ENCLOSURE 1

ORIGINAL

OFFICIAL TRANSCRIPT OF PROCEEDINGS

Agency: Nuclear Regulatory Commission

Title: Meeting of NRC and Pennsylvania Power & Light on Fuel Pool Cooling

Docket No.

LOCATION: Rockville, Maryland

DATE: Thursday, July 8, 1993 **PAGES:** 1 - 94

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UNITED STATES OF AMERICA

NUCLEAR REGULATORY COMMISSION

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MEETING OF NRC AND PENNSYLVANIA POWER & LIGHT

ON SPENT FUEL POOL COOLING

Nuclear Regulatory Commission
Room 2F-17
10555 Rockville Pike
Rockville, Maryland
Thursday, July 8, 1993

PRESENT:

ASHOK THADANI, NRC
DICK CLARK, NRC
GEORGE HUBBARD, NRC
DAVE NEY, NRC
DAVID SHUM, NRC
J. CUNNINGHAM, NRC
J.R. WHITE, NRC
VONNA ORDAZ, NRC
JOSE CALVO, NRC
KEN ECCLESTON, NRC
JOHN KOPECK, NRC
CHARLES A. MYERS, PP&L
DAVID G. KOSTELNIK, PP&L
ROCCO R. SGARRO, PP&L
MICHAEL H. CROWTHERS, PP&L
BRYAN SNAPP, PP&L
MARK A. MJAATVEDT, PP&L
JAMES M. KENNY, PP&L
GLENN D. MILLER, PP&L
GEORGE T. JONES, PP&L
DALE F. ROTH, PP&L
HERB WOODESHICK, PP&L

[continued next page]

JAY SILBERG, SHAW PITTMAN

ANDREW SMITH, NEWSDAY

LOIS M. JAMES, BECHTEL

ROBERT MACERS, PADER, BRP

PROCEEDINGS

[10:15 a.m.]

MR. CLARK: Good morning. My name is Dick Clark. I'm the Project Manager in the Office of Nuclear Reactor Regulation for Susquehanna.

We're having a meeting today between Pennsylvania Power & Light Company and the NRC staff, and the purpose of this meeting is related to the design of the spent fuel pool for Susquehanna and the designs that might be challenged by a design basis event.

I wish to emphasize that this is a meeting between Pennsylvania Power & Light and the NRC. It is open to interest members of the public to attend as observers.

At the end of today's meeting, there will be an opportunity for members of the public to make any comments they wish to offer.

There is an attendance list circulating, and when everyone has signed it, we will get copies made for each of you.

I want to also note that this meeting is being transcribed. A copy of the transcript will be available in about two weeks.

I know it's a little cumbersome, but it would be helpful to this transcriber if you'd state your name when you're making a statement.

Before we start this meeting, I'd like to go around the table and request that everyone introduce themselves and identify the organization they are associated with.

Glenn, do you want to start?

MR. MILLER: My name is Glenn Miller. I'm the Manager of Nuclear Technology at Pennsylvania Power & Light.

MR. KENNY: My name is James Kenny. I'm the Licensing Supervisor for Pennsylvania Power & Light Company.

MR. JONES: My name is George Jones. I'm the Vice President of Engineering for Pennsylvania Power & Light.

MR. ROTH: My name is Dale Roth. I am Systems Engineering Supervisor for PP&L.

MR. SGARRO: Rocky Sgarro, PP&L Licensing.

MR. CUNNINGHAM: I'm Jay Cunningham, Branch Chief, Radiation Protection Branch, NRR.

MR. WHITE: John White, Section Chief, NRC, Region I.

MR. SHUM: My name is David Shum, from NRR, Plant Systems Branch.

MR. HUBBARD: George Hubbard, Section Chief, Plant Systems Branch.

MR. CALVO: Jose Calvo. I'm Assistant Director for Projects in Headquarters.

MR. THADANI: Ashok Thadani, Director, Division of

Systems Safety and Analysis, NRR.

MR. CLARK: Since you were the last one to speak, I'd like to have Ashok, who is Director of the Division of Safety and Analysis, if he has some opening remarks he'd like to make prior to your presentation, Jim.

MR. THADANI: Thank you, Dick.

The most important thing to me is to make sure that we really fully understand what the concern is -- I believe we do, but I just want to make sure I do -- understand the concern and systematically go forward and say what does it mean, what the plant response will be and so on; if the issue is a combination of a loss of coolant accident and loss of offsite power, what the spent fuel pool response would be, we ought to say what it is.

Then we ought to go forward systematically, say, okay, if you lose spent fuel cooling system at time X, how long does it take to heat up the pool, when would boiling be expected to occur; even if you get boiling, what are the make-up sources and what would be the environmental conditions.

To go through this as a function of time, to get an understanding that we're really talking about days and day and days and so on, just to make sure that we don't lose sight of that element that we're talking about a very slow process, then the next element in this would be would the environmental conditions get so complex, severe, that the performance of certain components would come into question, and then the question, then, would be, okay, what are the components that are located in the vicinity and if they would perform their functions; if not, what would be the alternative course of action.

Then, the next thing would be, okay, what would be the consequences of this step-by-step process and if these were to happen.

During this period, if you discuss it as a function of time, it would be very useful to know what manual actions could be taken, some windows that would be available for those manual actions, and how they may change the course of the event that might proceed otherwise.

After that, it would be worthwhile to talk about probability of all these things actually happening, how likely or unlikely these areas are, and my motivation is to first get the whole issue in the safety world, to make sure we understand the safety element of this, and then talk about, okay, so now we understand how important this issue is, now let's talk about what is the licensing base, is there a question about meeting the licensing base or not.

So, let's go through the technical elements first, before we get into that. I would appreciate it if you would approach it that way.

MR. JONES: We hear what you say. We're here at your request to discuss the design basis and licensing basis. We'll do that last.

We submitted material to you formally and discussed it before. I'm pleased to report to you that I believe our evaluations are essentially complete at this time.

We believe that we meet our licensing basis, we believe we meet our design basis, and more significantly, we believe that the plant has and is -- is safe.

We've been evaluating the system and the concerns associated with the design and how it responds to various accidents. As you would expect, we did an in-depth review of things already mentioned. We found enhancements that we have chosen to make as we go along.

We've learned much about how the systems interact; specifically, stand-by gas treatment, the HVAC, RHR service water, ESW, with the fuel pool cooling being postulated events. This work has been very beneficial for us.

In keeping with our basic approach to continually improve the safety of our units, we have been and will be making some improvements in procedures and training and hardware.

The presentations will follow this agenda, and in the introduction at this point, the technical evaluation will be covered by Glenn Miller, the Manager of Nuclear Technology. I believe Glenn will answer all of your questions that you've presented to us.

Then we'll discuss the licensing basis, exactly how it fits, and then we will try to close the presentation and, of course, have questions.

So, with that -- and I apologize for my voice today -- Glenn?

MR. MILLER: I'm Glenn Miller, the Manager of Nuclear Technology for PP&L, and today what I'd like to do is review with you the fuel pool cooling issue and discuss the things that we have done as part of our evaluation and response to this issue.

This is an outline of what I'm going to talk about today. I'd like to describe briefly the systems that are involved here that are important to understanding the issue, the design bases for those systems.

I'll talk in a little bit of detail about the outage sequence, because that is important to understand the various configurations that need to be looked at in light of the concern.

Then I'll speak to the accident scenarios, and hopefully I can provide the timeframes that you're looking for at that point, and our conclusions and actions taken.

We have thoroughly evaluated this issue, and we have learned many things as we've gone through this evaluation. We have a much better understanding today of how our plant would respond under these conditions.

I will be showing you today that safe operation of the plant is assured. We can cool our fuel pools for seismic events and for other events which could initiate a loss of fuel pool cooling.

As a result of our evaluations, we have strengthened our controls, we have improved our procedures, and we are planning to add some modifications to the plant to provide level and temperature indicate of the fuel pools in the control room, and today we'll be providing answers to the questions you've asked, describe our ability to take actions to mitigate this event, and answer your questions that you have concerning the environment.

It's important to understand the plant layout in order to follow through the various accident sequences that we'll be talking about today.

Susquehanna is a dual unit BWR 4 with a Mark II containment. We have separate reactor buildings. We have a common refueling floor.

Our post-accident ventilation system is shared between the two units. We have two stand-by gas treatment system trains that work in combination with that post-accident ventilation system.

This shows a cross-sectional view of the Susquehanna plant, and it shows the Mark II containment structure with the reactor vessel, Unit 1, Unit 2, and shows the refueling floor elevation.

The two spent fuel pools are located centrally between the two reactors, and we have a cask storage pit located between the two fuel pools. This elevation is common to both reactor buildings and is referred to as Zone 3 as part of our ventilation system.

The Unit 1 secondary containment will be considered Zone 1. Unit 2 is considered to be Zone 2. The refueling floor is considered to be Zone 3.

I'd like to show you a plan view of the refueling floor, and again, here you see the Unit 1 reactor, Unit 2 reactor, spent fuel pools located between them.

In the center, we have a cask storage pit. We have removable gates between the cask storage pit and the fuel pools and also between the fuel pools and the reactor cavity and well, and in addition, the fuel pools are connected together through two skimmer surge tanks.

We have overflow weirs between the pools and the surge tanks and the cask pit and the surge tanks. So, the fuel pools are actually cross-connected together through the surge tank arrangement.

I'd like to show you a simplified ventilation diagram. What this diagram shows you is the Zone 1, 2, and 3 areas. This would be the refueling floor, Unit 1 and Unit 2.

We have a recirculation system which connects all three zones together, and depending upon the initiation signal, this system will respond in different ways.

We can isolate Zone 3, the refueling floor, by itself and take suction on that volume of the stand-by gas treatment system without involving either Zone 1 or Zone 2.

If we get a LOCA signal on Unit 1, we will isolate Zone 1 and Zone 3 with the recirculation system. Zone 2 would be isolated from that.

If we get a combined LOCA and loss of offsite power, all three systems will line up and isolate to the stand-by gas system, through the recirculation pond.

The stand-by gas treatment system takes suction from the recirculation pond, and the recirc pond has a supply and return from each of the three zones.

We can manually control the dampers and the fans from the control room for this system.

The fuel pool design -- each fuel pool has a capacity of 2,850 fuel assemblies. The fuel pool and the fuel storage racks are seismically designed structures, and as I have already mentioned, we have a common cask pit located between the two fuel pools.

Each fuel pool has its own surge tank, and they are both connected to that cask pit.

This diagram is a simplified PNID showing, on the right-hand side, the normal fuel pool cooling system. That system consists of three pumps and three heat exchangers per pool.

The capacity of the system is to be able to remove 13.2 million btu's per hour with a service water temperature of 95 degrees. Service water is the cooling medium for the fuel pool cooling heat exchangers.

So, we have three pumps, three heat exchangers. They provide supply to the fuel pool. They take suction from the skimmer surge tanks.

In addition to that, we have the capability to line up our residual heat removal system to the fuel pool in order to provide additional cooling, and the left side of the diagram illustrates that particular line-up.

We would take suction from the skimmer surge tank through the RHR pump and heat exchanger, and that water would be returned to the spent fuel pool.

The RHR system is powered from a 1E power supply. It is powered from the diesels in the event of loss of offsite power. It is a Seismic Category I system. The RHR system and all the interconnections to the fuel pool are seismically designed systems.

The RHR heat exchanger is cooled from the RHR service water system or our ultimate heat sink, the spray pond.

Also, we have the capability to provide emergency make-up from our emergency service water system. Each fuel pool has two connections from ESW through the supply lines to the spent fuel pools, and those systems are also 1E powered and Seismic Category I systems.

MR. HUBBARD: Glenn, I have a question. Is either train of the RHR able to be hooked up to the --

MR. MILLER: Yes. Either train can be used. The connections to the fuel pool are via the shut-down cooling portion of the system. So, we can use either train of RHR.

One limitation that we do have is we cannot run normal shut-down cooling at the same time we're run our fuel pool pond, but we can run alternate shut-down cooling.

MR. HUBBARD: Where does the alternate --

MR. MILLER: Well, alternate shut-down cooling is not shown on here, but that would be a mechanism whereby we would basically run one loop of RHR and suppression pool cooling and provide a flow path to the reactor through the relief valve, as described in the FSAR.

MR. CALVO: That requires some manual -- Jose Calvo. That requires some manual operations, right?

MR. MILLER: Yes. This would be a manual line-up to do this.

MR. CLARK: Glenn -- Dick Clark. Right now, you're decontaminating the heat exchangers in the Unit 1 pool and you're using the Unit 2 pooling system for cooling both the Unit 1 and Unit 2 pool. Can you maybe describe how you have that capability?

MR. MILLER: Our configuration in the power plant today is we have the gates between the cask pits and the fuel pools removed, so the fuel pools are cross-connected through the cask pit, and we're cooling both pools with one unit's fuel pool cooling system, and we have adequate capability to do that, and as I talk about the outage sequences, you'll see that, normally, during an outage, we also have the fuel pools cross-connected, so we have additional water volume and we have the capability to use the opposite unit's systems to cool both pools, and the heat load is well within the capacity of the single system.

MR. WHITE: Would that be true, also, if you had full core off-loaded into your --

MR. MILLER: Yes. I'll describe that one.

MR. MILLER: Let me discuss the design basis part of the system.

As I mentioned, the fuel pool and the racks are seismically designed. The fuel pool cooling system -- the normal fuel pool cooling system is not seismically designed.

It is designed to ASME Section 3, Class 3 requirements, but it's not seismically supported.

As part of our design basis, we have also established what is referred to as an emergency heat load, and that is a heat load which is in excess of the normal design heat load, and that is what is used in terms of the RHR fuel pool cooling mode.

The emergency heat load is used to establish the design requirements for that, and I'll discuss that in more detail.

The design basis loss of fuel pool cooling event is an event caused by an earthquake. That is the postulated event in our FSAR, and that event scenario is used to determine the offsite dose consequences of a boiling spent fuel pool.

That particular calculation, as shown in the FSAR, results in a boiling pool at 25 hours after the loss of pool cooling caused by an earthquake given a heat load of 9.8 million btu's per hour.

The resulting offsite doses were within the 10 CFR 100 guidelines and within the 1.5 rem thyroid guideline of Reg Guide 1.29, which is the seismic design classification guideline. That particular analysis was used to support the seismic classification of the fuel pool cooling system.

The emergency heat load is used to determine the design requirements on the RHR system in the fuel pool cooling mode, and to determine the emergency heat load, we assume a typical fuel cycle discharge schedule.

We assume that a single fuel pool is filled and a full core offload fills that fuel pool. The requirement is to maintain a temperature below 125 degrees Fahrenheit for a heat load of 33.94 millon btu's per hour.

Let me just mention that 33.94 -- that is the number which is in our FSAR update. That number includes consideration of our power-up rate for Susquehanna and that we are establishing as a new design heat load, and it is within the capability of the RHR system.

The emergency heat load is applied anytime the expected heat load in the fuel pool exceeds the normal heat load for the fuel pool cooling system.

I've mentioned that the design heat load for the normal fuel pool cooling system is 13.2 million btu's per hour. The actual capability of that system can be greater than that, depending on the conditions in the service water system at the time.

We've considered the effects of the decay heat in the fuel pools. We've looked at our spray pond calculations, our ultimate heat sink analyses, and we have determined that our design basis ultimate heat sink calculations bound any of the conditions that we are looking at for the fuel pool heat load. So, we can accommodate fuel pool heat load within the ultimate heat sink calculations.

I'd like to describe our outage sequences. It's important to understand this, because as we talk about the scenarios, in order to understand what the heat load is in the fuel pools, it makes a big difference whether you're in an outage or a non-outage.

So, I will talk about that, and what I will show you here is that the non-outage events are more limiting than the outage events.

For a typical refuel outage, we will take an in-depth look at our plan for that outage, and we do assess our shut-down risks. We conduct multiple reviews of our outage plans, and outage periods, as opposed to operational periods, do impose the highest heat loads in the fuel pools, and whether we did a full core offload or not, we are putting fuel in the pool which is at its highest decay heat rates.

So, the outage periods impose the highest heat loads on the pools. However, the configuration that we are in during the outage also provides us the greatest flexibility to prevent pool boiling.

We have the largest effective fuel pool volume during the outages, and that is because we do cross-tie the two fuel pools through the cask pit, and we also maintain the gates open between the reactor cavity and the equipment storage pit during the outage.

Also, there is no fuel in the reactor vessel after we complete a core offload.

We do conduct full core offloads, because we believe that it enhances safety from a shut-down margin perspective, and also, it reduces the potential for fuel movement error, and that's why we do full core offload.

Prior to every outage, we review that outage schedule to assure that the FSAR seismic event analysis is bounding, and that is a particular analysis that establishes the time to boil requirement from a design basis perspective.

We do full offload our cores. We also monitor very closely the fuel pool conditions both before and during that core offload, and we maintain an administrative limit at 110 degrees on the fuel pools during our outages.

Fuel pools are cross-tied and connected to the reactor cavity.

Mark, if you could just put the plan view up.

So, we'll take as an example Unit 1 outage.

For a Unit 1 outage, we would be flooding the reactor cavity and the adjacent equipment storage pit up to the same level as the fuel pool.

We would remove the gates between the reactor cavity and the Unit 1 fuel pool, and that would establish cross-connection between the reactor cavity and the fuel pool.

Then we will pull the gates between the Unit 1 fuel pool and the cask pit of the Unit 2 pool. So, basically we have this entire volume flooded during a major portion of our outage.

Now, this figure shows the relationship between the decay heat rate and the time to boil and the configuration of the fuel pools.

This shows three curves. The lower curve is for a single isolated fuel pool, the center curve is for two fuel pools connected together, and the upper curve is for two fuel pools plus the reactor cavity and equipment pit cross-connected together.

What this shows you is that, for higher heat loads, the time to boil that you would calculate for these configurations is less.

Now, we will use this information in order to examine the time to boil as we progress through an outage sequence.

This is calculated on the basis of all of the heat being generated by the fuel at this point -- all the decay heat goes into the water and results in increasing the temperature of the water, no credit for heat losses to the racks, to the walls, any kind of heat losses. It's purely add heat to the water and calculate the temperature increase that results.

A typical outage sequence in terms of a fuel sequence -- we'll begin on day six to start our core offloads. At that point in time, we will have the reactor cavity flooded and the gates open to the Unit 1 fuel pool.

On day 11 of the outage -- and these are typical numbers -- we will isolate the ventilation system to the outage unit. So, for example here, we would isolate the Unit 1 reactor building, or Zone 1, from Zones 2 and 3 as part of our outage sequence.

That's important in terms of understanding that what-if questions. If you're in an outage on one unit and you have a LOCA on the other unit, what conditions do you have in the outage unit?

MR. THADANI: Can you explain why day 11?

MR. MILLER: The schedule is tied to the work that is scheduled for the outage.

So, there is a point in time where we would want to isolate the Unit 1 reactor building in order that we are no longer required to maintain secondary containment on that unit because of it being in a shut-down condition.

So, core offload starts on day six. We complete that on day 13, and at that point we cross-connect the other unit's fuel pool.

So, between day -- well, prior to day six and day 13, we've got the Unit 1 pool connected to the reactor cavity; day 13 we connected it to the opposite unit's fuel pool.

Up through day 13, while we are doing our core offload, we have one division of RHR in shut-down cooling through that whole period of time. So, we are removing our decay heat with the RHR system, and that system is maintained in operation through day 13.

We do schedule a common RHR work window in order to maintenance work on the valves that are part of the common portion of RHR, and that is the portion which is associated with the shut-down cooling operation. That outage window is scheduled between day 17 and day 26.

So, the sequence here is to -- when we begin our outage, we do our maintenance work on one division of RHR. We get all that work complete except for work on the common portion of the system.

We then begin that work and release the system that's been in operation to do its maintenance from that point on during the outage.

Now, on day 30, we begin to reload the core. That's completed by day 37. At that point, we install the cask gates, which isolates the Unit 1 pool from Unit 2.

Two days later, we install the gate to the reactor well, and by day 48, we restore ventilation and complete the outage by day 55.

I'm going to show you the decay heat that we're dealing with for this same typical outage, and then I will illustrate the effect that that has on time to boil.

This shows decay heat as a function of days after shutdown, and this graph shows you the total amount of decay heat which is in this effective fuel pool volume. So, on day 13, that's when I complete my core offload.

Essentially, I have a full core offload in the Unit 1 pool plus whatever fuel had been in there from prior offloads. That's in the Unit 1 pool.

On day 14, when I open the gates to the Unit 2 pool, I add the residual decay heat from the Unit 2 fuel, because I'm opening the gates between the two pools. So, the curve takes a step up, and then, as you see, decay heat continues to drop off until I begin to reload the fuel.

So, here, on day 37, I have closed the gate to the Unit 2 pool.

So, again, I'm taking out some residual decay heat that's in Unit 2, and then, on day 39, I close the gate to the reactor cavity, and this is what I'm left with in the Unit 1 pool. It's on the order of 5 to 6 million btu's per hour.

MR. SHUM: This is David Shum.

MR. MILLER: Yes.

MR. SHUM: Is this curve based on 32.91 megawatt or 34.41?

MR. CROWTHERS: This is what is going to happen in the outage coming up this fall. So, that 33.9 number is based on our power upgrade number.

MR. SHUM: So, in other words, the decay heat loads in this package, some is based on 34.41 and some is based on 32.91.

MR. MILLER: The emergency heat load value of 33.94 is based on the operating condition. This is a typical outage. In fact, this is what we've just got done calculating for our upcoming Unit 1 outage.

The curve will be shifted upward somewhat to look at a power upgrade outage, and it will basically move this part of the curve up.

Now, we're reloading the core between day 30 and day 37. So, in fact, I have included the heat from the fuel I've put back in the core at this point on that curve, and I will, once again, have my RHR system in operation as soon as I begin to put fuel back in the reactor. Then I isolate the pool, and at day 39, I close the gate.

Now, I've also included here a graph. This shows the effective fuel pool volume. Initially, we have the Unit

1 pool and the reactor cavity connected -- that's the volume -- and I increase the effective volume by adding the Unit 2 pool, when I open those gates.

This just shows you closing the gates again and then closing the gates to the reactor cavity, leaving you with a volume for a single fuel pool.

So, if I take my decay heat curve now and my effective volume, I can calculate and show you the time to boil curve, and that is shown here.

Now, this curve begins on day 13. That was the day I fully offloaded the core, and we've calculated the time to boil in excess of 25 hours for that condition. That's with one fuel pool plus the reactor cavity connected.

Then I open the gates to the Unit 2 fuel pool. That increases the time to boil by adding the extra water volume from the opposite unit's pool.

Now, we have done calculations that show that the mixing of the water in the pools is very effective. We've used multi-dimensional fluid models to do that.

We've actually run -- not tests, but we've actually measured conditions during our outages, and we know that the water between the two pools mixes very well, sets up a very good circulation pattern within the pools.

So, we're looking at the volume of two fuel pools plus the reactor cavity at that point.

As the decay heat decreases, then, our time to boil will increase up to this point, and now I close the gate to the Unit 2 pool, so I am removing that volume from my calculation.

That reduces the time to boil, and then, when I put the gate between the reactor and the Unit 1 fuel pool back in, then all I have in terms of my decay heat is what I've left in the Unit 1 pool. So, my time to boil increases again as decay heat drops out. It continues to increase.

Now, this is an important point right here, because this is really the first time during the outage where I have a single isolated fuel pool from the outage unit, and if you notice from the data here, the time to boil at that point in time is greater than two days.

So, by the time I've put the plant in the configuration which is essentially equivalent to what was originally analyzed in the FSAR, my time to boil is in excess of two days.

The FSAR assumption was that I offload a quarter core, put it in the pool, and put the gates in, and that was the starting point for that calculation.

We offload the full core, but we leave the systems interconnected. So, we basically have a much larger volume of water, plus we have additional systems to use.

Now, to talk a little bit about how -- what the effects would be here in an outage scenario -- number one, the outage scenario -- we had have the highest heat rate in the fuel pools.

If we assume we have a loss of coolant accident or a LOCA with a loss of offsite power on the operating unit at that point in time, the things to remember are that the outage unit -- the fuel pool systems are cross-tied.

I have my RHR system available for cooling the pool for most of the duration of the outage. I actually have it in operation for a large portion of the outage and available to cool the pool directly during my outage.

So, if I have a loss of coolant accident on the operating unit, I do not need to rely on the operating unit's systems to maintain pool coolant.

MR. THADANI: At some point, I assume you are going to go through scenarios during which RHR has been tied in, at what time, and what its significance is.

MR. MILLER: Yes.

MR. THADANI: Okay.

MR. MILLER: Now, in addition to RHR, we always have the emergency service water system operable during the outages to provide make-up to the fuel pools, plus we always maintain one division of core spray operable through the entire duration of the outage.

Since the reactor cavity is connected to the fuel pool, that provides a direct make-up source to the fuel pools during the outage.

In addition to that, I have isolated the reactor building. So, if I had a LOCA on the operating unit and if that LOCA produces a radiation source term, because my reactor building is isolated, I will not be transferring any of that airborne activity over to the outage unit.

So, habitability of the outage unit is assured during an outage scenario. So, there's no question about being able to access equipment in the outage unit, because it is isolated from the non-outage unit.

I also have the maximum amount of water volume present. So, that gives me a long time to deal with any condition for which I would lose fuel pool cooling.

MR. WHITE: You say the reactor building is isolated and you have access in the reactor building. What is that based on?

MR. MILLER: It's isolated from the ventilation system.

MR. WHITE: The question is do you have -- you will have access to the reactor building --

MR. MILLER: Yes.

MR. WHITE: Is that what your FSAR says?

MR. MILLER: Yes. The access to the reactor building in terms of doing work in the building is that portion of time between day 11 and day 48 where we do not need to maintain secondary containment on the outage unit. So, we isolate it from the post-accident ventilation system.

So, if we got a LOCA signal on the operating unit, the stand-by gas system would initiate, and the recirculation system would be operating on Zone 2 and 3. Zone 1 would be isolated from Zones 2 and 3.

Therefore, any airborne activity that might be present on the LOCA unit would not be moved over to the outage unit, because the ventilation -- it's the ventilation system which is isolated.

MR. WHITE: Just one more question. For any of these conditions to exist, do you have to have access to -- do you have to have to manual --

MR. MILLER: The ESW is a manual operation, yes.

MR. WHITE: But you don't have to get into the floor to manually operate ESW.

MR. MILLER: No. The ESW valves are located within the reactor building at elevation 749 and also at elevation 670, and there are two sets of equipment in either reactor building.

Now, for an outage condition, with the fuel pools cross-tied, you could use either set of ESW from either unit to put water into the fuel pool, and also, because the fuel pools -- even if they were isolated, the cask pit and the surge tanks cross-tie the two fuel pools together.

So, you can provide make-up on one unit's pool, and it will flow over to the other unit, and that's something we'll get into a little bit later when we talk a LOCA with both units operating. That's a point that we want to make.

MR. HUBBARD: Let me see if I understand it correctly. If you have a LOCA, just the LOCA, you will isolate Zone 1 that's on Unit 1.

MR. MILLER: You will isolate Zone 1 and Zone 3 on a Unit 1 LOCA.

MR. HUBBARD: Okay. And Zone 3 is the refueling area.

MR. MILLER: Zone 3 is the refueling area.

MR. HUBBARD: So, if you have the accident in Unit 1, that will go the stand-by gas treatment --

MR. MILLER: This will line up to the recirculation system. The normal reactor building ventilation will shut down. You're isolating the building. It will line up to the recirculation system and stand-by gas to take suction on that.

When we're in an outage, a Unit 1 outage, these dampers will be closed and they will be isolated. So, the system will not line up to the outage unit.

MR. HUBBARD: If you have an accident in Unit 1, then Zones 2 and 3 -- Unit 2 would be the outage unit, say, and that's isolated and so is the Zone 3.

MR. MILLER: No. If you have a LOCA signal in Unit 1, you get Zone 1 and 3. If you have a LOCA signal on Unit 2, you get Zone 2 and Zone 3. We do not need to access the refueling floor to provide make-up to the fuel pools.

The valves are not located on our refueling floor. They're located at a lower elevation.

MR. HUBBARD: I'm confused, then, as to where the stand-by gas treatment is going to be pulling from.

MR. MILLER: The stand-by gas system pulls off the recirculation plenum.

MR. HUBBARD: Yes, but if I have the accident on Unit 1, which zones is my stand-by gas treatment?

MR. MILLER: Zone 1 and Zone 3.

MR. HUBBARD: Okay. And that's the refueling area.

MR. MILLER: The refueling area.

MR. HUBBARD: Okay.

Now, relative to the zones, where is the make-up elevation? 766, you say, for make-up for service --

MR. MILLER: For make-up, there are three valves that would need to be operated. Two of them are located with these two valves from ESW. There's 90A and the 91A valves and B valves. Those are located at reactor building elevation 749.

MR. HUBBARD: How is that relative to which zone it's in?

MR. MILLER: On Unit 2, that would be in Zone 2. On Unit 1, that would be Zone 1. The entire building, other than 818, would be Zone 1 or Zone 2. The other valves, the 500 valve and the 501 valve, those are located at elevation 670.

MR. WHITE: When you indicate that you have access to the building, what assumptions are you making about fuel damage?

MR. MILLER: We have evaluated access to the building with consideration of the Reg Guide 1.3 source term. I've got some discussion on that later on, as I talk about the accident scenarios.

MR. WHITE: At this point in the discussion, though, are you saying that you have access to the reactor building using Reg Guide 1.3 source terms?

MR. MILLER: For an outage condition, what I'm telling you is that, on the outage unit, this zone is physically isolated from the other unit. So, if I have an accident on this unit, I will not spread activity into the outage unit.

We can access the reactor building of the accident unit. We have studied that. We have done calculations. We can access the ESW valves. In fact, we've determined -- we've done man-motion studies, and we've determined the dose to the operator for those conditions.

MR. WHITE: You have access with the assumption of --

MR. MILLER: Reg Guide 1.3 source term, yes.

MR. WHITE: Right.

MR. KENNY: I think, right now, John, Glenn's talking just about outage, because one of the questions was -- we've made statements to the effect that the most severe case is a non-outage case. So, Glenn's focusing on the outage configuration right now.

MR. WHITE: You made conclusions earlier, when you were addressing the 0737 issues, that you cannot have access to the reactor building. What's changed?

MR. MILLER: When we met with you in March, we indicated that there were two valves on Unit 1 that we could not get access to based on the NUREG 0737 study, which essentially assumes that the entire room is at the dose rate of the highest point in the room.

Since then, we have gone back and specifically analyzed the room for the location of the sources. We have included airborne within that calculation, and we have conducted man-motion studies to see how much time it would take to get into the room, operate the valves, and leave the room, and we completed those evaluations, and we determined the dose to the operator for those set of valves would be 4.2 rem. So, it's within the 5-rem number that we're dealing with.

MR. WHITE: That's a new analysis or a new study.

MR. MILLER: It's something we've developed since we met with you in March.

What we are also saying, however, is that we would not need to access the accident unit reactor building, because we can provide the make-up from the opposite unit.

We can access the same set of valves on the opposite unit and fill the fuel pool through the other unit's pool, because they are essentially cross-connected through the cask pit and through the surge tanks.

MR. WHITE: As I recall, last time we met, you indicated that could be done whether or not the gates were on. Is that right?

MR. MILLER: That's right.

MR. WHITE: Has that been tested?

MR. MILLER: That is a fact. If you look at the equipment, there is a weir connecting the spent fuel pool to the skimmer surge tank and another weir connecting that same surge tank to the cask pit, and there's nothing in between. These are just open passages here. We could fill this volume, and it will overflow into the cask pit and on into the opposite unit's fuel pool.

Now, obviously, if the gates between the cask pit and the pools are open, then the pools are cross-connected and we have a direct path, but we have evaluated access to these valves, and we can access the valves on the accident unit within the 5-rem guideline.

MR. ECCLESTON: The assumption you're making regarding the source term involved in that, though, is this consistent with NUREG 0737?

MR. MILLER: We used a Reg Guide 1.3 source term, which is what NUREG 0737 requires, and we have also included an airborne source term within that calculation, which is not required by the NUREG. We've included that here.

The area where the operator has to go to operate the valves down in the 760 elevation, he has to walk past two core spray pipes, and those are the highest radiation areas within that room.

He's basically walking down a corridor with the pipe running vertically up along the wall, and he has to walk past those pipes, two of them, to get to the valve, open the valve, and then walk back out of the room, and that's the area that we've looked at.

We had an operator -- put him in -- fully suited up, with an air pack, and he walked down and performed the actions, and that forms the basis for our man-motion studies.

MR. WHITE: Does that include additional shielding?

MR. MILLER: No additional shielding.

MR. ECCLESTON: Is the RHR system in the -- I think it's both the -- the assist mode -- is that RHR water at the levels of concentration that they talked about in NUREG 0737?

MR. MILLER: Yes. We would not use the RHR fuel pool cooling mode from an accident unit. We do not believe we would get access to that. If we did the same types of calculations, we would not be able to access RHR for the accident unit, and that's what we said in March.

MR. ECCLESTON: On page 23 of your May 24th submittal, on the bottom there, what are you talking about in terms of spent fuel assist -- RHR assist mode for the spent fuel cooling assist?

MR. MILLER: I believe the question there had to do with, if I put the RHR fuel pool cooling mode in service, would I be adding activity to the fuel pool itself that I would have to be concerned with, and that's --

MR. ECCLESTON: So, you're not trying, then, to take credit for this.

MR. MILLER: Not from the accident unit, no. If I have a Reg Guide 1.3 source term, I would not be able to access RHR fuel pool cooling mode on the accident unit.

MR. ECCLESTON: Okay. That's what I think you were saying in here.

MR. MILLER: What we are saying, in addition to that, is that for a loss of coolant accident, we don't necessarily expect to have a Reg Guide 1.3 source term unless you have multiple equipment failures occurring, and for that condition, I could access the equipment.

So, we have to state what our assumptions are here in terms of which equipment are we dealing with, and there are a lot of capabilities here, and depending on the condition of the plant, you could use different capabilities.

So, we are not saying we would take credit for RHR fuel pool cooling mode on an accident unit with a Reg Guide 1.3 source term. We cannot do that.

MR. ECCLESTON: That's what I thought you were implying here, and that's what was giving me a problem. I understand what you're saying now. Thank you.

MR. THADANI: Clearly, I think, to meet the design basis, you have to do, I think, what you described, flood the units that are --

MR. MILLER: Yes.

MR. THADANI: -- experiencing LOCA and so on, but you are going to go through, later on still --

MR. MILLER: Yes.

MR. THADANI: -- a scenario -- that's still -- okay.

MR. MILLER: Yes. Okay. Slide 15. Okay.

What I'm trying to contrast here is the outage configuration versus the non-outage, because the conditions are different.

For a non-outage scenario, I can postulate a LOCA or a LOCA with a loop on either unit. For that configuration, I have both reactors that I need to take care of, and I have both fuel pools, if they are isolated.

However, the heat load is lower than it would be during an outage, and in any case, for either fuel pool, the time to boil is always greater than two days.

Now, that time increases as I move away from the outage, and as I approach the end of that 15-month operating cycle, the time to boil will be in excess of 10 days.

Now, we've provided specific cycle-dependent calculations so that we know what the time to boil is in either fuel pool, and as of right now, the time to boil for a Unit 1 pool would be in excess of 10 days, and on Unit 2, it would be in excess of five days.

Unit 2 was the last unit that we refueled. So, as we approach an outage, that number approaches 10, 11 days if the pool is isolated.

MR. CALVO: Can you put that picture back up? If the accident was in Unit 1, what do you have to do in Unit 1 to provide cooling to the pool, irrespective of how long it takes? If Unit 1 is the one with the accident, can you cool the pool? Can you protect the equipment? Can you put water in the pool?

MR. MILLER: I can always put water in the pool under any conditions, always.

MR. CALVO: Physically, what do you have to do?

MR. MILLER: Physically, we would add water. If I can't use my normal source of water, which is the first I would go to --

MR. CALVO: Your normal source of water on Unit 1 is the fuel pool cooling pumps.

MR. MILLER: Normally, fuel pool cooling will be in operation, and I can add water to the skimmer surge tank with the condensate system.

MR. CALVO: If I have a LOCA in Unit 1, loss of the offsite power in Unit 1, you have lost the fuel pool cooling pumps. How do you put water in the pool?

MR. MILLER: With the ESW system, emergency service water. This is a split diagram. This shows the normal systems and the other systems here. They're both on both units, though.

MR. CALVO: Oh, both units. Okay. I see now.

So, you have the ESW system.

MR. THADANI: See, the key point, as I understand it -- it is clear that you always have the ability to provide make-up, because you are isolating the zones. That makes a difference, it seems to me. If you did not isolate the zones --

MR. MILLER: Even if you don't isolate the zones --

MR. THADANI: I understand, with your new calculations. Okay.

MR. MILLER: Yes.

MR. THADANI: At least, as I understand it, that was a question.

MR. JONES: We can always supply ESW water to either pool from either unit, outage or non-outage, accident or non-accident. We can always do that.

MR. THADANI: This actually gives you more flexibility with handling these combinations of events.

MR. JONES: Absolutely. We could actually supply supplemental fuel pool cooling from all accidents except those accidents that are severe accidents requiring 1.3 source term. Then we could get to it in another way.

MR. THADANI: But again, you are going to go, as we go forward, into scenarios that --

MR. MILLER: Yes. I'll show you the accident sequence.

MR. THADANI: -- and the environmental effects.

MR. MILLER: Yes.

The point here was that the condition that we believe is more limiting is one where both units are operating, not the outage configuration, because of the capabilities.

We can provide ESW make-up from the non-accident unit or from the accident unit, and if I leave my pools cross-tied, which is something that we're considering, we can provide RHR cooling from the non-accident unit.

I can't necessarily access it on the LOCA unit, but I can get to it on the other unit, and if I cross-tie my pools, then I can provide cooling to both pools that way.

MR. CALVO: You said that you can cross-tie -- you can use the RHR from the LOCA unit to the non-LOCA unit -- you can do that, you can cross-tie that?

MR. MILLER: Yes. Each unit's systems will cool that unit's pool, but when the pools are cross-connected, you're effectively cooling the total mass.

MR. CALVO: Okay. So, there is no way that you can go from --

MR. MILLER: No, you can't do that. The piping isn't laid out that way, no. You'd have to have the gates out to do that.

MR. HUBBARD: Glenn, just a quick question. Have you looked at yet whether the power upgrade -- or do you still stay more than two days from boiling?

MR. MILLER: Yes.

MR. CALVO: You can do that with the emergency service water system.

MR. MILLER: Through the cross-connections in the cask pit and the surge tanks.

Put the PNID up there again, Mark.

MR. CALVO: Those are not done automatically, right? You have to do it manually.

MR. MILLER: These three valves are manual valves, and they have to be manually opened, but once you open these valves, you start filling the pool. You will overflow into the surge tank --

MR. CALVO: Okay.

MR. MILLER: -- into the cask pit, the surge tank, and the other pool. You don't have to do anything else.

MR. CALVO: I understand. Thank you.

MR. MILLER: Okay.

To kind of wrap this outage and non-outage thing up, the outage periods have the highest heat loads, but we have the greatest flexibility, because we've got cross-connection.

During the outage, one unit is shut down. It's already shut down. So, decay heat is less, the pools are cross-tied, and we have less demand on RHR because of that.

Now, I'd like to talk about the accident scenarios.

There are a number of ways that you can result in a loss of fuel pool cooling. You can have the original event, which is the seismic event. I'm not going to be talking about that here. We did talk about that in March.

That could knock out the system, but that leaves you with all of your other equipment available, no source term, and you could also lose fuel pool cooling if you lose offsite power, because it's supplied from non-1E power.

The ones we want to concentrate on are the loss of coolant accident and a LOCA with a loss of offsite power, and I have also indicated here severe accident, and the reason I'm doing that is because I want to talk about the responses with respect to the design basis LOCA and then, in addition to that, assuming this Reg Guide 1.3 source term, which we believe is non-mechanistic, but we will apply it, and we will show that we can move through the sequence here and take the proper actions for that source term being present.

A design basis accident LOCA -- we are analyzed for our worst-case single failure. We assume a double-ended guillotine break in the recirculation piping, and there are a number of break locations postulated, but generally the worst-case breaks are in the recirculation piping.

Our ECCS systems are designed to rapidly respond to that, inject into the reactor vessel, even including worst single failure. We provide rapid re-flood capability, and we ensure long-term cooling.

It would require multiple system failures to take us to the point where we would expect to have significant fuel damage. That's just part of the design of the plant. That's part of defense-in-depth as applied to the design of the BWR.

MR. CALVO: When you say analyzed for the worst single failure, which was -- what's that failure when it was the worst?

MR. MILLER: For the power upgrade analysis, which was the worst case? Injection valve failure, LPCI injection valve failure on top of a recirculation line break results in the highest peak cladding temperatures. The worst-case single failure is generally viewed in terms of peak cladding temperature results.

We've recently completed, as part of our power upgrade work, the new analysis of our design basis accident based on the General Electric SAFER/GESTR methodology, and those calculations show that, for the best-estimate case, peak temperature is around 1,000 degrees; for the Appendix K evaluation, on the order of 1,500 degrees, both of which are below the threshold failure point for clad rupture.

So, we would not expect, based on this analysis for our design basis case, to have fuel failures. That's also consistent with our existing FSAR calculations from the previous GE analyses.

Under these kinds of conditions, there would be no question about access to the reactor building, because without the fuel failures, you do not have the source term.

We will have applied the source term to this question of access. We have looked at that, and we'll talk about those results.

Now, the sequence for a design basis accident: On a loss of coolant accident, the fuel pool cooling system will lose its power initially, and that's because of a feature in our plant design referred to as the auxiliary load shed feature, and that is built into the design to assure that our emergency equipment will be guaranteed adequate voltage levels to respond to the immediate event that's occurring.

Following that initial response to the loss of coolant accident, you can restore power to the fuel pool cooling system, along with any other system that you may have shed off the electrical supplies at this point.

MR. CALVO: How can you do that? You do that manually?

MR. MILLER: Manually.

MR. CALVO: From the control room.

MR. MILLER: Yes. There are manual actions that are required to restore non-safety-related systems.

MR. CALVO: I just wondered where have you got to go in the plant to do that?

MR. MILLER: A portion of the fuel pool cooling system is in the reactor building elevation 749.

MR. CALVO: That's where the --

MR. MILLER: That's where the controls are to operate the fuel pool cooling system. That's where I would go to restart that particular system.

MR. CALVO: So, the electrical switch gear is there.

MR. MILLER: The switch gear --

MR. CALVO: Keep in mind what you did, your worst case.

MR. MILLER: I believe the switch gear is in the turbine building, but that particular area is a lower-dose area.

MR. CALVO: That's what I'm getting at. If you lose the offsite power, you lose the capability --

MR. MILLER: No, this is not a loss of offsite power. I've shed the load.

MR. CALVO: You shed the load.

MR. MILLER: I shed the load.

MR. CALVO: So, they didn't lose offsite power in this case yet.

MR. MILLER: Right. Breakers open automatically. Breakers open, drops the non-essential loads to direct --

MR. CALVO: Oh, I see.

MR. MILLER: Normally, my emergency systems are powered via the ESS transfers, which are connected to the start-up transformer. So, I'm using an offsite power supply, as opposed to using the diesel.

MR. CALVO: I'm just curious. What did you do that for? You haven't lose offsite power.

MR. MILLER: We shed this load to maintain -- to assure that the voltage levels for the emergency systems are adequate to start those big pumps up.

Normally these loads are supplied off of the auxiliary transformers, which are connected to the big generators. If I trip the unit, those large buses transfer over to the start-up bus, and I don't want to do that. I don't want to add any extra loads to my start-up bus. So, we shed that load.

Now, we expect that normal fuel pool cooling system to be functional following a LOCA. So, our first action would be to restart the normal system, get power back to the system and realign it.

We also would expect our reactor building to be accessible under these conditions.

I've already mentioned the two-day number. The worst-case initial condition for this would be at the conclusion of an outage. That would give me the highest heat load in the pool immediately following an outage, but it's always greater than two days to boil.

If take no action to restore cooling, it's always greater than two days. That's adequate time to perform these actions to restore the normal cooling systems.

Now, I can -- in the case of a loss of coolant accident, without significant fuel damage, I can access the RHR system to use it for fuel pool cooling mode. So, I could either use the normal system or that. In any event, I can provide make-up from ESW, and we will look at that scenario.

Also, one other thing that I can do is, if the fuel pools are cross-tied, then I have the normal fuel pool cooling system from the opposite unit that I would have in service. That system would still be operating. I could also use the RHR system from the non-accident unit.

If have power available and my pools are not cross-tied, I can go to the refueling floor, take the gates out, and cross-tie.

MR. CALVO: You can do this, even if you assume a single failure, with the emergency service water system.

MR. MILLER: Yes.

MR. CALVO: So, that means to me that either train in each unit can provide --

MR. MILLER: The systems in each unit.

MR. CALVO: In each one. So, either one of those can provide cooling to the pool.

MR. MILLER: Right.

MR. CALVO: Okay.

MR. WHITE: Now, what are the conditions? Is there any hydrostatic load or background condition that the spent fuel pool is going to experience?

MR. MILLER: We've looked at the effects of hydrodynamic loads in the fuel pool cooling system, and we don't believe that that would cause any problem. It has not specifically been analyzed for that, but we have looked at that and do not believe that that is a concern.

MR. WHITE: The spent fuel pools are essentially isolated then.

MR. MILLER: The pools are seismically designed, and they are normally isolated. So, there would be no problem with the pools themselves.

MR. WHITE: How about any environmental situation?

MR. MILLER: The only condition would be if you have to go to restart the fuel pool cooling system, you do have to go to reactor building 749. The dose rates there are lower. If we had airborne radiation present, then there would be dose rates there, but they are much lower than they are in the lower elevations of the reactor building. So, I could access that location, and actually that's part of what we looked at.

The three ESW valves that I open -- two of those valves are at the same location as the fuel pool cooling equipment. They're actually in the room with the fuel pool cooling heat exchangers, and I've looked at that, and we can access those valves.

MR. ECCLESTON: What kind of source term -- when you did the time-motion studies, what kind of source term were you assuming in the area? What is the Reg Guide 1.3 again?

MR. MILLER: Yes.

The next slide shows the loss of offsite power added. Now, in this case, I would lose the fuel pool cooling system due to the loss of offsite power. So, in either case, I've lost the system.

We do expect to be able to restore offsite power, certainly, within a 24-hour time period, but we've considered, if I can't do that, if I can't restore that power, I can use the RHR system in the fuel pool cooling mode, as I could for the LOCA scenario.

MR. THADANI: Let me make sure I understand. The case we are trying to look at now is still where you are realistic, no fuel failure --

MR. MILLER: Right.

MR. THADANI: -- and the RHR that you're talking about restoring is the affected unit?

MR. MILLER: The affected unit, correct. Now, if I have the pools cross-tied, I can use the RHR --

MR. THADANI: I understand that. Before we get there, let me ask you -- what is being used to cool the suppression pool?

MR. MILLER: We would use the other division of RHR.

MR. THADANI: What are going to inject into the reactor?

MR. MILLER: You can line that system up to recirculate. If you have the loss of coolant accident, you can provide make-up to the reactor with core spray to use the other division in the pool cooling. You could swap back and forth between RHR fuel pool cooling and RHR in the suppression pool cooling.

MR. CALVO: But if your single failure is the RHR --

MR. MILLER: That single failure on RHR would not affect my ability to use RHR for fuel pool cooling.

MR. CALVO: You still could use the remaining within the RHR to cool the reactor.

MR. MILLER: I have core spray, two divisions of core spray I could inject into the reactor. I have two divisions of RHR. If I fail my ability to inject with one division of RHR, I can use that division to cool the pool.

MR. CALVO: It seems to me you said that the worst single failure was this injection valve.

MR. MILLER: Peak cladding temperature.

MR. CALVO: Peak clad temperature. I think I can understand that. It could be that it's loss of one EDG, for example, may be a more limiting scenario.

MR. MYERS: The worst single failure overall is the valve things that we talked about and then loss of the train due to an electrical failure is another reason and not losing some offsite power, so that we have to handle the heat sources in the offsite power. That's the kind of things you add together with your licensing basis there, and that's what you see.

MR. THADANI: I guess, following up on this particular line of thinking, if had a situation -- I grant you that your peak clad temperature will be lower.

I also agree with your earlier statement that it's a totally non-mechanistic approach to the way we do this when we assume Reg Guide 1.3 source term and say peak clad temperature shouldn't exceed -- except that -- it is true it's non-mechanistic.

However, if you have a scenario -- if you're also going to tack on single failure, recognize this may not be the worst one as far as the peak clad temperature, but if I assume single failure is loss of a diesel generator, it seems to me, then, you are down to one train -- I don't know the details of Susquehanna.

MR. MILLER: I would lose a single RHR pump if I lost a diesel generator, but that doesn't take away my capability to use the other pump.

MR. THADANI: Right.

MR. MILLER: I only use one pump to do fuel pool cooling, by the way.

MR. THADANI: What I'm trying to get at is now you're down to one pump, and that pump is to be used to cool the suppression pool, provide some injection to the core, and --

MR. MILLER: Well, let's take this scenario. Let's take a diesel failure.

MR. THADANI: Okay.

MR. MILLER: Let's say it's the "A" diesel. I would lose the "A" RHR pump. I would be able to inject to the vessel with the other loop of RHR. It depends on where the break location is.

MR. THADANI: We're being very arbitrary.

MR. KOSTELNIK: There are four RHR pumps, two in each unit.

MR. CALVO: I'm sure that you've got four, but each one is 50-percent capacity.

MR. KOSTELNIK: No, they're 100-percent capacity.

MR. CALVO: You have 100-percent capacity. So, if you use one train, you've got 200-percent capacity left in the other train.

MR. KOSTELNIK: Yes, for fuel cooling and suppression pool.

MR. CALVO: Will you divert the water to both places? I guess you can.

MR. KOSTELNIK: Yes. You can use one of the trains in suppression pool cooling and the other train --

MR. CALVO: Assume that one train is gone.

MR. MILLER: Each pump is on a separate bus.

MR. CALVO: You've got four buses?

MR. MILLER: Yes.

MR. CALVO: You've got four diesels?

MR. MILLER: We have a fifth diesel that we can rely on for any of the others. We have four diesels. Each diesel supplies two 1E SS buses on each unit. So, we have four diesels shared between the two units, four RHR pumps per unit, one per diesel.

Now, if I fail a diesel, I have a fifth diesel that I can line up to any of the other four. I should have explained that part of the system in the beginning. It would have been helpful.

Again, if my Reg Guide 1.3 source term is present, I would not use RHR fuel pool cooling.

Again, I've got greater than two days, adequate time to restore cooling. I always have emergency service water to provide make-up either way, and if the pools are cross-tied, I have additional capability.

MR. WHITE: Do you have an ELP that requires you to discontinue non-1E power to the reactor building?

MR. MILLER: We have an emergency procedure, and I don't recall which one it is, but we had at one point included a statement that, in the event of a loss of coolant accident, with or without the loss of offsite power, one of the actions that we want to take -- and it depends on the exact nature of the event and conditions at the time of the event -- there is a step in the procedure that would shed some of the non-essential load from the reactor building in order to maintain reduced temperatures within the building.

One of the things that we shed was power to the fuel pool cooling pumps, but that was only at the direction of the Emergency Director. So, it's part of our emergency plan procedures.

It was not an action that the operators would automatically go out and do, and that was used at that point in time to selectively reduce the heat load within the reactor building. It was at the discretion of the Emergency Director, basically.

MR. WHITE: The ELP is still there, then. The ELP does say that, within 24 hours, if your temperature limits in the reactor building are exceeded, the Emergency Director may, in fact, elect to shut down all non-1E power to the reactor building. Are you saying that that would not happen here?

MR. MILLER: Certainly, in light of what we have done in evaluating this issue, we would very carefully make that decision, and we would look at the actual conditions in the plant at the time before we would take an action to shed that load, and in light of this issue, I believe we would maintain cooling to the pool under those conditions.

MR. WHITE: Currently -- I know it's -- it's a small point now, but what -- in the emergency situation, in the fog of dealing with a LOCA event --

MR. MILLER: What we have done is we have included -- within the procedure that is used in the Technical Support Center, we've included their instructions for the engineering people that would man the Technical Support Center, and that's in the power plant, regarding the fuel pool.

We've provided guidance there in terms of monitoring the fuel pool. We've provided actual curves of the decay heat as a function of time based on the actual plant conditions. We've put guidance in there in terms of how long would it take to reach a boiling condition.

So, we've put information into the hands of the emergency response organization within the plant.

MR. WHITE: Is it possible that the Emergency Director could elect to establish power to the building with temperature limits being exceeded?

MR. MILLER: Can you restate that question?

MR. WHITE: The reason that you could take the power off is because you're approaching some EQ value for the temperature limits in the building, I presume.

MR. MILLER: We were concerned with the temperature response post-accident. This was one of the things that we put a provision to use only if the temperatures were very excessive under these conditions.

MR. WHITE: My question is, if the temperatures are excessive, if they did exceed whatever that value is, is the Emergency Director going to still respond,by restoring power back to the building in order to establish spent fuel pool cooling?

MR. MILLER: I believe we would look at the fuel pool conditions at that point, and if we had to shed that load -- you know, we would have to compare the conditions in the pool to the conditions in the reactor building at that point in time. I would expect that we would provide cooling to the fuel pools prior to shedding the load.

MR. ROTH: There are certainly other auxiliary buildings that you can shed and still reduce heat in the reactor building but maintain fuel pool cooling.

MR. MYERS: I'm not an ED, but I am the lead recovery manager, and this a fairly simple thing one deals with in an emergency, because in both cases we're dealing with the same thing, maintaining the heat situation within the reactor building.

So, it's not a competing environment, and so, in considering what to do in terms of the equipment that you leave running or not, of course cooling the fuel pool is a concern there.

So, it's a fairly simple straightforward thing, and as I said, you can select which pieces you put in.

We can't give you a real definitive answer, because it depends on what broke, what's there and what's not there, what's running and not running there, but in general, I feel comfortable that that decision wouldn't be tough at all to make. That would go routinely.

MR. CALVO: I think, personally, the answer to the question -- you can show that you've got capability, given the single failure, to cool the pool or put make-up in the pool.

Now, the question is how you implement that capability, in view of the fact of the environment and other situations, how you implement that capability.

MR. MILLER: We have several procedures that would come into play under these conditions.

We have an off-normal procedure on loss of fuel pool cooling, we have a procedure to put the RHR system into the fuel pool cooling mode, and we have another procedure to provide ESW make-up to the fuel pools.

The first procedure is an off-normal procedure on loss of fuel pool cooling or coolant inventory, and this would instruct the operator that, if you get alarms on service water or fuel pool cooling, to respond to this particular procedure, and those would be loss of service water, loss of fuel pool cooling flow, system breach, or finally, fuel pool cooling cannot be established, instructs the operator to attempt to restore fuel pool cooling to comply with technical specifications and consider implementation of the emergency plan.

Now, within this procedure, one would -- in the case of, let's say, inventory loss -- would be to provide make-up to the fuel pools, and that normally is done with the condensate system. Again, we do have the emergency service water system to do that. We can also use the fire protection system to do that, and those steps are included in this procedure, as well.

We've also provided the guidance that I've already mentioned to our emergency plan organization within our Technical Support Center to monitor pool conditions.

This procedure goes on to advise the operator that one of the ways you can restore cooling is by cross-tying the pools. So, there are steps in the procedure to do that, to remove the gates to the cask pit, cross-tie the pools, and also, it directs the operator, if necessary, to use the RHR system in the fuel pool cooling mode.

It directs him to always maintain and monitor water level, to maintain 22 feet above the top of any irradiated fuel, and finally, it does direct him to go into make-up via ESW in the event that he cannot restore cooling with any of those other means.

The RHR fuel pool cooling procedure directs the operator to take the RHR system from a stand-by alignment, manually align the system to RHR, and he would do that by lining it up to the shut-down cooling portion of the system, then place emergency service water and RHR service water in service. He would fill and vent the RHR system and then start the RHR pump.

Now, one of the things the operator would do in here is he would raise the level of the water in the fuel pools up to a higher point in order to provide adequate flow from the pools into the surge tanks to put the RHR system into operation. The RHR pumps would take their suction from the surge tanks and provide the return directly to the fuel pool. The operator would then establish a flow rate of on the order of 4,000 to 6,000 gpm to the fuel pool.

MR. HUBBARD: How long does it take to do this alignment?

MR. MILLER: We believe the entire alignment could be done within an eight-hour time period.

MR. HUBBARD: Do you know what time it takes to get the pool filled up?

MR. MILLER: It depends somewhat on the configuration. If the cask pit is empty and I have to raise the level, because the pit is cross-connected, it would take me on the order of, I believe, 22 hours to raise the entire level up.

MR. CROWTHERS: That's with one loop of ESW, assuming we lose the other loop.

MR. MILLER: I can inject 60 gpm with either of the loops of ESW. So, for a minimum configuration, that would take about 22 hours to raise the level up, assuming that would be done in parallel with this.

MR. HUBBARD: Okay. That's what my next question was.

MR. MILLER: Remember, we're talking two days as our minimum time to boil once I lose cooling. So, we've got at least 48 hours in order to take action, and that's considering he's first going to want to restore normal fuel pool cooling, cross-tie the pools if possible, and then use this particular mode.

We've already talked a little bit about ESW make-up.

MR. WHITE: Excuse me.

MR. MILLER: Yes.

MR. WHITE: Can you go back to that slide before? I assume, then, that the heat exchangers have sufficient capacity to do this?

MR. MILLER: Yes.

MR. WHITE: And what flow is required there? You said 4,000 to 6,000 gpm? That can be achieved with the existing net positive suction head?

MR. MILLER: Yes. We ran tests on both units, and we were able to establish a flow of 5,700 gpm with that adequate net positive suction head.

MR. WHITE: So, this has been tested then.

MR. MILLER: Yes, it has been tested.

MR. WHITE: Is that something recent?

MR. MILLER: It was there. I think, originally, we had some difficulty locating the test records themselves, but the systems were both tested as part of our normal start-up test program.

MR. WHITE: So, this was tested years ago then.

MR. MILLER: Approximately '81, '82, '83.

MR. ROTH: Unit 1 was tested in August of '82, and Unit 2 was tested in July of '84, during our pre-operational start-up testing.

MR. WHITE: Those test records are available now?

MR. ROTH: Yes.

MR. WHITE: Were they not available earlier?

MR. MILLER: They were in archives, and they weren't easily available. They were there.

MR. MYERS: Originally, the testing was proposed, I believe, under the pre-op test program, and then it was actually conducted, however, under the start-up test program.

MR. MILLER: The ESW make-up is also part of the off-normal procedure.

If the pool level is less than 22 feet above irradiated fuel, the operator is instructed to start ESW, open ESW to fuel pool isolation valves, and those are the three valves that I already mentioned, one valve located in the reactor building 670 elevation, and two valves at reactor building 749, where the controls are for the fuel pool cooling system. He would open two of those valves as isolation valves and the third one to establish flow to the pool.

MR. THADANI: The fuel pool level information, that's in the control room?

MR. MILLER: No. That's something that we are adding.

MR. THADANI: Okay.

MR. MILLER: One of the things we've done here is to --

MR. THADANI: Could I ask, as you go through, then, to make sure -- so we get a clear understanding of the situation today, can you identify what changes you've made and where they appear in this logical scenario, the information that you're looking at to take certain actions, what are the changes, if you can identify those as you go through.

MR. MILLER: I think we can probably identify them separately. I'm not sure I can identify them all at the right points in this evaluation.

MR. THADANI: In any case --

MR. MILLER: Level and temperature -- that's one of the modifications we're proposing to enhance safety, to provide in the control room level and temperature for each pool.

MR. THADANI: Otherwise, level and temperature information is available where?

MR. MILLER: The skimmer surge tank level is available on the refueling floor and also at the 749 elevation, which is where the controls are for fuel pool cooling; also have temperature indication available at the 749 location.

The operator would be using the skimmer surge tank level as a basis for establishing level within the fuel pool at that point.

MR. THADANI: Are there alarms associated with those?

MR. MILLER: There are, I believe, trouble alarms in the control room. The local alarms would be at the panel itself.

MR. THADANI: At the panel.

MR. MILLER: Yes.

MR. THADANI: The LOCA panels are where?

MR. MILLER: There is a LOCA panel at 749. There is also a panel on the refueling floor.

MR. THADANI: Okay. Thanks.

MR. WHITE: In the fuel pool cooling mode, where does the heat get ejected?

MR. MILLER: To the RHR heat exchanger and the ultimate heat sink.

MR. WHITE: It would normally be ejected to --

MR. MILLER: Normally to the cooling tower.

MR. WHITE: The ultimate heat sink is designed for this additional heat loading?

MR. MILLER: Yes.

MR. HUBBARD: On the design for that additional heat load, you're considering, if you have an accident, you have suppression pool cooling and the additional load?

MR. MILLER: Really, what we're dealing with is removing decay heat in either case. LOCA, loop, unit shut-down, it's all decay heat, and what's in the pool is a small increment that will be added on top, but we've looked at the different configurations.

We looked at outage versus non-outage, because you've got the full core offload issue, and those conditions are enveloped by the design basis ultimate heat sink calculations.

MR. WHITE: All the valves that are required, are they currently in your test program now?

MR. MILLER: Yes. One of the changes we've made is to include some of these valves in terms of a -- it's a preventive maintenance step during our outages to cycle the valves; for example, the RHR fuel pool cooling valves. So, it's not something that we would normally run a test on a periodic basis.

MR. ROTH: It's not in the IST program, but we're going to be doing a revision to the IST program to manually cycle all the valves. That's a new change. Those will be done this coming outage.

MR. KOSTELNIK: The fuel pool cooling valve relative to the ISI program will not be required, per the requirements in the ISI, in Section 11, to be tested, because they were intermediate valves instead of bounding valves.

MR. MILLER: So, the operator would then open those valves, establish flow, restore the level to 22 feet above irradiated fuel, and then terminate that flow.

MR. HUBBARD: Just for reference, in the RHR, you said it took about eight hours to line up for RHR cooling mode. How long --

MR. MILLER: This would take about 10 or 15 minutes, I believe. That was part of the -- when we did the man-motion study, we actually had him go and do all three valves, and it took about 10, 12 minutes. They're small valves. They're easy to open.

MR. WHITE: When you're in RHR cooling mode, what happens to the spent fuel pool? Do you have fission products being gathered there in a LOCA situation?

MR. MILLER: That, I think, is the same question that you were addressing earlier. If you have a source term present on a loss of coolant accident, you would not use RHR fuel pool cooling mode in that unit. So, I would not be transporting fission products to the spent fuel pool.

In looking at the Reg Guide 1.3 source term, we applied the Reg Guide 1.3 source term, we applied an airborne source, and we conducted a study of the operator actions required in terms of providing ESW make-up, and the conclusions of that study are that we do have access to those valves; the dose would be equal to 4.22 rem for the valves at the reactor building 670 location.

RHR fuel pool cooling under these conditions would not be accessible. The refueling floor airborne dose would also be high, but we don't need to go to the refueling floor. The valves are not located on the refueling floor. They are located at elevation 749 and elevation 670.

So, for this case, with the source term present, we can access any of the ESW valves to provide make-up.

For this scenario, then, we are assuming that the fuel pools are isolated; in other words, the gates are in place. What we would do, in response to that, on the non-accident unit, we would isolate the ventilation to the non-accident unit.

So, if you could put that ventilation diagram back up, if we have a loss of coolant accident with a loss of offsite power, all three zones line up to the recirculation system and the stand-by gas system would then be in operation all three zones.

Now, what I would do, if I have a loss of coolant accident on Unit 1, then in response to that, I would manually isolate Zone 2 from Unit 1, and that would normally be the case.

If I did not lose offsite power, this system would be operating only on the accident unit. If I have a loss of offsite power on top of that, I can manually close these dampers, and that would prevent the spread of any airborne into the non-accident unit.

MR. THADANI: And that's done from where?

MR. MILLER: That's from the control room.

Now, for these conditions, then, for the non-accident unit, I can use the normal fuel pool cooling system, if I have off-site power. If not, I can use the RHR fuel pool cooling mode for the non-accident unit.

So, what I've shown here is, on the accident unit, pools are isolated; the pools are going to boil; I'm going to add ESW water to the accident unit pool.

On the other pool, I'm going to provide cooling. The outcome of that is I don't expect to have a condition where a single fuel pool reaches the boiling condition. I can provide make-up to that pool with ESW, and I can use the valves on either unit.

I can use the valves on the accident unit, or I can use the valves on the non-accident unit through the overflow path through the cask pit.

We've taken this condition and we've looked at what are the environmental impacts of allowing that pool to boil out on the accident unit.

As that pool reaches the boiling condition, the majority of the moisture will recondense or will condense within the refueling floor elevation.

The floor has a series of drains, and we would expect, as that water condenses, it would flow down the drains equally to either unit's reactor building sump.

Stand-by gas would be in operation, and the stand-by gas system is designed for boiling pool conditions. It is designed for 100-percent humidity conditions. It would remove some of the moisture but not all of it. It would remove a small portion of the moisture.

MR. SHUM: You said that's designed for 100-percent humidity?

MR. MILLER: Yes.

MR. SHUM: At what temperature?

MR. MILLER: 180 degrees.

The result of this evaluation -- the boil-off that would occur over a 30-day time period -- we're considering 30 days -- would result in accumulation of about 250,000 gallons per unit in the reactor building sump room area.

That's based on providing make-up to the fuel pool that keeps the water level at its normal level throughout the 30 days.

So, we're not going to turn ESW on and just flood the pool. We'll turn it on to maintain level. We will regulate that.

MR. THADANI: That was a procedural change that you made?

MR. MILLER: That's part of the procedure.

The boil-off that results -- and keep in mind here, we're talking about decay heat levels that result in time to boil greater than two days.

So, we are not dealing with a heat load from a full core offload, because in looking at those outage scenarios, you don't really get to this kind of condition when you're in an outage.

For the single boiling pool, 250,000 gallons in the basement.

Now, if we don't have off-site power available, we cannot pump out the sumps, because those pumps are powered from non-1E power, but we've looked at the flooding that results and the sump room would flood.

Adjacent to the sump room is one division of core spray. That area would also flood under these conditions.

On the other side of the room is the RHR division, which has a water-tight door, and then the other division of RHR, core spray, HPCI, and RCIC, they are all protected with water-tight doors, but the sump room and one adjacent core spray pump room would be flooded in the event that the pool was boiling for 30 days.

We can accommodate that amount of flooding within the basement and still have adequate systems available to provide long-term cooling for both units.

Now, in addition to that, we have looked at the effects on the environment in terms of the temperature conditions within the reactor building, and what we have determined is that, if we shut down the recirculation system at the time the pool starts to boil, we can effectively limit the temperatures within the reactor building.

Now, we've completed preliminary calculations on this, and we were able to show that all of the safety-related equipment will perform its safety function throughout the course of the 30 days, even in the presence of the boiling fuel pool, if I shut down the recirculation system.

So, if you put that ventilation diagram back up there, what I'm talking about here is basically turning off the recirculation fans at the time the pool starts to boil, and I can do that from the control room. I believe that's on the same panel as the control room dampers.

I allow stand-by gas to continue running. I can maintain secondary containment without the fans operating, and basically what that does is it limits the moisture travel throughout the building, I'm not spreading it with the recirculation system, and we've done calculations to show that we can maintain temperatures within the limits that allow us to show equipment operability throughout the 30-day period.

MR. CALVO: Have you considered the failure of one of those dampers to close?

MR. MILLER: The dampers that we're talking about closing are on the non-accident unit.

MR. CALVO: That's correct.

MR. MILLER: If they don't close, then at worst, I'd have some airborne activity contribution to deal with on the non-accident unit, but we've said we can access the valves for make-up on the accident unit, so that any dose on the operating unit would be much lower. Most of that dose is from contained sources on the accident unit.

MR. MJAATVEDT: Also, there's two sets of dampers.

MR. HUBBARD: About your statement on the equipment being operable, are you saying that it stays within your qualified limits?

MR. MILLER: We've determined that -- and these are preliminary calculations, so we need to complete that work, but the ECCS pump rooms and ECCS switch gear room, I believe, are within their qualification limits, and we've looked at other equipment, determined that it will be able to perform its safety function during that 30-day period. We have more details on that.

MR. KOSTELNIK: There are a number of MCCs, 480-volt, 250-volt, DC, and a couple of other instruments. The qualification temperature for those components at day 30, or in that vicinity, on the order of day 25 to 30, in that range, would exceed its qualification limit, the number that we use in our EQ program.

However, looking at the test data, the calculations and equations, we determined that if you take it up to that temperature, the peak temperature is on the order of 135 degrees versus the qualification temperature of 124. As Glenn said, these are all preliminary calculations.

At 135 degrees, you could get 55 days of operation out of these instruments even at that higher temperature. However, the MCCs, the components, perform their safety function in day one of the accident. So, they're not required to operate at the time they would exceed their temperature.

MR. HUBBARD: Then you would be required to -- if they did exceed the temperature, you would have to look to see is a failure going to --

MR. KOSTELNIK: We've looked at that, also, and there is one MCC which would affect the "C" core spray pump and the "C" RHR pump, but again, you have redundancy of those pumps.

You still would have enough equipment, even if that failure were to affect those pumps, to still accomplish long-term core cooling.

MR. HUBBARD: Let me just verify something on the 135. Your temperature would go to 135, and your preliminary looks at the EQ data looks like it would allow you to qualify it to the 135?

MR. KOSTELNIK: It looks like you would get 55 days instead of 100 days.

MR. HUBBARD: So, your qualification looked at 100 days --

MR. KOSTELNIK: Yes.

MR. HUBBARD: -- post-accident?

MR. KOSTELNIK: Yes.

MR. WHITE: What is the normal -- the designed heat load of the building, the reactor building? What's the range of temperatures?

MR. MILLER: I don't have a good answer for that.

MR. WHITE: What values are the limit out there?

MR. KOSTELNIK: Typically, like for the switch gear rooms, for instance, they would -- for an accident without the boiling pool or isolating the recirc, it would get to on the order of 99 to 100 degrees, and they're qualified to 104. In this event, they would get to 103.

MR. MJAATVEDT: I think, normally, they would range -- post-accident, they would range from 110 to 130, depending on where you are in the reactor building.

MR. WHITE: That assumes stand-by gas treatment is functioning?

MR. MILLER: That's correct.

MR. WHITE: Is the duct-work and the stand-by gas treatment and the other HVAC system, is that sufficient to handle this increased condensation?

MR. MILLER: Yes. We've looked at the duct-work, and we believe that the point of condensation will be near the train itself, where there is an outside air connection, and the stand-by gas treatment system has a de-misting section on the heater section and a drain that will be able to accommodate the accumulation of moisture at that point. We've looked at that.

Mark, if you could put that previous slide up for one second, number 21.

So, we've looked at the long-term effects of this, and by shutting down the recirculation system, we can limit the conditions within the building.

Now, that is something that -- we've just learned this. So, that's something that is new information that we're providing to you, and we plan to go back and look at procedures and incorporate that change. That's something that we were not aware of earlier in time.

MR. WHITE: Where is the fuel pool level readout? Is that local or is that remote?

MR. MILLER: The fuel pool level is determined by the operator by looking at the skimmer surge tank level in the reactor building 749 elevation, where the control panels are. So, he can determine if he's got an adequate level in the pools by looking at his skimmer surge tank indication.

MR. WHITE: That's a level location.

MR. MILLER: The level indication is --

MR. WHITE: He has to access the reactor building.

MR. SHUM: In this slide, you indicate that the accumulation is 250Ks, but in your previous submittal, in response to our questions, you show about twice as much, more than twice as much. Why is there that much difference?

Here they show 250Ks. In their previous submittal, on page 22, there they show -- the calculations show that the accumulation would be 800,000 gallons.

MR. CROWTHERS: What this number is based on is the decay heat curves that we showed you earlier for an outage. The heat load that was used to calculate this number, 250K, was 5 1/2 million btu's.

The earlier number that we gave you was -- we attempted to bound anything possible using the heat load that would be in the pool that would give us a 25-hour time, and so, that must have been twice that high.

MR. MILLER: This is the volume commensurate with the actual plant configuration, the isolated pool after an outage.

The only way you could get the other number -- we were doing that at that point to provide a bounding condition -- would be to do your offload and isolate the pool right away, which is something that we don't do.

MR. SHUM: So, you're going to provide a detailed analysis.

MR. MILLER: Yes. By the time we get to the single pool configuration, the time to boil is in excess of two days, and that's what we used to establish this, keeping in mind that, when you're in an outage, you can't have a LOCA on the outage unit. So, you can't really have the configuration that would create this until you start the unit back up.

MR. SHUM: I hope you will explain this in more detail, because we will have to answer the same questions.

MR. MILLER: So, to kind of sum this one up here, the time to boil is always greater than two days. We can provide ESW make-up via either unit.

We can access the accident unit, although we don't have to. We can go to the non-accident unit. We can restore cooling via normal systems or RHR.

We've done the man-motion studies. We can always access either the accident unit or the non-accident unit, and if we cross-tie the pools, we can then use the non-accident unit's systems for either unit.

MR. WHITE: Relative to the instrumentation for the temperature -- spent fuel pool temperature and level, is that instrumentation environmentally qualified?

MR. MILLER: The instrumentation is designed for these conditions. It's not part of the EQ program. It's not required to be part of the EQ program, but we did design it to operate and function under these conditions.

MR. HUBBARD: On your cross-tie of your pools, as I understand, with the LOCA, to cross-tie the pools -- get it straight. With the LOCA on one unit, say Unit 1, Unit 1 and Zone 3 would be connected HVAC-wise.

MR. MILLER: That's correct.

MR. HUBBARD: To do this cross-tie, you need to be in Zone 3.

MR. MILLER: Yes. What I mean here is, if I cross-tie the pool as a configuration, as a normal configuration, I don't have to do anything then.

MR. HUBBARD: Okay.

MR. MILLER: That's something we're considering.

MR. HUBBARD: Okay. So, there might be a problem if they weren't already cross-tied.

MR. MILLER: If they weren't already cross-tied, you'd need offsite power so you can run the crane and move the gates, and you would then have to consider the presence of an airborne source term. With no source term, you can do it.

MR. HUBBARD: Okay.

MR. WHITE: It would be a pretty time-consuming process, I imagine.

MR. MILLER: I don't have an estimate of how long it would take to pull the gates.

MR. ROTH: A couple of hours. Once access was available and you had the crane, an hour to two hours, max.

MR. MILLER: In terms of the actions that we have taken, we have revised a number of procedures, including the fuel pool cooling off-normal, the RHR fuel pool cooling procedure, and the emergency plan procedure that is used by the engineers in the Technical Support Center, and those are all changes that we have made as a result of our review of this issue.

We've also conducted additional operating training. We added a portion of training to the operator re-qualification cycle, and they are alert to these conditions and to the things that we have learned as a result of our evaluations, and we are planning to add fuel pool level and temperature indication to the control room.

The design for these particular modifications is scheduled to be completed by the end of the year and will be installed during the first quarter of 1994.

MR. WHITE: Is that 1E power?

MR. MILLER: Yes.

MR. THADANI: Do we have all this? Have you sent us all this information on the analyses of this?

MR. MILLER: We are preparing an additional report that incorporates all of this information, because some of this is new. A number of these things we reviewed at the March 18th meeting and included in our May 24th report. We've since gained additional information, and we'll provide that.

So, in summary, we've looked at these accident scenarios. We have shown that safe operation of the plant is assured. We can cool the fuel pool for seismic events, for loss of offsite power events, for loss of coolant accidents.

In addition, we can mitigate these conditions, under severe accident conditions where we would have high source terms present.

We have strengthened our controls, and we've made improvement to our procedures, and we've planned some modifications.

So, this concludes my remarks, and at this point, Jim Kenny, the Licensing Supervisor, will proceed.

MR. KENNY: I'm Jim Kenny. I'm the Supervisor of Licensing for PP&L, and I'm planning on discussing the licensing basis for Susquehanna, the Part 21 events as they relate to our licensing basis.

We've recently sent a letter to the Commission that forwards our position. So, I'm not going to spend a lot of time on any one of these key items that we're going to walk through.

What I intend to cover are the regulations and the guidance, the Susquehanna submittals with respect to fuel pool cooling, our assessment of the Part 21 events as they relate to our licensing bases, and finally, our determination of reportability of these particular events.

The design of the Susquehanna spent fuel pools are in compliance with the applicable regulations and guidance. The applicable regulations and guidance are:

General Design Criteria 61, whose title is "Fuel

Storage and Handling of Radioactivity Control," and let me quote to you the relevant section with respect to fuel pool cooling within that particular design criteria.

"Systems shall be designed to prevent significant reduction in fuel storage coolant inventory under accident conditions." What's key there is that we must maintain water in the fuel pool under accidents.

Reg Guide 1.13 also provides guidance from the standpoint of what your licensing criteria are. Its title is "Fuel Storage Facility Design Bases," and again I'll quote from the Reg Guide.

"Non-operation or failure of such systems, including failures from the safe shutdown earthquake, will not cause fuel to be uncovered."

To be in compliance with that particular Reg Guide, PP&L has designed our system to assure our piping will not result in any inadvertent uncovery of the spent fuel pool, and we have, as Glenn has mentioned several times, a Seismic Category I make-up.

Conclusion off of the regulations and the guidance: It's clear we must maintain water in the fuel pool under any and all accident conditions. It does not provide guidance with respect to what accidents need to be considered.

Thus, we need to look at the submittals that were provided as part of Susquehanna's licensing proceedings and the NRC's review of such submittals to provide additional guidance on what accidents are to be considered.

Our conclusion with respect to the submittals that we've made to the NRC at time of licensing is that the licensing bases of the Susquehanna Steam Electric Station considers loss of spent fuel pool cooling resulting in pool boiling to be initiated from a seismic event. The bases for that conclusion are the following:

Our Preliminary Safety Analysis Report which was submitted to support our commencement of construction for Susquehanna had a change made in 1976, specifically with respect to design of the fuel pool cooling system.

That change defined our intention from the standpoint of quality classification for the system and a classification of fuel pool cooling to Seismic Category II.

The fuel pools themselves, the racks, are designed, as Glenn said, to Seismic Category I. They would withstand a seismic event. Seismic Category II assumes they would not withstand a seismic event.

The next submittal is the Final Safety Analysis Report, and this supports our operating license. Contained within that report on spent fuel pool cooling is, as Glenn mentioned, an analysis for a seismic event, which is the bounding condition for fuel pool cooling.

That seismic event would render the cooling system inoperable. We'd have to perform an analysis with respect to the loss of fuel pool cooling. We'd look at a boiling fuel pool and have to assess and assure that we're within the requirements of 10 CFR 100 from the standpoint of dose, offsite dose.

Looking beyond the specific analysis that was done in the spent fuel pool that's contained in the FSAR, we looked at all other accidents defined in our Final Safety Analysis Report to see to what extent pool boiling was or was not considered for all those other events. Glenn has mentioned them. We're talking about loss of coolant accidents. We're talking about loss of offsite power.

We determined that a boiling fuel pool was not considered to be the consequence of any other accident within our Final Safety Analysis Report.

We then need to look at the NRC Safety Evaluation Report, which is their review of our final Safety Analysis Report, for further guidelines. Within that, the NRC has concluded that PP&L was in compliance with General Design Criteria 61, Regulatory Guide 1.13 and Regulatory Guide 1.29. 1.29 has to do with seismic design requirements.

Conclusion: Susquehanna's design is in compliance with the requirements. This is at time of licensing.

Now I'm going to discuss our assessment of the events as described in Part 21 with respect to our licensing basis.

Our conclusion: The existing licensing bases for Susquehanna's spent fuel pool cooling system is acceptable. Our logic for that conclusion is the following, looking at the events as described in Part 21.

As Glenn has mentioned, no immediate action is required to restore spent fuel cooling. We have two days, in excess of two days coming out of an outage. Currently, the plan in its current configuration has in excess of five days. So, it depends on how far out from an outage you have to take compensatory actions.

This is an extremely low-probability event. The input assumptions take the analysis that is done for separate accidents. It takes a design basis accident and it adds to it a loss of coolant, two separate accidents.

We've calculated using our individual plan evaluation our probability results from this particular event, and we've concluded that the event's probability is 5 times 10 to the minus 15.

MR. THADANI: When you quote a number like 10 to the minus 15 and put 5 in front of it, it belies knowledge and understanding well beyond -- I'm going to use my words to see if this is what you're saying. That number is just carrying through a combination of events and multiplying them and coming up with something.

MR. KENNY: That's correct.

MR. THADANI: What you firmly believe, I think, from what you have said, that the sequence of events we're talking about has an extremely low likelihood of occurring.

MR. KENNY: Yes.

MR. THADANI: If you said 10 to the minus 10, I might even argue with that.

MR. KENNY: It's our position that the probability of this event is far beyond the probability of the other events that we're required to design for.

MR. THADANI: If you believe this event is of such low likelihood of occurrence and if you believe you meet the licensing basis, why are you doing what you are doing?

MR. JONES: Let's see if I can rephrase your question. If we believe this a low-probability event and we believe we meet our licensing basis and we believe we meet our design basis, why are we here? Why are we working on this?

This issue was raised, and we have spent a lot of time and effort digging into these issues and have asked ourselves the questions. We have found thins that will help the operators and will actually make our response better.

Our basic philosophy is we are assigned to continually improve the defense-in-depth of the plant through the design improvements and the interaction of engineering with operations. So, every opportunity we get where there is a payback, we will take that payback.

So, we have changed procedures. We have sent some modifications in that we know will help the operators respond to this event, as well as an event like a drain-down in some other places.

So, it's the right thing for us to do. It's going to cost us half a million a unit.

MR. THADANI: That was going to be my next question.

MR. JONES: But to us, because it gets one of those things off of the operator's back during the accident and it's something that we can use and is useful, then we want to do it.

We've spent untold hours analyzing flows in the pool, untold hours analyzing heat responses in the room, because our engineers now understand a lot more about how these systems interact than we did when we started. I'll say that up front, and that's why we wanted to spend the time.

MR. THADANI: Okay. I am troubled by your argument on probability which implies this is even less likely than a meteorite striking a part of earth and destroying --

MR. JONES: We can argue about the numbers, and the fault tree that you have to follow to get to this point is very good. We all know what that means, and the way we use our IPE is to help us to find those things that we want to make better. You can create the numbers easily. We all know what the threshold is for taking action.

MR. KENNY: I think you ought to understand, Ashok, that the modifications that we're looking at making will improve our operators' ability during outages. So, they will assist us, and these were identified as modifications, I think, George, before this event was --

MR. MYERS: These mods originally came out of reviews of the safety systems by our nuclear safety assessment group. They were on the record. This concern, however, focused us on it, and George decided to take action last year when it came up.

In regard to the other part, where we're trying to make sure the FSAR is accurate, that had also been identified, and we're following through with that.

MR. KENNY: Beyond probability, we believe actions will be taken by plant operators. We will ensure that we have adequate water level within our spent fuel pools, and we will take necessary steps to assure we have pool cooling.

We do believe it is beyond the specifics of the Susquehanna licensing submittals. Our position is consistent with what we see as prior regulatory evaluations.

One issue is Generic Issue 82, which is titled "Beyond Design Basis Accidents in Spent Fuel Pools." What we've looked at there, we've looked at other kinds of deliberations, have concluded that this is a low-probability event and that procedures should be in place to mitigate the consequences of the event. So, we have taken those actions.

Lastly, I want to address reportability, as this was a Part 21 report submitted to the Commission. It is our conclusion that the postulated events did not require reporting by the regulations. Those regulations would include Part 21, 50.72 and 73, 50.9. Bases for that conclusion is the events as described are beyond the licensing bases for our station. We believe --

MR. THADANI: Do you also believe that if you -- it's a little more difficult in your case, but if you were a single-unit plant and you didn't have this ability to cross-tie from the unaffected unit, would your conclusion have been different.

MR. KENNY: I think that everybody could maybe have a different answer on that. I do not. For a single-unit plant, some of the conditions would remain the same. One, you have a lot of time. So, time provides anybody's capability to respond.

I believe these events are typical of what operating facilities are attempting to deal with in severe accident respond.

I would say those units, even though they would not have the capability of having a second pool, would have capability and time to put in place compensatory actions, one to get -- surely get water to the pool and, two, attempt to get cooling to the pool.

MR. THADANI: I guess the reason I'm asking you is --

MR. JONES: What I heard you asking was, if I follow the regulations as stated in a single-unit plant, then I think I'm okay. Is my design then satisfactory? I will let you draw this conclusion.

If have a single unit, the regulation says put water on the pool to handle the steam, and I could do that even I'm a single unit. So, if I meet the regulation, then we consider that design adequate.

MR. THADANI: But you did some special calculations to see what --

MR. JONES: Yes, we did.

MR. THADANI: Okay.

MR. KENNY: The basis for our conclusion on reportability: one, beyond the licensing basis; as we defined, we considered them extremely low-probability; and lastly and most importantly, we do not consider it the substantial safety hazard.

We believe we have the systems, structures, and components, as well as trained operators, to assure that we can mitigate the consequences of the events as described, and I think Glenn has gone into detail on exactly what we have available to us.

That completes my remarks. I'd like to turn it over to George Jones now for some closing remarks.

MR. JONES: If there is need for further information, we'll make certain that we get that to you as quickly as we can if we know what it is.

Of course, our files are always open to you, including the file and the tape of the time-motion study, and we will assist in those in any way that we can.

We've spent a significant amount of effort on this issue. I believe that we have received some payback in doing that, both payback in terms of the safety of the plant and in terms of our understanding of the way the plant operates and should operate under accident conditions.

These types of issues we want brought up by our people. Sometimes it's torturous to get to the end, but you always learn something, and it's that learning that we want.

We sincerely appreciate the opportunity to discuss these issues with you. I want to thank you for your patience, and if you have any questions, we're certainly available.

MR. CLARK: I'd certainly like to express our thanks and appreciation for you coming in today, George, and again, it was relatively short notice.

MR. THADANI: I do want to thank you. You've certainly answered my questions, some of the questions that we sent you, the ones I asked my staff, and I wanted to make sure I heard directly from you on those issues, and to my mind, at least, you have answered my questions, and it's clear to me you've done a fairly detailed and thorough analysis and seem to have a full understanding of the issues.

We will, of course, review the information, and we would expect to receive your submittal. I'll give you my initial reaction beyond just saying you've answered my questions.

It seems to me you've really gone about it in a fairly responsible manner. You have looked at the safety significance of the issues. You have done analyses.

You have looked to see where you can enhance guidance to the operators and others in a sort of multi-dimensional approach which I think makes a lot of sense, and I think it's fairly effective.

I also happen to agree with you. I think this situation we're talking about is, in fact, a very low-probability event. I wouldn't go as far as to say it's as low as you said, but I agree with you it's very low-probability, and again, I want to thank you for coming at such short notice and addressing these questions. Thanks.

[Whereupon, at 12:40 p.m., the meeting was adjourned.]

REPORTER'S CERTIFICATE

This is to certify that the attached proceedings before the United States Nuclear Regulatory Commission
in the matter of:

NAME OF PROCEEDING: NRC & PA Power & Light Spent Fuel Pool Cooling

DOCKET NUMBER:

PLACE OF PROCEEDING: Rockville, Maryland

were held as herein appears, and that this is the original transcript thereof for the file of the United States Nuclear Regulatory Commission taken by me and thereafter reduced to typewriting by me or under the direction of the court reporting company, and that the transcript is a true and accurate record of the foregoing proceedings.

Jan Rothrock

Official Reporter
Ann Riley & Associates, Ltd.

ENCLOSURE 2

LIST OF ATTENDEES

MEETING BETWEEN NRC AND PP&L

JULY 8, 1993

NAME	ORGANIZATION
R. Clark	NRC/NRR
S. Varga	NRC/NRR
J. Calvo	NRC/NRR
A. Thadani	NRC/NRR
G. Hubbard	NRC/NRR
D. Shum	NRC/NRR
J. Cunningham	NRC/NRR
V. Ordaz	NRC/NRR
K. Eccleston	NRC/NRR
J. Kopeck	NRC/OPA
J. White	NRC/RGN-I
C. Myers	PP&L
D. Kostelnik	PP&L
R. Sgarro	PP&L
M. Crowthers	PP&L
B. Snapp	PP&L
M. Mjaatvedt	PP&L
J. Kenny	PP&L
G. Miller	PP&L
G. Jones	PP&L
D. Roth	PP&L
H. Woodeshick	PP&L
J. Silberg	Shaw Pittman
A. Smith	Newsday
L. James	Bechtel, SERCH
R. Macers	PA DER/BRP
D. Ney	PA DER/BRP

AGENDA

PP&L PRESENTATION TO THE USNRC: THE SUSQUEHANNA SES SPENT FUEL POOL COOLING SYSTEM

THURSDAY, JULY 8, 1993

INTRODUCTION

GEORGE T. JONES
Vice President-Nuclear Engineering

TECHNICAL EVALUATION

GLENN D. MILLER
Manager-Nuclear Technology

LICENSING BASIS

JAMES M. KENNY
Supervisor-Nuclear Licensing

MANAGEMENT PERSPECTIVE

GEORGE T. JONES

Fuel Pool Cooling Issue

- System Overview
- Design Bases
- Outage Sequence
- Accident Scenarios
- Conclusions & Actions Taken

SSES Plant Layout

- Dual unit BWR 4 with Mark II containment
- Separate reactor buildings
- Common refueling floor
- Shared post-accident ventilation system
- Two SGTS trains

Fuel Pool Design

- Storage capacity: 2850 fuel assemblies
- Seismic Category I structure
- Common cask pit
- Surge tanks cross-connect to cask pit

Fuel Pool Cooling System

- Three pumps and heat exchangers
- 13.2 MBtu/hr capacity
- Cooled by Service Water
- RHR Fuel Pool Cooling mode
- ESW supply for emergency makeup
- RHR & ESW 1E powered & Seismic Cat I

Design Bases

- Structural Design
- Emergency Heat Load
- Loss of Fuel Pool Cooling Event
  - Seismic event
  - Radiological Consequences

Emergency Heat Load (EHL)

- Assumed fuel cycle discharge schedule
- Fuel pool filled
- Full core offload
- Maintain temperature < 125°F
- Heat load = 33.94 MBtu/hr
- Credit for RHR system Fuel Pool Cooling mode

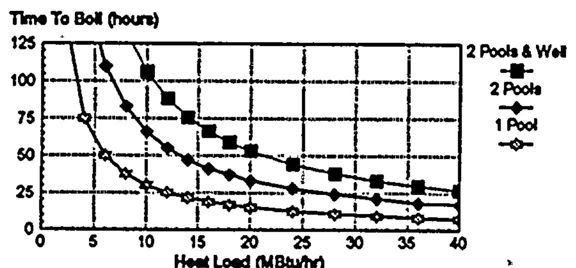
Typical Refuel Outage

- Shutdown risk assessed and managed
- Outage periods impose highest heat loads due to core offload
- Configuration provides greatest flexibility to prevent boiling
- Largest effective pool volume:
  - Fuel Pools cross-tied via Cask Pit
  - Rx Cavity & Storage Pit cross-tied
- No fuel in vessel

Typical Refuel Outage Sequence

- Outage schedule reviewed to assure FSAR seismic event analysis is bounding
- Core fully offloaded
- Fuel Pools monitored
- Administrative limit set at <110°F
- Fuel Pools crosstied and connected to RX Cavity

Time-to-Boil T(0)=110°F

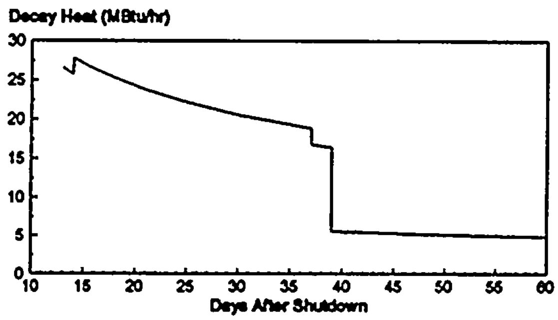


Volume (2 Pools & Well) = 173,146 cu-ft
Volume (2 Pools) = 107,178 cu-ft
Volume (1 Pool) = 48,600 cu-ft

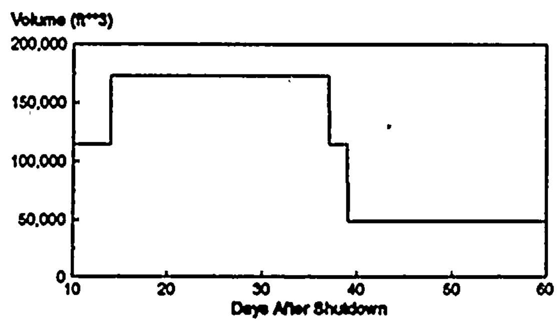
Typical Outage Sequence

- Day 6: start core offload
- Day 11: isolate ventilation
- Day 13: complete core offload/cross connect pools
- Day 17-26: common RHR work window
- Day 30: start core reload
- Day 37: complete core reload/install cask gate
- Day 39: install gate to reactor well
- Day 48: restore ventilation
- Day 55: complete outage

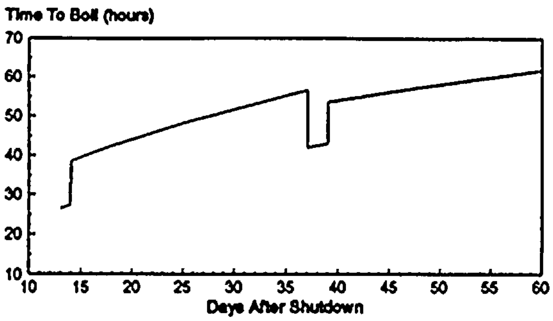
Typical Refuel Outage - Decay Heat



Typical Refuel Outage - Effective Fuel Pool Volume



Typical Refuel Outage - Time To Boil



Outage Scenario

- Highest heat load
- LOCA or LOCA/LOOP on operating unit
- Outage Unit:
  - Fuel Pools Cross-tied
  - RHR available for pool cooling
  - CS & ESW operable for makeup
  - Reactor Building isolated
  - Maximum water volume

Non-Outage Scenario

- LOCA or LOCA/LOOP on either unit
- Must provide cooling for both reactors and both fuel pools (if isolated)
- Heat load lower than during outage
- Time-to-boil always > 2 days
- Can provide ESW makeup from non-accident unit
- If pools cross-tied can provide RHR cooling from non-accident unit

Outage/Non-Outage Comparison

- Outage periods impose highest heat loads
- Configuration provides greatest flexibility to prevent boiling
- During outage one unit is shutdown and fuel pools are cross-tied
- Less demand on RHR due to cross-tied pools and shutdown unit

Accident Scenarios

- LOCA
- LOCA with Loss of Offsite Power
- Severe Accident

DBA LOCA

- Analyzed for worst single failure
- Break in recirc loop
- ECCS systems inject into vessel
- Provides reflood capability
- Assures long-term cooling

DBA LOCA - Fuel Response

- Analyzed with GE SAFER/GESTR
- PCTs ~ 1000°F for best-estimate case
- PCTs ~ 1500°F for Appendix K evaluation
- Results are below threshold for clad rupture
- No fuel failures expected
- Reactor Bldg is accessible

DBA LOCA

- FPC lost initially due to Aux Load Shed
- Expect normal FPCS to be functional following LOCA; perform manual restart
- Reactor Bldg is accessible
- Worst case time-to-boil is >2 days
- Adequate time exists to perform operator actions
- Cooling can be restored
- Makeup via ESW is assured
- Non-LOCA unit can provide cooling via cross-tied pools

DBA LOCA/LOOP

- FPC lost initially due to LOOP
- Expect to restore offsite power within 24 hours
- If offsite power cannot be restored use RHR FPC mode
- Reactor Bldg accessible
- Adequate time exists to perform operator actions
- Cooling can be restored
- Makeup via ESW is assured
- Non-LOCA unit can provide cooling via cross-tied pools

Operator Actions to Restore Systems (Procedures)

- Loss of Fuel Pool Cooling
- RHR FPC Mode
- ESW Makeup

Loss of Fuel Pool Cooling/Coolant Inventory (ON-135/235-001)

- Service Water and/or FPC System Alarms
- Determine Cause
  - Loss of Service Water
  - Loss of FPC Flow
  - FPC System Breach
  - FPC Cannot be Established
- Comply with Tech Specs
- Possible E-Plan Implementation

Fuel Pool Cooling Cannot Be Established

- Cross-tie Fuel Pools via Cask Storage Pit
- Place RHR System in FPC Mode
- Maintain/Monitor >22 ft Above Irradiated Fuel
- Allow Fuel Pool to Boil with makeup via ESW

RHR FPC Mode (OP-149/249-003)

- RHR in Standby Alignment
- Align RHR Pump Suction
- Place ESW and RHRSW in Service
- Fill/Vent RHR System
- Start RHR Pump
- Establish RHR Flow: ~ 4000 - 6000 gpm

ESW Makeup (ON-135/235-001)

- If Fuel Pool Level < 22 ft Above Irradiated Fuel:
  - Start ESW
  - Open ESW to Fuel Pool Isolation Valves
  - Establish Flow to Fuel Pool
  - Establish Level > 22 ft Above Irradiated Fuel

"Severe Accident"

- Reg Guide 1.3 source (100% core damage)
- Airborne source included
- Time/motion study of operator action
- All ESW makeup valves accessible
  - Dose = 4.22 Rem
- RHR FPC not accessible (accident unit)
- Refueling floor airborne dose will be high

Severe Accident - Non-accident unit

- Assume fuel pools isolated
- Isolate ventilation from non-accident unit
- Normal FPCS or RHR FPC mode on non-accident unit
- Only expect one pool to boil
- Makeup to isolated pool with ESW always possible
- Environmental impacts of a single fuel pool boiling are assessed

Environmental Impact - Single Pool Boiling

- Most moisture will condense on refueling floor and flow down drains to sumps
- SGTS designed for 100% humidity
- Boiloff results in accumulation of ~ 250K gallons per unit
- Can accommodate condensation for 30 days in RB basement without compromising long-term cooling (both units)
- Long-term decay heat removal assured: shutdown of recirculation system limits temperatures in reactor building

Severe Accident Conclusions

- Time-to-Boil > 2 days
- ESW makeup provided via either unit
  - Access to accident unit possible but not required
- Cooling can be restored via:
  - Normal FPC system
  - RHR FPC mode
- Access to non-accident unit always assured
- Cross-tie of pools allows use of non-accident unit systems under all conditions

Actions Taken

- Procedures revised
- Operator training
- Modification to add FP Level and Temperature to Control Room

Summary

- Safe operation is assured
- Fuel pool can be cooled for:
  - Seismic events
  - LOOP
  - LOCA or LOCA/LOOP
- Can mitigate effects for Severe Accident
- Controls strengthened
- Procedures improved
- Modifications are planned

LICENSING BASIS

The design of the Susquehanna Spent Fuel Pool Cooling system is in compliance with applicable regulations and guidance.

- GENERAL DESIGN CRITERION 61: Fuel Storage and Handling and Radioactivity Control

  - ". . . shall be designed to prevent significant reduction in fuel storage coolant inventory under accident conditions."

- REGULATORY GUIDE 1.13: Fuel Storage Facility Design Basis

  - ". . . maloperation or failure of such systems (including failures from the Safe Shutdown Earthquake) will not cause fuel to be uncovered."
  - piping is arranged to prevent inadvertent draindown from uncovering the spent fuel
  - Seismic Category I Makeup (ESW) is provided

There is no specific guidance regarding the type of accident conditions that must be considered in GDC 61 or Regulatory Guide 1.13.

LICENSING BASIS

The Licensing Basis of Susquehanna SES considers loss of spent fuel pool cooling resulting in pool boiling to be initiated from a seismic event.

- PRELIMINARY SAFETY ANALYSIS REPORT
  - Reclassification to Seismic Category II for cooling system
  - Seismic Category I Makeup (ESW) provided

- FINAL SAFETY ANALYSIS REPORT
  - Seismic event was bounding condition for fuel pool
  - Boiling evaluation performed to determine 10CFR100 compliance
  - Not linked to chapter 15 LOCA radiological evaluation

- NRC SAFETY EVALUATION REPORT
  - General Design Criterion 61
  - Regulatory Guides 1.13 and 1.29

- CONCLUSION : DESIGN IS IN COMPLIANCE WITH REQUIREMENTS

LICENSING BASIS

The existing Licensing Basis for the SSES spent fuel pool cooling system is acceptable.

- NO IMMEDIATE ACTION REQUIRED TO RESTORE SPENT FUEL POOL COOLING

- EXTREMELY LOW PROBABILITY EVENT

  - Input assumptions : DBA coupled with extended loss of pool cooling
  - IPE Result : 5×10^{-15}

- ACTIONS WILL BE TAKEN BY PLANT OPERATORS

  - Ensuring water level above spent fuel is a priority

- CONSISTENT WITH PRIOR REGULATORY EVALUATIONS

  - Generic Issue 82 : Low probability event. Procedures should be developed to mitigate the consequence of the event

LICENSING BASIS

The postulated events did not require reporting per the regulations.

- BEYOND THE LICENSING BASIS
- EXTREMELY LOW PROBABILITY
- NOT A SUBSTANTIAL SAFETY HAZARD
    - Operator training and procedures
    - Systems, structures and components