melt which is beyond the scope of degraded cores and beyond the scope of this testing.

Q Now, when you define the thermal environments from the quarter scale facility, what type of margins do you intend to incorporate therein?

JUDGE GLEASON: Ms. Hiatt, you are drawing a pretty fine line with some of these questions. And I think you are

#12-8-SueT

entitled to find out just the general objectives as far as the final analysis report is concerned. But as far as details, I think that is beyond the scope of this contention.

So I think -- I agree that if Ms. Woodhead were to raise that objection again that she raised before, I would sustain it. But inasmuch as she didn't, I will have to say that you can ask some general questions with respect to the final analysis, but you ought to keep them general.

MS. HIATT: Mr. Chairman, I don't think it has been determined yet exactly what is an appropriate --

JUDGE GLEASON: I understand that. But I think there are some limits where we have to say that nobody in his right mind would conclude that that could be anything other than having to be included in the final analysis.

Now, when we reach that point I think you have to make the questions more general, is what I'm saying. And I think we have reached that point.

BY MS. HIATT: (Continuing)

Q Ms. Buzzelli, Page 21-D of your preliminary analysis, you refer to the containment vacuum breaker and hydrogen mixing compressor check valves as having an external design pressure exceeded by hydrogen burn pressure; is that correct?

(The witness is looking at a document.)

JUDGE GLEASON: Did you say Page 21-D?

#12-9-SueT

MS. HIATT: There was a March 21st, 1985 update to the preliminary analysis which I received. I'm not sure if it's in there.

JUDGE GLEASON: All right.

WITNESS BUZZELLI: Page 21-D?

MS. HIATT: Correct.

BY MS. HIATT: (Continuing)

Q Yes.

A Can you repeat your question?

Q Okay. Do you not refer therein to the containment vacuum breaker and hydrogen mixing compressor discharge check valves having a design pressure which is exceeded by hydrogen burn pressures?

A That is -- the report does reflect that the external peak design pressure, which is provided and is exceeded by the hydrogen burn peak pressure, that's correct.

Q But do you not anticipate that these components will withstand pressures higher than the design pressures?

A Yes. And the reasoning is identified in that paragraph if you care for me to read that into the record.

Q Well, let me just ask this. Has that assumption been confirmed by testing?

A Specific tests on those components has not been conducted to that hydrogen peak pressure. The expectation is based on the component and its design, the material is used in

#12-10-SueT

the expected capability of that component.

It reflects our preliminary evaluation of equipment survivability, all of which will be dealt with again in the long term program on a final basis.

Q Are Tables 5.6-1 and 5.6-2 of the preliminary analysis intended to be complete lists of equipment to be evaluated for survivability?

A (Witness Richardson) The preliminary evaluation -- in the preliminary evaluation they are intended to be complete lists. There are some, as we discussed, the Hydrogen Control Owners' Group program plan was still under discussion with the NRC and if there are any additional items which must be considered as a result of discussions with the NRC on a long term program, then further evaluations may be conducted.

Q Now, your tables do not list any components of the reactor recirculation system, the B33 system. Is that true?

A That's true.

Q And isn't that system part of the reactor coolant pressure boundary?

A The system, the piping, is part of the reactor coolant pressure boundary.

Q And your tables do not list any components in the control rod drive or C-11 system; isn't that true?

A That's correct.

Q And why do you exclude these components?

#12-11-SueT

A Most of the components that are inside the containment, the control rod drive hydraulic system, are used for normal operation of rods, and in some cases some of the components are used for inserting the rods. And that function would have occurred long before hydrogen combustion so, therefore, the components are not included on the list.

Q Well, wouldn't it be true that if the accident scenario producing the degraded core accident were an anticipated transient without scram, this equipment would be important to maintain in a safe condition?

A If it is an anticipated transient without scram, then those components didn't work in the first place.

Q But wouldn't you want to hope that their function might be recovered at some point?

A First of all, the anticipated transient without scram is not an event which is considered for evaluation and has been eliminated because of the low probability of event.

Q Are you finished, sir?

A Yes.

Q Ms. Buzzelli, are you aware that Part Numbers 1-C-11-F0010, F -- 1-C-11-F0011, 1-C-11-F0 --

MR. GLASSPIEGEL: Would you slow down a little, Ms. Hiatt?

BY MS. HIATT: (Continuing)

Q 1-C-11-F0180, 1-C-11-F0181, are scram discharge

#12-12-SueT

volume vent and drain valves located in the containment?

A (Witness Richardson) Would you repeat those numbers again? I didn't hear them.

Q All right. 1-C-11-F0010, 1-C-11-F0011, 1-C-11-F0180, 1-C-11-F0181.

MR. GLASSPIEGEL: And the question was?

BY MS. HIATT: (Continuing)

Q Are you not aware that these are scram discharge volume vent and drain valves located in containment?

A (Witness Buzzelli) Those may be the correct MPL numbers. I don't have those memorized. We do have scram discharge volume vent and drain valves.

Q Are you aware that they have only been qualified to 185 degrees Fahrenheit?

A (Witness Richardson) That may be the case. They are not included on the list, because they have performed a function before the hydrogen event and, therefore, it's not necessary to evaluate their survivability during and after a hydrogen burn.

Q And are you aware that the HCU scram pilot valve solenoid has only been qualified to 215 degrees Fahrenheit and 17 psig?

A That's -- I'm not aware of what they actually are qualified to. It certainly is acceptable for the design basis case, and they have performed their function prior to

#12-13-SueT

the hydrogen burning. Therefore, they are not included on this list. It's not pertinent to this discussion.

Q Your tables also do not list any components of the standby loop control system or the C-41 system, do they?

A That's correct.

Q And why have you excluded those components from the list?

A Again, the -- we have not included anticipated transient without scram as an event that should be considered for degraded cores, recoverable degraded cores, because of the probability of event and also the probability of recovery of that event to consider it for this analysis.

Since it's not necessary to consider it for this analysis, the system is not necessary and don't meet the criteria that were established and, therefore, systems which should be included on this list and their criterias are also included in the hydrogen rule.

END #12

Walsh flws

Q Isn't it true that in a degraded core accident, once the control blade sheath has melted, or has otherwise been breached, that the boron carbide material therein will react quite rapidly with steam?

A That has been postulated to occur for severe cores, and things such as that. Severely degraded core.

Q Now if you were to recover a coolant injection system, wouldn't there be a possibility of injecting cold water into a core with diminished control rod worth?

A Excuse me. I guess I didn't follow that question.

Q All right. Supposing in the degraded core accident, we have substantial oxidation of the boron -- reaction steam with the boron carbide. Then you recover coolant injection system. Wouldn't there be a problem in injecting cold water into a core with diminished control rod worth?

MR. GLASSPIEGEL: I am going to object. If I understood my witness' answer, and I am not 100 percent sure I did on the last question, he testified that the hypothetical that Ms. Hiatt is proposing involves a severely degrated core. That again is well outside the scope of the issue.

JUDGE GLEASON: What is the purpose of the question?

MS. HIATT: We are determining whether or not components such as those in a standby with the control system had been improperly excluded from the equipment list, and this is a situation in which standby with the control system would be important to have operational and functional in a degraded core accident.

I want to know how far a degraded core can go before it is not recoverable is, I understand, a question of uncertainty. It is quite arbitrary to say in a severe accident with no further explaination on it.

MR. GLASSPIEGEL: That is why we have expert witnesses in hearings.

We could be here for a long time litigating severe accident rulemaking. The Commission intended that we not do that.

JUDGE GLEASON: Thank you, Mr. Glasspiegel. Objection is denied. Respond to the question.

WITNESS RICHARDSON: Could we repeat the question.

MS. HIATT: Could you possibly reread it. I am sorry.

REPORTER: It will take me a while. It is way back there.

MS. HIATT: All right.

REPORTER: Want me to read it back?

MS. HIATT: Yes.

(Reporter reads last question to witness.)

WITNESS RICHARDSON: The question started out with the premise it was a degraded core accident.

As I said, I could not answer the question in context with recovery of degraded core. It would be much beyond that point in time, and if you get much beyond that point in time , then the question asked about the reduced rod worth and whether it would be a problem or not when you inject your water back in, it would depend on how much rod worth, how much reaction, and a number of questions that have not been -- or at least I have not evaluated because it is beyond the scope of the recovery of degraded core.

Q Wouldn't it be useful in such a situation to have the standby control system operable?

MR. GLASSPIEGEL: Objection. We are not litigating whether --

JUDGE GLEASON: I think we had better get back on course here, Ms. Hiatt. Those questions go too much beyond where we are.

BY MS. HIATT: (Continuing)

Q Now, your tables list no components of the D-17 plant radiation monitoring system, is that correct?

A (Witness Richardson) That is correct.

Q Do you know why those components have been excluded?

A Because those components do not provide any direct automatic actions in the plant, and they are only provided for monitoring, and the operator is not instructed to take any action there from those monitors. Not necessary to have those monitors on equipment possibility list for evaluation for a hydrogen burn.

Q Wouldn't that give the operator some useful information on the course of an accident, even if they are not directed to consider them?

MR. GLASSPIEGEL: Objection. The witness testified that the operator doesn't use the monitor.

She is asking: Wouldn't it be useful? What does a question like that contribute to the record? He has already answered the question.

BY MS. HIATT: (Continuing)

Q Your table lists no components of the drywell containment, the M-14 systems, is that true?

A That is correct.

Q And why are those components excluded?

A They are not necessary for the hydrogen generation event.

Q Don't they perform a containment isolation function?

A There are a number of valves which perform a containment isolation function, and those components perform their function long before the hydrogen generation event, and therefore there is no need to evaluate them for the effects of hydrogen combustion.

Q Doesn't the system contain large butterfly valves with polymeric sheaths?

MR. GLASSPIEGEL: Objection. I think the witness' answers have established --

JUDGE GLEASON: Whay? Go ahead.

MR. GLASSPIEGEL: My objection is the witness has established that this particular component has no relevance whatsoever in the hydrogen event.

Further questions along this line are --

JUDGE GLEASON: I don't know why she asked this question. Go ahead, respond to it.

WITNESS RICHARDSON: I don't know the actual details of those components, because we haven't looked at them in detail since they are not on the list.

WITNESS BUZZELLI: The answer to your question is, yes.

BY MS. HIATT: (Continuing)

Q Wouldn't it be possible for high containment temperatures to degrade the polymeric sheaths on those valves?

A (Witness Richardson) I would say that I doubt it seriously, because the type of temperature that we have- evaluated for deflagrations, any component that is relatively large, the temperature response of the component does not result in that high temperatures.

Typically in the order of temperatures that most of the components qualify for.

I am not sure where those components are located exactly, but they are probably high in the containment, and therefore they would not be affected by the diffusion flame.

So, without looking at them, I couldn't say for sure, but my judgment is that they would have little effect.

Q Now, if you had thermal degradation of the valve sheet, couldn't that cause leaks?

MR. GLASSPIEGEL: Objection. We are pursuing a line of questions about --

JUDGE GLEASON: Sustained.

BY MS. HIATT: (Continuing)

Q Have you considered the potential for combustible material in containment for a drywell to be ignited by hydrogen burning?

A (Witness Richardson) That has been considered.

Q Is there any evaluation of that in your preliminary analysis?

A There is no statement that -- specific issue. There are analyses that were conducted in the preliminary evaluation to show that the temperatures that result from the Perry analysis, for the pressure and temperature response, in the Perry analysis, are predicted -- that are predicted in CLASIX results in equipment response which is less than that which was predicted and analyzed for the Grand Gulf case.

And Grand Gulf evaluated those components -- basically the same components, for the potential for secondary fires and things, and presented that to the NRC and showed that there was no potential for secondary fires.

Q Did you evaluate this potential assuming diffusion flames existed?

A Diffusion flames, thermal environment from the diffusion flames has not been defined yet. It is quite a long term program, and the capability of equipment will be evaluated after the thermal environment of diffusion flames is defined.

MS. HIATT: I have no further questions.

JUDGE GLEASON: I think this is an appropriate time to take a break.

(Short recess taken.)

MR. GLASSPIEGEL: Thank you. I am ready.

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REDIRECT EXAMINATION

BY MR. GLASSPIEGEL:

Q Mr. Alley I would like to ask you a number of questions concerning some of the testimony you gave yesterday on the structural analysis. Have O ring seals been a safety problem in your judgment for up to 300 degrees environmental conditions?

A (Witness Alley) No, it is not.

Q Why not?

A We had reviewed some of the available information on those seals. As noted earlier, they are etholene, propalene, dyamene, compound number 603 seals, made by Pethra Corporation.

The data available on those seals, as indicated in the O ring reference guide, and also as calculated by an erraneous equation, indicates that the compression set is not a factor for the temperature, range, and durations for which we are talking about for the hydrogen burn event.

End 13.
MS fols.

Sim 14-1

Q In your structural analysis have you considered mating surfaces between equipment hatch flanges and whether there will be sufficient smoothness at the surfaces to prevent any leakage?

A Yes, we have. We really manufacture drawings for those mating surfaces because of a smoothness on that mating surface of 80 micro-inches, which would be more than adequate to facilitate the leak tightness of the seals.

Q Beginning at transcript 3283, Mr. Alley, you gave testimony in response to questions from Ms. Hiatt relating to the use of mean lower bound values in some of your analyses. I believe you testified that analyses using mean and lower-bound values as contained in your final report were included primarily for informational purposes.

Would you please explain why your final report contains analyses utilizing mean and lower-bound values as well as the results of analyses using ASME service level values?

A In approximately 1981 we had a request from the NRC which stated several considerations that they wanted us to make in establishing a containment ultimate capacity. Two of those parameters were to consider as-built material strengths and to consider a lower-bound mean and upper-bound material properties.

The report was originally generated based on

Sim 14-2

those very early NRC requirements. The finally report, which addressed the NRC request to establish the structural integrity for a 45 psig and service level C limits did not delete that earlier information.

The report as it is written today provides all the information necessary that we satisfy the current rule requirements for the pressure capacities at service level C limits. However, the report does not clearly call this out as a requirement in the report itself. It is a little bit difficult to search through and find that information.

Q What are the principal differences in the analytical approaches that are used in these various analyses discussed in your report?

A The analytical approaches are essentially identical for the general shell. The main area of difference between the analyses to address the 45 psig service level C limits and the original penetration analyses were that finite element analyses were done for the final analyses to get a better prediction of their capability.

Q What differences in allowables were used in the various analyses discussed in your final report?

A The original report addressed both mean and lower-bound pressure capacities using yield as the guideline. The final report used solely the service level C limits, which for the membrane stress in the shell is also a yield limit.

For other stress components, such as the bending stresses, different allowables are permitted for those particular stress components.

Q Thank you. Mr. Alley, I think it might be helpful for the record if you were to highlight the portions of your final report, Exhibit 8-4, which set out your conclusions relating to ASME service level C allowables.

A Okay. The controlling pressure, as indicated in our preliminary evaluation report, Exhibit 8-1 was the 50 psig pressure for the penetration four one four. This value is found in our final report in Table 10, in Note No. 5 of Table 10.

The general shell allowables at service level C are provided in Table 8. These values have not been factored up to give the pressure capacity of the containment at service level C.

One of the key numbers to reference would be for the cylinder. The stress intensity shown in Table 8 currently is 21,625 psi. The allowable stress intensity at service level C is 38,000 psi. That particular stress is calculated by the simple equation for a cylinder unrestrained by stiffeners or other boundary conditions.

By merely ratioing the results up to the

Sim 14-4

allowable of 38,000 over 21,625 times the 35 psig pressure included in the table, the cylinder capacity of 79.1 psi can be easily calculated.

Q The term "KSI" was used yesterday and I believe the day before. Would you please define the term for the record?

A KSI is a unit meaning kips per square inch. A kip is equal to a thousand pounds. So 10 KSI is 10,000 pounds.

Q And for what purpose are qualifications based on kips used with respect to your analysis?

A They are used to quantify the stress.

Q Are the material properties of SA-516 rolled plate used in the containment taken in the test strength direction?

A For SA-516, Grade 70 plate, since that is a normalized plate material, it does not make any difference which direction the coupon is taken for your tensile test. The material has homogeneous properties in each direction.

Q At transcript 3286 you discuss the fact that for the temperature ranges expected to result following a hydrogen event the ASME Code provides for a reduction in stress allowables of approximately 10 percent. Would this reduction be applicable to the 50 psi controlling stress limit calculated for penetration 414 in your final

14-5

report?

A Yes, it would. However, the analysis of penetration 414 did not include the actual material strengths of that penetration.

A review of those material certs. indicates that it has an actual material strength a minimum of 30 percent higher than the minimum specified material strengths.

Q And, therefore, what is your conclusion with respect to the 10 percent value that was discussed previously?

A This actual material cert. showing it is 30 percent higher would mean we would have 30 percent greater capacity for that particular penetration.

Q Is this further evidence of the conservatism in your analysis?

A Yes, it is, and even beyond that, that additional analytical techniques could be used to demonstrate the further capability of that particular penetration.

Q Based on your interpretation of the final hydrogen rule, is the use of ---

MS. HIATT: Objection. It calls for a legal conclusion, interpretation of the rule.

MR. GLASSPIEGEL: We must interpret the rule in order to try to comply with ---

JUDGE GLEASON: We are not really going to be necessarily bound by it. So let him interpret it.

Sim 14-6

BY MR. GLASSPIEGEL:

Q Based on your interpretation of the rule, Mr. Alley, were the analytical techniques that you just discussed, are these analytical techniques consistent with the guidelines provided in the rule?

A (Witness Alley) Yes, they are.

Q Turning to the version of the final rule, the Federal Register version dated January 25, 1985, in Section 50.44 C-3 4-B and the various sub-sections thereunder, I would ask you whether you have since preparing your final report had occasion to review the final requirements set forth in that section?

A Yes, I have.

Q And based on your interpretation of the language in the rule, is your report on the analytical techniques utilized in your report fully consistent with the guidelines set forth in the rule?

A Yes, it is.

Q I want to show you a copy of the section and ask you if you could to just track through the section and comment upon the extent to which your report follows the guidelines set forth in subsection B of 50.44 C-3 4-B?

(Pause.)

The first sentence in subsection B of 50.44 C-3-4 states that "Containment structural integrity must

Sim 14-7

be demonstrated by use of an analytical technique that is accepted by the NRC staff."

Was your report consistent with this requirement?

A Yes, it was.

Q The subsection reads further "This demonstration must include sufficient supporting justification to show that the technique describes the containment response to the structural loads involved."

Do the techniques that you have utilized in your final report adequately describe the containment response to the structural loads involved?

A Yes, it does.

Q The subsection further states that "This method could include the use of actual material properties with suitable margins to account for uncertainties in modeling, in material properties, in construction tolerances, and so on."

To what extent have you used actual material properties with suitable margins in your analysis, Mr. Alley?

A We have only used actual material certs. currently in one case for the service level C limits established in our report.

Q Did the use of those material properties

Sim 14-8

include suitable margins?

A Yes, they did.

Q The rule further states that another method could include a showing of the following specific criteria of the ASME boiler and pressure vessel code are met, and the rule sets forth a number of criteria thereunder. Could you state for the record which of those criteria are applicable to your final report?

A We have established that the containment vessel and all key components meet the service level C requirements of the ASME code.

Q And was this based on a consideration of pressure and dead weight alone?

A Yes, it was.

Q Using actual material properties and taking into account the temperatures expected following a hydrogen event, do any parts of the containment, other than the limiting penetration 4i4, have a stress limit below 15 psi?

A No, I do not believe so.

Q There was discussion in OCRE Exhibit 13 of the Aptech review yesterday. I want to ask you whether the Aptech review, to your knowledge, considered the temperatures expected following a hydrogen event?

A No, it did not.

Q Would the conclusions in the Aptech report

Sim 14-9

be affected by considerations of the elevated temperatures expected following a hydrogen event?

A No, they would not, and I would like to read you, if I may, two references out of that report.

On page 2-5 of OCRE Exhibit No. 13 it states "The temperature dependence of touchness properties means that at ambient or higher temperatures both SA-516 steel and E-7018 weld metal are above their lower shelf values on a fracture energy versus temperature curve. This, in turn, implies that the use of standard elastic fracture mechanics will be conservative."

A second reference, which is on page 5-5, of the same report states "The test temperature used to evaluate K sub IC, which is the fracture toughness, is minus 20 degrees F, whereas a higher temperature during operation will result in correspondingly higher toughness."

My conclusion is that the analysis is in fact conservative and were you to use higher temperatures, the results would even be more favorable.

JUDGE GLEASON: Which analysis?

WITNESS ALLEY: The Aptech fracture fatigue analysis.

BY MR. GLASSPIEGEL:

Q There were some references that you gave in response to Ms. Hiatt's questions when we were talking

Sim 14-10

about the Aptech report and your report and in some cases you referred to our review.

In the context of the Aptech study it might be helpful to clarify for the record what the relationship was between Gilbert and Aptech.

A Gilbert/Commonwealth hired Aptech Engineering Services, who are specialists in the area of fracture fatigue analyses to evaluate the defects in these weld joints to demonstrate their acceptability to the operation of the plant for the 40-year life of the plant.

Q When the Aptech report was complete did you review that report?

A We did review that report.

Q Were you satisfied with the conclusions in the report?

A Yes, we were.

Q In testimony on Tuesday at transcript 3306 you referred to "postulated hydrogen burn pressures at 50 psi." Would you care to clarify that reference?

A Yes. I inadvertently said postulated hydrogen burn pressures of 50. I should have been referring to the 21 psi that was postulated. The 50 is the limiting containment pressure capacity for penetration 414.

Q To you knowledge, did the Aptech report, OCRE Exhibit 13, in Table 3-1 take credit for the concrete in

Sim 14-11

the Perry containment annulous?

A No, it did not. Again, stresses were conservatively calculated to ensure the conservatism of the report.

Q At transcript 3314 you testified that the potentially rejectable weld defects referred to in the Aptech report are in the area that is backed by annulous concrete. Would you care to clarify your answer to that question?

A Yes, I would.

JUDGE GLEASON: This is strange kind of redirect, some of your question, Mr. Glasspiegel. Your redirect is supposed to be talking about new facts developed in cross-examination. You are supposed to rehabilitate the witness as far as impeachment is concerned and, you know, you are just using this as a method of getting new testimony and you know that is improper.

MR. GLASSPIEGEL: The question referred to testimony in response to Ms. Hiatt's questions at transcript 3314, and I wanted to address the testimony that was given in response to Ms. Hiatt's questions.

JUDGE GLEASON: That is not the way I heard it. You referred to testimony again and you asked him to amplify his testimony.

Sim 14-12

MR. GLASSPIEGEL: Well, on that particular one is was more in the way of a clarification of the testimony or a correction of the testimony.

JUDGE GLEASON: That is what I am saying. I just think redirect is not supposed to be used for that purpose. You know, we went through a whole series of questions which I didn't say anything to, and of course you have got to be held to a higher standard than of course the intervenor.

You talked about the rule and I let you go through all that thing and it was merely putting in new testimony. That is rebuttal inforamtion. It is not redirect information.

MR. GLASSPIEGEL: The purpose of my examination is to attempt to clarify the record. On the rule, the problem I had with Ms. Hiatt's cross-examination for a day and a half was many of the questions fell outside the rule as we interpret it.

Now I thought it would be helpful for the record to clarify which portions of the structural analysis ---

JUDGE GLEASON: All I am saying to you is I think that is refutational type of material and it should be put in with rebuttal testimony so we keep the record straight.

Sim 14-13

MR. GLASSPIEGEL: Well, as I ask my questions I will pause and see if you consider them to be appropriate.

JUDGE GLEASON: Well, I don't really like to proceed that way. All I am doing is pointing out to you to keep redirect in the redirect area.

BY MR. GLASSPIEGEL:

Q At transcript 3345, Mr. Alley, Ms. Hiatt asked about different stress levels. I frankly don't recall, but Mr. Silberg believes that I didn't get an answer to the last question. I don't know whether you want to permit an answer.

JUDGE GLEASON: I don't want to permit it.

MR. GLASSPIEGEL: All right, fine. I will move on.

BY MR. GLASSPIEGEL:

Q At transcript 3345, Ms. Hiatt asked, Mr. Alley, about different stress levels due to differences between as-built dimensions of the containment vessel and the values called for in the specification. Ms. Hiatt asked you to compare the ideal circumferential stress for element No. 88, a 5.886 KSI to the as-built calculation of 7.103 KSI.

You stated that the difference was a little more than 1 KSI, which is about 20 percent. What is the effect of the 20 percent increase in calculated stress levels due to as-built conditions?

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A In that non-conformance report Newport News had summarized in the conclusions of that report on page 6 of Attachment 6 that NCR 17-426 that the largest increase in the circumferential stress, which was a bending stress, was approximately 4.37 percent.

In the vertical direction the increase in vertical bending stress was approximately 9 percent.

I would like to clarify that the shell capacity in the cylindrical shell region is only marginally affected by those slight increases in stress caused by the as-built conditions. The pressure capacity in the cylindrical shell region is about 79 KSI. Even if you very conservatively assume that that stress was proportionately reduced, you would still have a pressure capacity well above the 50 psi minimum for the controlling penetration.

Q You were asked a number of questions by Ms. Hiatt about the dome region and the buckling analysis. Why is the dome region a limiting region with respect to buckling?

A The dome region is limited with respect to buckling, it is the only area of the containment vessel which is affected by buckling for an internal pressure. The pressure capacity of the dome in that region is about 78 psi.

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Q What is the pressure capacity for the cylindrical region about which you were asked?

A (Witness Alley) About 79 psi.

Q At Transcript 3350, you stated that the methodology used in your ultimate capacity report was to analyze the shell first and then separately analyze the penetrations including a large segment of the shell.

Is this technique the standard method of analysis?

A Yes, it is.

Q At Transcript 3361, there was a discussion on different yield criteria.

Did your analyses use the maximum shear stress yield criteria as provided for in the ASME code?

A Yes, it did.

Q At Transcript 3361, you stated that you would expect to see displacements on the order of one-half inch for penetrations.

Would you expect a one-half inch displacement to cause leakage or loss of structural integrity?

A No, I would not. The stresses are well within the elastic range and that's a small displacement for the geometry of the structure involved.

Q You were asked at Transcript 3400 about whether finite element analysis provides upper bounds on buckling loads. And I believe you were unsure of this question at that

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time. Have you considered the question since then?

Are you now able to answer the question?

A Yes. We have considered it some more. We do believe that nonlinear finite element analyses used to evaluate buckling would provide upper bounds on the buckling loads.

However, Gilbert Commonwealth did not use finite element analyses to predict buckling capacities to analyze ultimate capacities of the containment vessel.

Q In those areas where you did use finite element analyses, is it your professional opinion that the use of that technique was consistent with accepted standards of structural analysis?

A Yes, it is.

Q At Transcript 3411, you were asked by Ms. Hiatt whether there was a lower factor of safety at 50 psi than at 15 psi, using service level C limits.

I would like you to clarify whether there is a different factor of safety for the 50 psig stress capacity limit calculated in your report as compared with a factor of safety for the 15 psig design limit.

A No, there isn't. For the 15 psig design basis, there are additional loads which must be included in calculating the stress.

Some of these load combinations use both service level C and service level D limits of the code, and as permitted by the NRC. The new hydrogen rule requires the use of the service level C limits; therefore, there is no reduction in the factor of safety.

Q Ms. Buzzelli, I have a couple of redirect questions for you. At Transcript 3264 and adjoining pages, you were asked about a November 15, 1984 meeting that was held with the Staff, and there was a discussion of offsite dose values.

I would like you to describe in greater detail the meeting that occurred.

A (Witness Buzzelli) The meeting between CEI representatives and NRC Staff was a meeting to discuss containment system issues, and related to pool dynamic loads as well as 10 CFR of Appendix J, containment testing.

In that meeting, proposed increase to bypass leakage, and very preliminary offsite dose estimates were discussed. The tables that we presented were for bounding estimates to characterize the changes to the input parameters and the offsite dose calculations.

Q Has subsequent work been performed in light of the offsite dose analyses that were the subject of that meeting?

A Yes. Additional calculations have been made. They have been performed in accordance with the NRC requirements and in accordance with the Regulatory Guides.

And the preliminary results relative to the numbers

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identified in the November 15th meeting, specifically the 299.6 rem thyroid dose at the exclusion boundary, present results factoring in -- taking into account the assumptions for the NRC re~uirements show that dose value to be less than 200, more on the order of 170 rem.

This is based on taking into account accident meteorology, using seven year data as well as factoring in the iodine removal. When you factor containment sprays into account, a similar reduction in the low population zone dose values would be expected.

Q Are there any other differences between the current work that is being performed and the values presented in that November 15, 1984 meeting?

A No. All of the other parameters are as identified.

Q In your judgment, are the current dose values that have been calculated conservative?

A Yes. The current results that have not been finalized in the FSAR are conservative because of the conservatisms inherent in the NRC requirements, such as extending the maximum leakage for a full thirty day duration of the event, using the fifth percentile meteorology values, using -- taking no credit for pool scrubbing, and a number of other conservatisms.

Q How much of an overestimate of the doses does this represent, the actual doses would this represent, in your

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judgment?

A An exact number -- I don't have an exact number, together all of these parameters and others would be at less an order of magnitude or greater.

Q And is it your conclusion that the current leakage in offsite dose limits being considered provide significant margins over the expected values?

A That is correct.

Q Mr. Holtzclaw, I would like to ask you a number of questions about some of the exhibits that Ms. Hiatt referred to over the last two days.

OCRE Exhibit 12 has been introduced and it relates to your testimony concerning the likelihood of degraded cores or severe accidents.

Please provide some background on why the Exhibit 12 letter was sent to GE.

A (Witness Holtzclaw) The Nuclear Regulatory Commission has a proposed policy regarding severe accidents. It requires an application for a future standard plant design, such as the GESSAR II design, to comply with requirements of 10 CFR 50.34(f), which has been commonly referred to as the construction permit manufacturing license, or CP/ML rule.

Paragraph 1(i) of the CP/ML rule requires the applicant to assess improvements in the plant design that have potential for significant risk reduction and are practical but do not impose an excessive economic impact on the plant.

I might point out that Perry does not involve an application for future standard plant design.

The April 13th NRC letter, OCRE Exhibit 12, was sent to GE, to aid GE in assessment of a number of potential design improvements in accordance with the Paragraph 1(i) of the CP/ML rule.

Q Does the evaluation of these proposed design improvements identified in the exhibit, in your view, reflect a perception of the level of safety as indicated by the likelihood of degraded core accidents for the Perry BWR-6 MARK III design?

A No, because the rule requires, as I said, that an applicant for a future standard plant design perform these evaluations of proposed design improvements irrespective of the likelihood of degraded core or severe accidents for the design that is undergoing review.

As I also indicated, Perry does not involve an application for a future standard plant design.

Q Based on your knowledge of the discussions between GE and the NRC, has the NRC suggested the design improvements listed in OCRE Exhibit 12 because the NRC disagrees with the likelihood of degraded core or severe accidents is extremely remote?

A No. The NRC has not suggested that these design --

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or has not suggested these design improvements because they do not agree with the low likelihood of degraded core or severe accidents.

As noted in my testimony, an independent review by the NRC Staff and its contractors resulted in a core damage frequency value of approximately two times ten to the minus fifth per reactor year, which supports the conclusion that core damage events which lead to significant quantities of hydrogen generation are very low in likelihood.

Q Did GE's assessment of the suggested improvements identify any need for these improvements?

A No, it did not. In fact, many of the suggested improvements had already been incorporated in the BWR-6 MARK III design prior to the April 13th, 1984 NRC letter.

For example, the NRC letter included a number of design modifications such as the post-Three Mile Island accident modifications covered in NUREG 0737 that had been incorporated into the design.

GE's evaluation of those items that were not already included in the design indicated that none provided significant risk reduction and none could be incorporated into the plant design without excessive impact.

In NUREG 0979, Supplement Number 2, which is the NRC Safety Evaluation Report related to the final design approval of the GESSAR II BWR-6, Nuclear Island Design, dated

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November 1984, the Staff states, and I quote: "On the basis of the results of current Staff analyses using currently available methodology, the Staff believes that very costly preventive or mitigative plant design modifications to the GESSAR II design cannot be justified on a risk reduction basis."

Q Ms. Hiatt asked you a number of questions about NUREG CP-0038 at Transcript 3286 and adjoining pages. And I believe you testified that you were not intimately familiar with the paper that was included among the papers in that proceeding.

The paper was by General Electric, and it was entitled "Assessment of Hydrogen Combustion Effects in a BWR-6 MARK III Standard Plant."

Have you now had the opportunity to become familiar with that paper?

A Yes, I have.

Q What was the purpose and the scope of the study discussed in the paper?

A As stated in the abstract on Page 266 of NUREG CP-0038, the study was performed as part of the GESSAR II probabilistic risk assessment. As part of the PRA, it considered the full range of possible hydrogen phenomena regardless of how improbable they might be. The report discussed the GE consideration of potential hydrogen combustion effects on the

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st/ndard plant MARK III containment during postulated severe accident sequences, which were assumed to progress directly to full core melt.

It should be noted that at the time the analysis was performed, the GESSAR II design did not incorporate a hydrogen igniter system which would have controlled the combustion of hydrogen as it evolves. Therefore, the study dealt with uncontrolled combustion of hydrogen during postulated severe accidents which are allowed to progress to full core melt.

Q Mr. Holtzclaw, let me show you a page from the transcript of the April 30th proceedings in which one of the witnesses read into the record a paragraph from that paper.

(Mr. Glasspiegel is showing the witness the transcript.)

What is the applicability of the information given in that paragraph that Ms. Hiatt asked to be read into the record? It starts at Transcript 3287, Line 16, for the record.

A The information provided in Transcript 3287, Line 16, is not applicable to the Perry Plant preliminary evaluation of hydrogen control for two principal reasons.

The first is that that paragraph assumed non-recoverable 4 core melt sequences and, therefore, the hydrogen

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release history is substantially different than that for a recoverable sequence.

Secondly, as I stated in response to a previous question, there was no distributed ignition system utilized in the design which would control the combustion of hydrogen as it evolved. In fact, the design assumed no system for controlling large quantities of hydrogen.

Therefore, based on these twc reasons, the temperatures, heat fluxes and burn characteristics were not representative of those expected for a recoverable event.

Q Mr. Holtzclaw, there was some testimony given during the cross-examination today regarding the role of net positive suction head NPSH, as related to suppression pool cooling.

Is it true that in the BWR-6 design the LPCI, L-P-C-I, LPSC, L-P-S-C, and HPCS, H-P-C-S, pumps are designed for adequate NPSH with maximum flow and thermally saturated pool temperatures? That is, 212 degrees Fahrenheit at atmospheric pressure?

A Yes, that's true.

Q And is it true that GE has performed analyses for events well beyond the design basis with no suppression pool cooling and has shown that the BWR-6 RHR pumps, which perform the containment spray and LPCI functions, will continue to operate at pool suction temperatures of at least 250 degrees

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Fahrenheit?

A Yes, sir. That has been shown.

Q Mr. Richardson and Ms. Buzzelli, there was some discussion today about OCRE Exhibit Number 16, the location of igniters.

And I would like to ask either of you one or two questions about that document and its applicability to your preliminary analysis.

If one were comparing the information in OCRE Exhibit Number 16 with corresponding information contained in Applicants' Exhibit 8-1, the preliminary evaluation, and if, with respect to any particular igniter, the information in the two documents indicated that there was for the same igniter the same elevation, the same azimuth, and the same center lines given for that particular igniter, would it necessarily be true that the final location of the igniter in the plant would be the same?

A (Witness Buzzelli) No, it would not necessarily be true. The same elevation and the same azimuth, the same distance from the center line, that information as reflected in OCRE Exhibit 16 was preliminary information.

The as-built information contained in the preliminary evaluation did allow for installation tolerances in accordance with the spacing criteria that was defined and is established in the preliminary evaluation. So, it would not be a one-to-one correspondence between the proposed location and the final as-built locations because of construction and installation tolerances.

Q And I believe Ms. Hiatt, in referring to OCRE Exhibit Number 16, pointed to the column of the document entitled "Location Description," and I want to ask you with respect to the location descriptions that are given in the exhibit whether those descriptions were intended for, or are in fact, precise descriptions of the locations of the igniters with respect to any adjacent structures in particular?

A That description was not intended to be a precise description of the adjacent structures relative to the igniter.

It was intended to be a qualitative reference. For example, it may have said HCU floor, and that igniter would have -- could have been above the HCU floor or below the HCU floor, and that was not specifically called out. In addition, when it said room ceiling, for instance, an igniter would not necessarily be at the ceiling. It could be at a location high on the wall and near that ceiling.

There was no intention of representing exactly the adjacent structures with that written description in the column of the preliminary list.

Q Ms. Hiatt asked a number of questions today about the possibility that there might be a need to vent or purge the containment. I want to ask the panel what the likelihood

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would be in your judgement that there would be a need to vent or purge the containment in the event of a hydrogen generation event such as that that you have analyzed in the preliminary analysis?

A (Witness Richardson) The probability of such a venting during a hydrogen generation event would be very low.

Q Ms. Hiatt also asked some questions about a station blackout scenario. With respect to potential station blackout, Mr. Richardson, at what point would you expect significant quantities of hydrogen to first get generated?

A Well, the events that we have analyzed consider hydrogen generation in the early part of the event, and for station blackout event is the reactor core isolation cooling system which would still be operable and would maintain coolant makeup.

As long as coolant -- as long as there is coolant makeup and water level is maintained there is no hydrogen generation.

Now, the evaluation is conducted on this plant to show that the reactor core isolation cooling system has the capability to maintain core makeup in a station blackout event to at least nine hours. And it makes it more of a long term containing heat removal event as opposed to a hydrogen generation event, as we have analyzed it.

Q During this nine hour period, what things can be

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done to restore or maintain containment cooling?

A Well, there is one point that most risk studies do not consider, the things that can be done during this time period, in that the operators have a lot of time over nine hours to provide additional sources of makeup into the vessel which might not normally be lined up.

For instance, they can provide ways of getting water either into the vessel, or into the containment, by using the diesel driven fire pumps. There are a number of ways that can be used to get additional makeup into the vessel or the containment for decay heat removal.

And in nine hours, you can do a considerable number of things, and you have plenty of time to restore power even.

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Q Is suppression pool temperature, by which you were asked by Ms. Hiatt today, a relevant consideration for a hydrogen generation event?

A No. The questions that were asked previously by Ms. Hiatt have to do with the design basis calculations for suppression pool, and the peaks varies after a long period of time after the initiation of design basis event on the order of like four hours or so, and as you can see in the preliminary evaluation most of the hydrogen burning is occurring early in the first one or two hours, and it would be an insignificant effect on suppression pool.

Q Thank you. I believe Ms. Hiatt asked the panel today about the draft emergency procedure guidelines, and what draft instructions are in those guidelines for the operator.

Do the draft emergency procedure guidelines instruct an operator to actuate sprays at high, high temperature regardless of core temperature?

A No.

Q Would there be a situation in which the -- under the emergency procedure guideline draft instructions, -- sprays would be actuated by the operator on temperature irrespective of core cooling?

A There is no step in the guidelines for actuating the sprays based on containment temperature, irrespective of core cooling.

Q Are the sprays in the PNPP containment redundant, and do they meet all NRC requirements and single failure criteria?

A Yes.

Q What assures maintenance of the containment integrity if the operator follows the emergency procedure guidelines in the areas of my questions?

A Well, there are other steps in the guidelines which the operator would take to assure that containment integrity is maintained, and there are anumber of steps throughout the guideline.

Q What systems are required for heat removal following a hydrogen event?

A RHR System is a system designed to meet long term decay heat removal. There are two RHR systems that remove long term decay heat removal, RHR-A and RHR-B.

Q And how do you know that these systems will survive the hydrogen event, and assure safe shutdown?

A The components -- pressure pool cooling, for instance, are all located -- all the active components are located outside the containment.

Q Ms. Hiatt asked a number of questions today about the impact of local suppression pool temperatures. What is the impact of local suppression pool temperatures. Elevated temperatures following a hydrogen event?

A Localized elevated temperatures in a suppression pool have really no effect on hydrogen generation event.

Q And why not?

A Because, as I said before, the temperature of the suppression pool has not increased to the types -- considerations Ms. Hiatt was mentioning this morning during the time that we have considered hydrogen burning.

Q If you only have the containment sprays available hypothetically, and no additional pool cooling, will the operators at the Perry Plant still be able to ensure long term decay heat removal?

A Yes.

Q Why is that?

A As I said, in the testimony previously, the RHR system, even in the spray mode, goes through the RHR heat exchanges, so the heat would be removed to the heat exchanger and would be sprayed into the containment.

So, you would have long term decay heat removal irrespective of whether it was in cooling mode or in the spray mode.

Q Mr. Richardson, Ms. Hiatt asked you today -- and I can't quote her words exactly -- but I believe she asked you whether Mr. Humphrey's work was valid. And you replied yes to that. How were you interpreting the phrase, 'valid,' in that context?

A My interpretation of the phrase, 'valid' were some of his engineering calculations and analyses valid, and I would have to say that some of his calculations which were just straight forward, simple calculations -- simplified calculations were valid.

However, the conclusions reached were certainly not valid. Those issues were, as I said this morning, were reviewed by Mississippi Power and Light and other Mark-3 utilities, and the NRC and several presentations were made before the Advisory Committee for Reactor Safeguards on those issues, and I think the conclusion was that they were all second or third order effects and not significant from the safety standpoint.

Q With respect to the paragraph that Ms. Hiatt asked you to read into the record today, were the issues discussed in that paragraph issues associated with design basis accident or were they issues associated with hydrogen generation conditions?

A They were associated with design basis considerations and design basis calculations. The effects are even minimal for design basis considerations, yet alone hydrogen generation.

Q Doctor Lewis, Ms. Hiatt asked you today a number of questions about ionizing radicals -- ionized radicals, and I want to ask you a followup question to that.

Based on your review of the PNPP hydrogen control system, how that system would operate, what is your judgment as to whether the ionizing radiation level that would be expected following a hydrogen event would create enough radicals to cause detonations?

A (Witness Lewis) It would be much too low.

REPORTER: Judge, may I ask the witness to please speak up. I didn't hear you well, sir.

WITNESS LEWIS: The ionizing radicals would be much too low for generating a detonation.

The radicals would not -- it they were in high concentration would not be effected by virtue of their being ionized, but by virtue of their being radicals.

Q Thank you. Have the NPSH curves been reviewed for the Perry ECCS pumps?

A (Witness Richardson) Yes, they have.

Q Will the, 'caution,' which was discussed in answers to Ms. Hiatt's questions earlier today apply to the Perry Plant?

A No. There is no need to include that caution in the Perry emergency procedures, because the calculation shows that the NPSH would be adequate for the worse case expected condition.

Q Ms. Buzzelli, do you know what the tech spec limit is for drywell bypass leakage in terms of A over square root K?

A (Witness Buzzelli) The tech spec limit in terms of A over square root K, is .168. Earlier today -- and I would like to clarify -- the table in the preliminary evaluation that was referenced, that value represents the tech spec value for drywell bypass leakage, not the design allowable value.

Q Does this fact change any of the conclusions in the report about the ability of the Perry containment to handle drywell bypass leakage?

A No, it does not.

Q Doctor Lewis, Ms. Hiatt asked you about certain experiments by Dr. Lee's earlier today, and I believe she cited some statistics to you about eight percent hydrogen and a flame speed of 20 m per second.

Do you have knowledge about the specific conditions of Dr. Lee's experiments and whether those conditions are applicable to the Perry hydrogen analysis?

A (Witness Lewis) Yes. His experimental conditions were quite different from the conditions which prevail -- that exists for determining a value of five feet per second.

He had all of his openings -- he has all of his openings through which a sonic jet of flaming gas would pass, and an apparent large propogation rate. This did not actually exist by basic calulations.

Q And what is the applicability of those conditions and those findings to the Perry hydrogen analysis?

A None whatsoever.

Q Why not?

A We don't have that kind of a condition at all. We don't have openings in baffels through which a flame could be propogated at sonic velocities.

Q Dr. Lewis, based on your review of the Perry Plant and of the hydrogen analysis, are there any conditions under which you could get direct detonation following a hydrogen event?

A In an open space, the only way you can get direct initiation of detonation is by using high explosive charges. And we have no such initiating charge. We only have thermal igniters, such as the hatch stobs and the glow plug itself.

Q Can you get detonation by acceleration from deflagration at Perry following a hydrogen event?

A Not with thermal igniters under the Perry conditions.

Q Dr. Lewis, Ms. Hiatt asked you about a paper from the Fifth Symposium discussing ionizing radiation. Does that paper have any relevance or impact on your analysis of the ability of the igniters to function following a hydrogen event?

A No, not at all.

Q Why not?

A They don't relate to ignition problems. They only relate to flame propogation rates as affected by ionizing radiation.

Q Ms. Buzzelli, Ms. Hiatt asked you to read sentences, and portions of sentences into the record today. And specifically, her question related to pages 6.2-22 and 6.2-23 of the PNPP Final Safety Analysis Report.

I believe that she asked you to stop reading in the middle of a sentence, so I would like to let you complete that sentence, and perhaps you could reread the section, because there is only a few sentences before it, and if you have any comments to make about the portions of the paragraph that Ms. Hiatt did not let you read, please make them at this time.

A (Witness Buzzelli) I am reading from Section 6.2.1.1.4.1, evaluation of drywell negative differential pressure.

Following the blowdown phase of a LOCA, air intitially contained in the drywell has been purged to containment and the drywell is full of steam. During this period the ECCS is injecting cooling water from the suppression pool into the reactor pressure vessel.

When the reactor pressure vessel is flooded to a level of the break, water begins spilling into the drywell condensing the steam and causing rapid depressurization of the drywell.

A bounding calculation of the peak drywell negative pressure differential is based upon the following conservative assumption: All air has been purged out of the drywell. So, vacuum breakers do not open, the suppression pool is at peak short term post-blowdown temperature, as determined from Figure 6212, containment is at the suppression pool temperature and 100 percent relative to humidity. Steam in the drywell is cooled to the suppression pool temperature.

The point I would like to make with respect to reading this section, this is a design basis accident, CA LOCA, large break.

We were referring to a small break, small break in the preliminary evaluation when we were comparing and assessing the conditions from the various tables. This is a bounding calculation in the FSAR, with some very conservative assumptions.

Drywell vacuum breakers, we have redundant drywell vacuum breakers. Both are assumed to fail. A number of other very conservative assumptions here.

Do you have anything to add?

A (Witness Richardson) Just that this calculation is done in a --

JUDGE GLEASON: You are questioning one witness, I believe.

MR. GLASSPIEGEL: I thought I gave them as questions to the panel, but you are right, I did ask Ms. Buzzelli. If Mr. Richardson has something to add, I would like him to have the opportunity.

WITNESS RICHARDSON: That analysis is done in a worse case manner. The worse that could exist in order to maximize the potential loading from the water from that event, and it does that, and the plant is designed to accommodate the loadings which may occur from such a worse case situation.

Q All right. Dr. Fuls, earlier today there was a discussion about a computer listing that was handed to you by Ms. Hiatt. I would like to ask you whether that listing or any of the discussion that took place earlier today causes you to question in any respect the analysis and conclusions set forth with respect to your analysis of the Perry hydrogen combustion event?

A (Witness Fuls) No. It doesn't make me change any of my conclusions.

Q Why not?

A The -- there is an apparent misunderstanding of what that represented.

The results of the program has been reviewed and qualified. They are in a QA program, and so that all of the results from the March analysis were appropriately used in the analysis.

End 16.
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Sim 17-1

Q Ms. Hiatt asked you questions, Dr. Fuls, about the HECTOR Code earlier today. Does the fact that the HECTOR Code came up with higher temperatures suggest that your analysis, which did not use the HECTOR Code, was in any way less conservative than the HECTOR Code analysis?

A (Witness Fuls) Not in my opinion. Extensive verification of the CLASIXS 3 program has been done and extensive hand calculations have been performed to demonstrate that the equations developed were appropriately incorporated in the program. Numerous test comparisons have been made with Fenwal tests and others, the latest being some of the tests from the NTS, the Nevada Test Station in a large diameter sphere, and in only one case were the predicted pressures of the same magnitude of the test results. In all other cases the pressures predicted by CLASIXS were conservatively high and the temperatures were all consistently conservative relative to the test data.

Q Ms. Hiatt asked you about one of the assumptions in your analysis, namely the assumption that sheet flow would be about half as effective as sprays. Do you believe that your assumption was a reasonable one and, if so, please explain why.

A Yes. I think it is reasonable in that the accumulation of the spray on floor surfaces running off into, down into the annular area as well as from equipment would

Sim 17-2

form curtains around and off the floors. When combustion would occur in the wetwell, the expanding gases must expand outward and propagate up into the containment and thus entraining the sheet flow and intimately mixing with it and it should be a very good suppression mechanism.

Q Mr. Richardson, Ms. Hiatt asked you today about the release rates that were used in the 20th scale testing, and I believe you testified that those are not reasonable release rates to use for a 75 percent metal water reaction.

Please explain the basis for that testimony.

A (Witness Richardson) Those release rates were based on some other work that was done based on release rates from the MARCH Code which were known to be conservatively high and for excessive durations.

Later work that was conducted by the Owners Group using the BWR Heatup Code, which is a more accurate code for predicting release rates during a degraded core, a recoverable core shows that the release rates would be lower and of shorter duration. There might be some short spikes which are in that same order of magnitude, as the release rates tested in the "20th scale," but they are of relatively short duration.

The basis for that is, as I stated earlier, that if you are going to try to sustain -- well, you can't sustain a high release rate, a high hydrogen release rate because the oxidation reaction gives off so much energy that it rapidly puts the core into a severely melted core and this anlaysis and testing is supposed to be for a recoverable degraded core which would therefore not be a high release rate of long duration.

Q Ms. Hiatt also asked today about the effects of expected diffusion flames on the polymeric seals used in the Perry drywell equipment hatch and lower personnel airlock hatches, and I believe there was testimony by one of the witnesses that it was that witness' judgment that the seals would be able to survive the expected temperatures from diffusion flame burning.

Please give the basis for that judgement.

A There are several factors. One is the previous equipment survivability analysis that has been conducted for deflagrations shows that those seals do not reach a relatively high temperature and there is a lot of margin between the temperature that results from hydrogen burning and the temperatures that they are qualified for. That is because they are next to a large mass of metal and there is a tremendous amount of heat sink. So they are typically not a limiting component.

In addition, for instance, the equipment hatch, the ceiling material that was mentioned is between the flange materials, which is essentially outside or on the

Sim 17-4

outside of the containment structure and would not be exposed directly to the hydrogen burning environment, but would require heat transfer through the metal and therefore would not be expected to reach high temperatures.

Additionally, the personnel hatch has two doors, an inboard and an outboard, and only the inboard would really see the possible high temperatures from the hydrogen combustion.

Q Ms. Hiatt also asked earlier today about whether actual components were planned to be used in the quarter scale test, and the testimony was that there is no present attempt to use actual components. Why not?

A Because the quarter scale test is a scale test and it was developed that way because we wanted to get -- as Mr. Karlovitz testified this morning, there were other issues that the Owners Group wanted to assure were accounted for in order to take account for the full geometry of the containment and, therefore, in order to take account for the full geometry of the containment and resolve all issues and therefore be conservative, you had to go through a quarter scale since you couldn't build a full-scale containment to do the testing.

With a scale test facility you can't really scale equipment and put it into the facility. You are not able to do that. If you put actual equipment in there it would not be appropriate since you have got a scaled facility with large size equipment.

Therefore, the program that we have laid out, which is a very comprehensive one, is to put a component in there and not really a real component, but a piece of material which is of complex geometry and made of material similar to the components that would be in the plant and instrument it to a high degree and evaluate its response and compare that using the same analytic techniques that will be used for the actual equipment based on the thermal environment in the quarter scale, and this in effect will validate the methodology that is going to be used, which is certainly an appropropriate technique used in many other instances throughout the industry.

. With respect to Ms. Hiatt's questions about the NRC's comments on the BWR Heatup Code, has HCOG and CEI considered or are they in the process of considering the additional conservatisms identified by the NRC?

A The areas that have been under discussion have been evaluated -- well there are ongoing evaluations of those areas, some of which have been completed and there have been sensitivity studies conducted based on those issues, and to date none of those show any significant change in the hydrogen release rates based on sensitivity studies accounting for those issues.

Sim 17-6

MR. GLASSPIEGEL: Mr. Chairman, I may be done. I would appreciate a five-minute break to consult with counsel and the witnesses.

JUDGE GLEASON: All right. We will take five minutes.

(Recess taken.)

JUDGE GLEASON: Come to order, please.

May I ask how many more questions you have?

MR. GLASSPIEGEL: I was just asking my co-counsel here.

(Pause.)

About five more questions.

JUDGE GLEASON: Proceed.

REDIRECT EXAMINATION (Resumed)

BY MR. GLASSPIEGEL:

Q Mr. Richardson and Dr. Lewis, Ms Hiatt asked a number of questions about the Nevada Test Site results, and I believe in one context she cited a test result in which the igniters did not ignite at low concentrations, and I believe the concentration used was around six percent.

Taking low concentration as a concentration of about six percent hydrogen and based on your review of the Perry situation and the possibility of a hydrogen event, would you expect any conditions in which the Perry igniters would not ignite at such low concentrations?

Sim 17-7

A (Witness Richardson) No. The conditions that were existent for those tests, first of all, there were several tests that were conducted at low concentrations where the hydrogen did ignite on the order of as low as 5.2 percent if I remember corrctly. There were several other tests conducted at 6 and 7 percent where the hydrogen did ignite

The igniter for the test Ms. Hiatt was referring to was a single igniter that was very high in the -- right at the very top of this volume, and the conditions were such that it just would not allow a hydrogen ignition because of the way it was physically located and we would expect that to really be applicable to the number of igniters we have in the Perry containment.

A (Witness Lewis) Let me just add one thing. Hundreds of ignition tests were carried out by Fenwal, Incorporated with a whole variety of compositions, including many of them down to five percent, and there never was one that failed to ignite leading me to believe that the igniters are highly reliant.

A (Witness Richardson) I might just add that the only place in the containment that even comes close to that exact physical arrangement is right at the very top of the dome where there are two igniters up there, and it is really not important because there are a hundred other igniters distributed throughout that will ignite the hydrogen.

Sim 17-8

The reference was made and it sounded like there were other types of igniters that had to be used to get this ignition, and what it was was the reference was really to igniters in other locations that were used. There were several igniters in the test facility, but not all were turned on during any particular test. Usually it was one igniter at one location.

Q Dr. Fuls, would all the hydrogen in a postulated hydrogen event bypass the suppression pool if the drywell leakage is at the allowable tech spec rate?

A (Witness Fuls) The allowable tech spec rate of leakage from the drywell is of the same order of magnitude as the compressors in the combustible gas controlled sytem. And when you consider the accident and releases from the reactor vessel, there are hugh volumes of steam and hydrogen being released at the same time. So that the vast majority of this release must go through the vents in the suppression pool and only a small fraction, because of the mixing effect, will go out through the bypass leakage.

Q Mr. Holtzclaw, have you assessed the potential for hydrogen bypass through the drywell?

A (Witenss Holtzclaw) GE has done some parametric calculations to determine the flow of hydrogen through the SRV's or the horizontal vents and bypass during a small break LOCA assuming a bypass equivalent of .168 A over the square root of K per square foot.

Under the expected conditions of hydrogen gas generation rate, steam flow and reactor pressure for this event, only a small fraction of hydrogen, about 14 to 19 percent of that total generated would exit through the postulated bypass I guess which is consistent with what Dr. Fuls was just talking about.

In other words, the bulk would go through the vents or the SRV pathway. From these results it can be concluded that drywell bypass leakage is of no concern to the operation of the Perry hydrogen control system.

Q There were questions by Ms. Hiatt about Sandia's 1/32nd scale test. What is the relevance of the snap-through buckling that occurred of the representation of the equipment hatch?

A (Witness Alley) That particular snap-through buckling is not applicable to Perry. The equipment hatch indicated in that particular test was concave inward, which means the pressure is acting against the curvature. In Perry our equipment hatches are oriented in the opposite direction where the pressures would tend to produce tensions in the membrane and therefore buckling is not a consideration on our equipment hatches.

Q Ms. Hiatt also asked questions about 1/8th scale testing performed by Sandia. What was the design

Sim 17-10

pressure used in that test?

A I believe the design pressure was 40 psig.

Q And what was the failure pressure identified in that test?

A It was approximately five times higher, or 186 psig.

Q What conclusions, if any, do you draw with respect to your analysis of the Perry structural integrity following a hydrogen event?

A As I have said before in my testimony, most of the Sandia tests were for the explicit purpose of trying to correlate and predict failure modes of containment vessels and key components. Our analyses, which are linear elastic analyses, we have used the service level C limits as the determining criteria and therefore most of the conclusions reached by those reports are not applicable to our analysis.

Q In that Sandia 1/8th scale test what code was used to predict performance?

A The MARCH finite element code was used. That code is primarily used for non-linear elastic type analyses, which is outside the range of the applications for our analysis.

Q And it is your testimony that your analysis looked at elastic ranges?

A Yes, it is.

Sim 17-11

MR. GLASSPIEGEL: No further questions.

JUDGE GLEASON: My Hiatt, do you have some recross?

MS. HIATT: Yes, I do. I would really appreciate the opportunity to take some time to prepare a little better. There is a tremendous amount of material obviously and I would like either to resume it tomorrow morning or if we could take a rather long break this afternoon.

JUDGE GLEASON: Do you have any estimation of time?

MS. HIATT: For the recross I wouldn't have that many questions, and I do not have a tremendous amount of questions for the NRC staff either.

JUDGE GLEASON: Well, what is your preference?

MR. GLASSPIEGEL: Mr. Chairman, I want to be reasonable here. I would prefer not to take an overnight break. I think we were required to move into redirect after a rather long cross-examination today, and I would be willing to take a half hour or 45-minute break if she only has a few questions. And I would also like to ask if Ms. Hiatt has any further questions for Mr. Karlovitz or Dr. Lewis. If not, I would like to request that they be temporarily excused.

JUDGE GLEASON: Well, I think she wants a chance to look over ---

MS. HIATT: Yes. I really can't say right

Sim 17-12

now whether I will have questions for them.

MR. GLASSPIEGEL: Fair enough.

JUDGE GLEASON: Well, just hold it a minute.

(Board conferring.)

JUDGE GLEASON: If we can have your attention, please.

We really think it puts too much of a burden on everybody to prolong the times of these sessions like this, and we think that the intervenor ought to have an adequate opportunity to look over what the recross will be. She operates by herself and you at least have some assistance to help you even though your time was short.

So I think we will recess tonight and it sounds to me like we ought to be able to finish by 12 o'clock tomorrow anyway because you indicated you didn't have a lot of questions of the staff. So let's get back at 9 o'clock tomorrow morning.

MR. GLASSPIEGEL: May I ask the Board, do you intend to ask any questions of the panel?

JUDGE GLEASON: We have a few we could ask now if you would like to get those over with.

MR. GLASSPIEGEL: I think it would be helpful.

JUDGE GLEASON: All right. There are very few.

BOARD EXAMINATION

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BY JUDGE BRIGHT:

Q Ms. Buzzelli, Ms. Hiatt was asking you about the

Sim 17-13

loss of offsite power, if I recall correctly. Am I right?

A (Witness Buzzelli) Yes, she had an initial question on the loss of offsite power.

Q And you indicated that the igniters were not hooked into the emergency power system; is that correct?

A No. The igniters are supplied by the emergency diesel generator system.

Q They are supplied by the emergency diesel generator?

A They are supplied by the emergency diesel generator, yes.

Q So in the event of a loop LOCA you would be able to operate; is that correct?

A That is correct.

JUDGE BRIGHT: Thank you.

end Sim
Sue fols

#18-1-SueT

BOARD EXAMINATION

BY JUDGE KLINE:

Q I'm not completely clear on the conditions of the model for hydrogen deflagration and detonation.

First, I would like to ask whether the assumptions that went into the modeling of hydrogen combustion are dependent on a complete mixing assumption with -- of the hydrogen with the containment air?

A (Witness Karlovitz) The transition from deflagration to detonation is not dependent on complete mixing. The mixture has to be such that it could detonate.

Q Yeah.

A Whether the mixture is fully mixed or not plays no role. And the transition is essentially a turbulence effect.

Somehow, the flame as it is ignited, the deflagration progressing has to be constrained in some ways. Like in a long tube. Where the burned gases push forward, the flame, and produces large intensity turbulence, whereby the propagating flame can reach a propagating velocity, not a flame velocity. The flame can go -- approach some velocity.

And at that time, the front of the flame is highly turbulent, involved. And little pockets burn suddenly producing pressure waves. They run forward, and as they reach the cold gas they are slowed down, they pile up. And piling

#18-2-SueT

up they produce the detonation rate.

Q Okay. That was my question, as to whether or not nonhomogenous conditions, that is to say, higher localized concentrations of hydrogen could produce --

A It can produce it if the concentration is high enough. But whether it is variable at places doesn't play any role.

Q As I understand it, the intent is to initiate thermal ignition at around eight percent hydrogen concentration?

A Yes.

Q Have you ruled out completely that a localized concentration of hydrogen could build up to fourteen or fifteen percent before ignition?

A It could happen and play no role. The essential point is --

Q No, I don't understand why it doesn't play a role.

A That's what I want to explain, please. Because it need not only the detonable concentration but also the specific geometry which confines the flame and produces the very fast flame progress and higher turbulence intensity.

And for this condition, we don't have anywhere in the containment.

Q I guess -- would these, the conditions you have just described hold for all conditions, even suppose that you

#18-3-SueT

did not intend to initiate a thermal ignition, what is the consequence of not igniting hydrogen then until it reaches very high concentrations and then igniting it in a burn if there is no detonation?

A It could produce a sudden pressure depending on the volume of the accumulated hydrogen mixture. But under the geometry of the containment structure, it could not go over into detonation.

Q In the modeling that has been done that produced certain estimates of temperature in the containment, are those temperatures the temperature of the containment atmosphere after detonation?

A You are back to the calculations. The flame temperature depends on the concentration only. But the temperature of the environment of the whole structure --

Q That's what I'm trying to distinguish between the flame temperature and the environmental temperature.

A The temperature of the structure depends on the calculations -- is given by the calculations.

Q The curves that are shown in this preliminary report show temperatures on the order of 300 degrees or something. Those are environmental --

A That is the structure temperature.

Q Okay.

A (Witness Buzzelli) Atmosphere.

#18-4-SueT

(Witness Richardson) Atmosphere.

Q The containment air, that's what I'm getting at. Now, the flame temperature itself is much higher?

A (Witness Karlovitz) Yes. That depends only on the concentration.

Q Now, given that, why is it not possible to initiate secondary fires? For example, in cable trays?

A Because the high temperatures would last only for a very short time, then comes again a cold blast of air or steam.

(Witness Lewis) It's intermittent.

(Witness Karlovitz) Intermittent. The average temperature is --

(Witness Lewis) The average time of a flame is short.

(Witness Karlovitz) The average temperature is given by the calculations is the low value. And that would act to ignite a cable also.

JUDGE KLINE: Okay. That's enough. Thank you.

CROSS EXAMINATION

BY JUDGE GLEASON:

INDEXXX

Q Could somebody explain to me who invented this igniter system as it is in the Perry Plant?

(Laughter.)

A (Witness Karlovitz) I recall that this solution

#18-5-SueT

came up through a discussion at Westinghouse, and recently I learned that the first suggestion came from Dr. Fuls.

Q We can hold him responsible?

(Laughter.)

A At this discussion, particularly Dr. Lewis and myself, resisted strongly until we got convinced that in this case this is the solution.

(Witness Fuls) I came up with the idea. I didn't invent the entire system.

Q Who did that?

A (Witness Richardson) A lot of the initial work, design and things like that were done by the ice condensor plants. Tennessee Valley Authority and Duke Power Company and the Cook Plant, Sequoyah, McGuire and Cook Plants, ice condensor plants.

Q Somebody put it in a pattern to be used in those plants?

A Yes. Those utilities, using the guidance from Dr. Fuls and Dr. Lewis and Mr. Karlovitz. Then a design and the criteria that they used were evaluated by Mississippi Power and Light and the Hydrogen Control Owners' Group and was developed further.

Their initial design was not a Class I-E safety grade system, and the system was then designed for Mississippi Power and Light, was then upgraded to a Class 1-E system and

#18-6-SueT

then criteria developed through the Hydrogen Control Owners' Group.

(Witness Fuls) May I add that the concept of the igniter itself was developed by the Tennessee Valley Authority. They investigated a number of different sources, particularly spark plugs and found that they created too much radio-transmission and interfered with a lot of their equipment and instrumentation.

Using the glow plug was very benign and didn't interfere with any of their --

(Witness Karlovitz) The glow plug is an industrial product.

Q And was this, Dr. Fuls, for a nuclear plant?

A (Witness Fuls) Yes. This is for the Sequoyah.

Q All right. Would it be an inaccurate assessment to say we've got -- everybody agrees we have got a great system here but nobody has seen it really work?

A (Witness Karlovitz) The system was subjected to a large experimental trial at Fenwall Corporation.

Q Where?

A At Fenwall Corporation. Near Boston, Massachusetts. I have here test results. And the system never failed.

Q In what kind of a structure was this?

A It was a large spherical room, which they established the proper conditions carefully and then ignited in the center.

They are -- it's a well known, respected --

Q How many igniters were in this room?

A One.

Q One. I see. We have a hundred and two here.

A That makes it a hundred and two times safer.

(Laughter.)

Q Refer to Murphy's Law and all that kind of stuff.

(Laughter.)

A Fenwall is a highly respected corporation. Their main line is explosion protection and fire protection where they develop explosion conditions and blow in suddenly large volume -- spreading large volume of elements which kill the fire. They are very successful.

Again, the system never failed except a few cases when the owners monkeyed with it.

Q Well, that can happen at Perry, too.

(Laughter.)

A Supposedly not.

Q I don't know whether Mr. Richardson or Ms. Buzzelli would be the proper person to answer this. I am referring now to the OCRE Exhibit 16 on which there were some questions and comments on redirect.

If I understood those questions, it was to demonstrate that one could not go from one -- from the exhibit over to your exhibit 8-1 with any degree of accuracy. You couldn't

#18-8-SueT

locate the igniters by the information in this exhibit?

A (Witness Buzzelli) You could not locate the igniters by the information in this exhibit. It would take some translation from --

Q It would take some translation. Would you say generally that their location points in OCRE's Exhibit -- I think you said they are substantially changed, but is the distance substantial for each igniter or is it small distances in most cases?

A Many are substantial change -- large distances.

Q Large distances?

A The others may be more on the order of small distances.

Q Have you been able to -- not that you have been asked to, but I raise the question, been able to put a date on this exhibit?

A No. I have not been able to put a date. I would estimate -- this was an early draft document in the development of the system and its design that eventually was superseded and resulted in the preliminary evaluation.

I would estimate for this interim report possibly late '83, early '84 time frame. Late '83 possibly. That's an estimate on my part. I could do some checking to find out what that date is.

Q All right. We appreciate you doing that if you

#18-9-SueT

could. Also as to whether this is -- is this the first layout of this system or is it --

A No. Prior to this document, there was a preliminary report.

Q You say a preliminary --

A A pre-preliminary report that preceded this interim report in this form, and again showed very, even the earlier estimated locations, proposed loccations, for igniters.

So there is a report before this one that you have as an exhibit. Once again, the final evaluation is that which we submitted in March of '85.

BOARD EXAMINATION

BY JUDGE KLINE:

INDEXXX

Q In the subsequent stages of evolution, I would say, are those changes produced by analysis of hydrogen combustion or were they produced by something practical, or you just couldn't find a place to hang it when you got there?

(Laughter.)

A (Witness Buzzelli) More from practical reasons and from following and reevaluating and insuring that the criteria established, spacing criteria established, for the Owners' Group and established for Perry was followed.

So, more from a practical standpoint and insuring available supports and so on. There was no feedback from the analysis to the specific igniter locations.

#18-10-SueT

(The Board members are conferring.)

BOARD EXAMINATION

BY JUDGE GLEASON:

INDEXXX

Q Essentially, the idea is to have one of these igniter parts everywhere that hydrogen can go; isn't that right?

A (Witness Richardson) That's correct. I might also point out that you were asking about the analysis and the feedback and everything, and the analysis essentially assumes that there are igniters there. It's not important as to specifically what location they are.

The location is based on criteria that has been established originally by the ice condensor plants and carried over through the MARK III plants. And most of the placement changes were, as Ms. Buzzelli said, meeting -- meet the criteria. And when you find there is no place to locate it, evalute it, place it in a different location, and then that might the location of another one because you are trying to meet the criteria.

Q If I understood some comment that was made yesterday, during the visit there, generally about thirty feet apart?

A That's the criteria.

Q And that's based on what?

A Well, the criteria is that they are approximately

#18-11-SueT

thirty feet apart from one another, both divisions of power are available, and approximately sixty feet from one another for a given, you know, one division of power supply available and --

MR. GLASSPIEGEL: Judge Gleason, just one point. I want to make sure that there is an understanding here. You referred a couple of times to the hundred and two igniters, and I just -- there was an implication, at least to me, that you might think that all hundred and two igniters would be needed. And I would just like --

JUDGE GLEASON: No. I understand. All right. We will see you all tomorrow at 9 o'clock.

(Whereupon, the hearing is recessed at 5:00 p.m., Thursday, May 2, 1985, to reconvene on Friday, May 3, 1985 at 9:00 a.m.)

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CERTIFICATE OF OFFICIAL REPORTER

This is to certify that the attached proceedings before the UNITED STATES NUCLEAR REGULATORY COMMISSISON in the matter of:

NAME OF PROCEEDING: Perry Nuclear Power Plant, Units 1 & 2
The Cleveland Electric Illuminating Co., et al

DOCKET NO.: 50-440/50-441

PLACE: Perry, OH

DATE: Thursday, May 2, 1985

were held herein appears, and that this is the official transcript thereof for the file of the United States Nuclear Regulatory Commission.

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