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NUCLEAR REGULATORY COMMISSION

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ADVISORY COMMITTEE ON REACTOR SAFEGUARDS

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MEETING OF THE SUBCOMMITTEE ON

RELIABILITY AND PROBABILITY RISK ASSESSMENT

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THURSDAY

JANUARY 23, 2003

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ROCKVILLE, MARYLAND

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The Subcommittee met at the Nuclear Regulatory Commission, Two White Flint North, Room T2B3, 11545 Rockville Pike, at 8:32 a.m., Dr. George Apostolakis, Chairman, presiding.

SUBCOMMITTEE MEMBERS PRESENT:

DR. GEORGE APOSTOLAKIS, Chairman

DR. MARIO V. BONACA, Member

DR. F. PETER FORD, Member

DR. THOMAS S. KRESS, Member

DR. GRAHAM M. LEITCH, Member

DR. VICTOR H. RANSOM, Member

SUBCOMMITTEE MEMBERS PRESENT: (CONT.)
DR. STEPHEN L. ROSEN, Member
DR. JOHN. SIEBER, Member
DR. WILLIAM J. SHACK, Member

NRC STAFF PRESENT:
MEDHAT EL-ZEFTAWI, Designated Federal Official
MICHAEL R. SNODDERLY, Cognizant ACRS Staff Engineer
LARRY BURKHARDT, NRR
NICHOLAS SALTOS, NRR
WALT JENSEN, NRR
MARIE POHIDA, NRR

PRESENTERS:
MICHAEL CORLETTI, Westinghouse
TERRY SCHULTZ, Westinghouse
SELIM SANCAKTAR, Westinghouse
JIM SCOBEL, Westinghouse
ED CUMMINS, Westinghouse

C-O-N-T-E-N-T-S

P-R-O-C-E-E-D-I-N-G-S

(8:32 a.m.)

CHAIRMAN APOSTOLAKIS: The meeting will now come to order. This is a meeting of the Advisory Committee on Reactor Safeguards, the Subcommittee on Reliability and Probablistic Risk Assessment.

I am George Apostolakis, Chairman of the Subcommittee. The Subcommittee Members in attendance are Tom Kress, Graham Leitch, Mario Bonaca, Victor Ransom, William Shack and Jack Sieber.

The purpose of this meeting is to review the PRA provided by Westinghouse Electric Company in support of its application to the NRC for certification of its AP1000 design. The subcommittee will gather information, analyze relevant issues and facts, and formulate proposed positions and actions as appropriate for deliberations by the full committee.

Medhat El-Zetawi is the Designated Federal Official, and Michael Snodderly is the Cognizant ACRS staff engineer for this meeting. The rules for participation in today's meeting have been announced as part of the notice of this meeting, and previously published in the Federal Register on December 27th, 2002.

A transcript of the meeting is being kept and will be made available as stated in the Federal Register Notice. It is requested that speakers first identify themselves and speak with sufficient clarity and volume so that they can be readily heard.

We have received no written comments or requests for time to make oral statements from members of the public regarding today's meeting. We have already reviewed some time ago the AP600 design and PRA as the members know, and this is a first in a series of meetings to support the future full committee meeting on the staff's last safety evaluation report on the AP-1000.

We will now proceed with the meeting and I call upon mr. Michael Corletti of Westinghouse to begin.

MR. CORLETTI: Thank you and good morning. My name is Mike Corletti from Westinghouse, and I am just going to take a couple of minutes to go over a few introductory slides. Are we able to deem the lights?

The first several slides are the agenda, which I was not planning to go over.

MR. SNODDERLY: I'm sorry, Mike, but can we go back to Friday's agenda.

MR. CORLETTI: Sure.

MR. SNODDERLY: To accommodate the committee would it be possible if we could look at the summary of -- I guess when were we going to do the uncertainty?

MR. CORLETTI: We were going to do the uncertainty -- yeah, we had moved the uncertainty assessment until today, and in the last session, and so the lone presentation tomorrow will be kind of a summary of the PRA insights.

MR. SNODDERLY: Fine.

MR. CORLETTI: So uncertainty assessments will be discussed this afternoon's presentation.

MR. SNODDERLY: Thank you, Mike?

MR. CORLETTI: Is that okay?

MR. SNODDERLY: Perfect. Thank you.

MR. CORLETTI: Okay. I just wanted to go over briefly the overall schedule. This really lists our past milestones on design certification, and we submitted our application.

We received the staff RAIs in September of last year, and we provided our responses to those RAIs by December of last year. We are now in the process of where the staff is reviewing those RAIs and assessing how many of those are acceptable and which of those do we need additional information to close out those issues.

The staff is working towards a June deadline for the draft safety evaluation report, and it has been our goal to provide sufficient information to the staff so that we could attempt to close out all open items for the DSER.

This is our goal. However, it is not necessarily a commitment, but it is a goal that we are working to. And we would then see that we would be looking for the ACRS letter sometime later this year.

Today we are going to provide hopefully a very thorough presentation of our PRA, including the Level 1, 2, and 3 PRA, supporting thermal hydraulic analysis that supports the success criteria for Level One, and the thermal hydraulic studies that we performed for level two.

MEMBER KRESS: Refresh my memory. Has either the AP600 PRA or this AP1000 PRA been subjected to the industry peer review process?

MR. CORLETTI: The AP600 PRA I believe was subjected to a peer review process. The AP1000 we did not. We followed the same model. And it is our intention to try to address all issues related to the PRA in today's meeting. That would be our goal for a successful meeting.

Finally, I just wanted to identify some of our future interactions on some of the subject matter that we would be discussing so that -- and I think that we are flexible on the subject matter of the future meetings, and so if during these next two days you see something that you would want adjusted in those future meetings, we could accommodate that.

And with that, I am going to turn the presentation over to Terry Schulz, where he is going to give a presentation on the overview of AP1000 design.

MR. SCHULZ: Thank you, Mike. My name is Terry Schulz, and my objective here is to talk a little bit about the plant, and especially the parts about the plant that may relate to the PRAs, and some of this I know that you have seen before, but I will try to give a bit of a slant related to the PRA.

Here you see a list of the key design changes that we made in going from AP600 to AP1000. So this will obviously increase the core size and the number of assembles and the length of the assembles to accommodate the increase in power, and the reactor vessel got longer, and did not get bigger in diameter.

We obviously have bigger steam generators like the Westinghouse CE designs. We have maintained the use of the canned motor pumps, and that is an important element in both the design and the PRA connections.

We used variable speed controllers during shutdown modes and not at power. So they don't affect the reliability of the pumps operating at power. There is a larger pressurizer to try to maintain the same kind of capabilities, in terms of riding out transients.

Containment capacity has been increased to accommodate the increased mass energy. Passive system components have been increased and I will talk specifically about that, and obviously the turbine has been increased.

Here you see some of the key power capability parameters. The AP1000, compared to the AP600 and the three loop plants at Westinghouse built in Europe that are of a similar core capability from the number of assembles and the length of the core.

Some of the hot leg temperatures are a little higher than AP60, but still well below operating plant experience. As I mentioned the fuel is the same portion and length as we have operated in both South Texas and in these plans built in Europe.

The power density is higher than these

plants, but there are some operating three-loop plans that have power densities that are the same as AP1000 will be.

And you can see some of the other numbers. The steam generators surface area has been increased significantly to accommodate the power.

MEMBER SIEBER: Is that portion of the steam generator harder? I mean, could we be looking at a Palo Alto drive out problem?

MR. SCHULZ: No, I don't think so. The combustion engineering at Westinghouse has built bigger steam generators than these. The design has lots of -- I think if you work out the square foot per megawatt that it is like AP600. So it is not really being pushed harder there.

I think that the moisture separation is very comparable

MEMBER SIEBER: Now, this is the same as the ALN1 steam generator, right?

MR. SCHULZ: It is similar.

MEMBER SIEBER: It's similar.

MR. SCHULZ: It is not the same design, no. I actually don't have a separate slide on steam generators in this presentation, but the design features are basically the Westinghouse design features, in terms of materials, tube supports, motion separators.

It is scaled up and we show that ALN generator because Westinghouse-Pittsburgh built that before we joined with Combustion Engineering. Now, since we joined with Combustion, we have consulted back and forth on the design of this bigger steam generator to take advantage of their experience.

So they have looked over the design to make sure that we weren't extrapolating beyond what we could do. And so then they would have an increased comfort factor on that.

MEMBER LEITCH: Terry, one of the Doel units that had pretty major steam generator problems with tube sheet cracking, and went to a big sleeving campaign, and eventually replacement of the steam generators, was that Doel 4 do you know?

MR. SCHULZ: I am not sure of all of the different generators that have had problems. However, we have had a lot of experience with replacement generators now using the latest tube materials, Zinc-690 thermally treated, and the way we expand the joints now, and we seem to be getting out of those problems with our steam generators.

And in terms of the number of tubes that we have problems with now, it is really, really small with the new technology and the latest design features.

MEMBER LEITCH: I am not really sure that the problems with Doel were with this particular unit. Okay.

MR. SCHULZ: There is no bottom-mounted instrumentation. This is like AP600. and so we have top-mounted fixed in-core instrumentation. This is a benefit when we get to in-vessel retentions. We don't have those kinds of penetrations at the bottom.

We have adopted a core shroud instead of a radial reflector as we had in AP600, and that was partially or mainly due to we added a few more fuel assemblies into the reactor, and that made some of the sections get to be rather thin.

So that was going to be a bit of a challenge from a design point of view, whereas, in an AP600 it was an easier design. The core shroud, the Westinghouse-Pittsburgh has not built, but the combustion engineering folks who are now part of us have extensive experience with this in very similar sized reactors.

So we are making use of that technology. There is some side effects which Jim Scobel will get into in terms of again that IDR core melt progression, and the amount of the material in the reactor. So there is some connection there.

MEMBER LEITCH: Are there any bottom mounted penetrations? You say no bottom mounted instrumentations.

MR. SCHULZ: No bottom mounted instrumentations at all. The lowest penetrations are up above the core to direct vessel injection connections, which are about at the bottom of the hot legs. So there is really nothing that is below a couple of feet above, or several feet above the core.

MEMBER KRESS: Is the bottom head insulated?

MR. SCHULZ: The bottom head is insulated, and we will show you some pictures about how that insulation is arranged. It is similar to AP600, in that it stands off of the reactor vessel, and so there is a gap --

MEMBER KRESS: So it allows the flooding to --

MR. SCHULZ: Right. So we have engineered inlets of water in the bottom and the steam water vents at the top. We have changed that design to optimize the performance for AP-1000, and we will talk specifically about that.

The canned motor pumps are like what we were using for AP600, and the next slide will talk a bit more about those. There have been a lot of these pumps built mainly for the nuclear Navy, but also early commercial reactors have used these kinds of pumps, and they tend to be very reliable, and require very little maintenance, and so they are a very good fit with the plant design.

The loop connections are simplified versions of our operating plants, and this is basically a weld at either end of the pipe, which reduces the amount of weld significantly, and the way we connect the steam generators into the reactor coolant pumps, and also greatly reduces the amount of supports that we have.

So that the loop is significantly simplified and the pressurizer is larger. A little more information on the reactor coolant pump, and I just want to mainly point out that there is no shaft seals.

This has good implications relative to the PRA, because if a shaft seal is leaking, or failing, is a source of challenge to the safety systems and is modeled in the PRAs as one of the ways that you can get small LOCAs.

It is also a benefit if you lose all station power and have to sit on a station blackout. You don't have issues with this pump in terms of again leakage, or a possible failure of seals.

Another PRA related connection is the use of water lubrication of the bearings. There is no oil in this pump. Oil can leak and can cause fires, and so fires inside containment are reduced by this kind of pump design.

The high inertia flywheel we have increased its capacity in AP1000, and have actually improved the loss of flow performance of AP1000, versus AP600. So the minimum ABWR margin is better in the AP-1000 than AP-600.

For AP-600, we did perform some tests in terms of manufacturing and testing of the flywheel.

CHAIRMAN APOSTOLAKIS: The 12-year mean time between repairs, how was that estimated?

MR. SCHULZ: This was experience from nuclear Navy type operations. They have or basically don't do much to these pumps. They don't have to. There is very little scheduled maintenance on them.

The bearing don't really wear, and there is no seals, and which is a very stark contrast to our operating pumps with the seals. They have to be -- the pumps have to be taken apart and the seals replaced on a periodic basis.

MEMBER LEITCH: Your mentioned, I think, if I understood you correctly that the shutdown there was at a variable speed?

MR. SCHULZ: Yes.

MEMBER LEITCH: But a constant speed at power?

MR. SCHULZ: Right, a constant speed at full power, without use of a variable speed frequency controller, and so that is bypassing that power.

MEMBER LEITCH: Oh, so that is completely bypassed?

MR. SCHULZ: Yes.

MEMBER LEITCH: And then at shutdown there is variable -- can you vary the speed up to full-speed?

MR. SCHULZ: Yes.

MEMBER LEITCH: So then I guess what I am envisioning in a start-up situation that you vary the speed up to full-speed and then bypass the speed controller?

MR. SCHULZ: Well, basically when you are at colder temperatures, you need to slow the pump down, because it tends to draw out more power. And one of the ways that we have limited the horsepower of the pump, which is a challenge in these bigger canned pumps, is that we have minimized the size of the pump motor by not having to over-design it for cold conditions, and this is why we are doing this.

So at cold conditions, we need to use the -- to slow the pump down. Now, as the temperature comes up, then we can increase the pump speed, and eventually go to the point where we can go to the full speed, and then cut out the variable speed drive.

So there is a bumpless transfer then if you will from this variable speed mode to the full speed mode?

MR. SCHULZ: I don't know exactly how that is.

MR. CORLETTI: It is an electrical parallel and transfer. You have two separate electrical supplies, and you transfer, and you synchronize, and transfer to the regular plant bus.

MEMBER SIEBER: So it is a hot transfer?

MR. SCHULZ: Yes.

MR. CORLETTI: The pump keeps running, and you do this before you start the reactor up. So you are in good shape by the time that you do that.

MEMBER LEITCH: Thanks.

MEMBER RANSOM: Excuse me, but how do you mount the pump to the steam generator to prevent things like fatigue and also a possible breaking off? I mean, is that one of the design basis accidents?

MR. SCHULZ: No, the casing of the pump is welded in the factory directly to the channel head of the steam generator, and typically those kind of -- it is considered part of the pressure vessel.

So we don't normally postulate breaks of pressure vessels.

MEMBER RANSOM: Was that designed, or I guess the maximum stress there such that over the life of the power plant that you would not expect fatigue to be an issue?

MR. CUMMINS: This is Ed Cummins again. This is an ASME code pressure vessel, and we have to meet all of the stress and fatigue limits of the ASME code, and it is treated like a pressure vessel though. I think a break there would be very similar to a --

MR. SCHULZ: It is still basically limited by the hot leg-cold leg typing, which we take full breaks of to analyze for large LOCAs. Now I would like to move on to the safety systems and the approach to safety. I think that most of you have heard this slide, where the use of the passive systems, and what we mean by that, in terms of we have a few active valves, and most of which are fail safe, that have to be activated when the systems are aligned.

Once they are aligned, then the plant can continue operation indefinitely in that mode of operation. We don't have to reclose valves, and we don't have any continuously operating equipment -- pumps, fans, diesels -- that have to run in our safety systems.

We have a greatly reduced dependency in operator actions, in terms of operator action timing. It is greatly extended over the operating plants. In the PRA, when you start talking multiple failures, there are some operator actions that are beneficial, and that will come out when we talk about the PRA.

When I&C Systems fail, there is some backup manual actions that can happen. If the core makeup tanks completely fail, they produce a signal that actuates ADS. So the operators can get by with just accumulators in most LOCAs if they turn on ADS in 20 minutes or so.

But even that, if we look at -- you will see PRA studies of where we turn off the operators completely, fail them, and AP1000 has pretty good answers, and much better than operating plants without operators.

We also have active non-safety systems in the plant. They are primarily in the design to support normal operation or anticipated transients. It is typically redundant equipment, powered by our non-safety diesels. These systems also minimize challenges to the passive systems, and they are not required to mitigate the design basis accidents.

MEMBER KRESS: Let me ask you maybe a strange question about that. When you look at your design basis accidents, and you take no credit for those and just look at passive systems, did you do the inverse of that?

Did you take no credit for passive systems, and see if the non-safety related systems would handle the design basis accidents?

MR. SCHULZ: Well, we do that in the PRA.

MEMBER KRESS: In the PRA?

MR. SCHULZ: Yes. When the PRA -- and I will be talking later today about the thermal hydraulic analysis, and I am going to concentrate mainly on the passive systems, because that's where there has been more questions.

MEMBER KRESS: Of course.

MR. SCHULZ: But we look at both mixed operations, where we use some passive and some active, and we have some cases where that is beneficial. And there is some cases where it is active systems alone

Now where we have or where we take credit for active systems to mitigate an accident, or a mixed situation, we have analyzed those, and not necessarily with design basis codes and assumptions. But we have analyzed it to justify in the PRA, taking credit for start up feed water to mitigate a loss of feed water or the RHR to provide low pressure injection.

MEMBER KRESS: Yes. I guess my question is motivated because there are questions as to how you determine the reliability of the passive systems, and although they tend to be very reliable, and one way to address those questions and put our minds at ease would be to say, okay, we have got this whole set of non-safety related systems, and if we didn't have the passive systems, we could still meet the design basis accidents with these.

I have just never seen you look at it from that viewpoint yet, and I recognize that you take credit for them in your PRA, and they show up as part of the LOCA CDF, but I have never seen them that way.

MR. SCHULZ: Well, the active systems

don't have the same capabilities as a passive system, in terms of the extreme accident, like large LOCA, and you could not mitigate with just active systems. You need accumulators. They are a safety.

There aren't non-safety accumulators, okay? So there are certain things, in terms of some accidents, like shutting down the reactor with control rods. Those are safety, and there aren't non-safety rods.

MEMBER KRESS: I guess I included those though in the -- I would just -- the non -- the safety related systems I would turn off would be the ECCS related, and I would keep the other ones.

MR. CUMMINS: Maybe I can make a comment. In general, the challenge is that we have automatically actuated the safety systems with a very reliable ANC system. In general, the active systems would mitigate the types of accidents that you are talking about, but require manual action.

So in a probablistic sense, you have this sort of unreliable operator requirement that is required to have the active systems work. But I think that for most of the cases they do provide first-line mitigation.

MEMBER KRESS: Okay. Thank you.

MR. SCHULZ: Here you can see the passive core cooling system, and you will see some capacity increases here that we have incorporated into AP1000, and it gives you a feeling for how we sized up the equipment, and later on when we talk about success criteria and the T&A capabilities, this would give you a little feeling for that. The power has gone up about 76 percent, and the passive RHR capacity has almost matched that.

So in terms of transient mitigation the passive RHR capacity is essentially the same as AP600. For the makeup tank flow, it has not been increased as much and this was an insight that we got out of both testing and analysis of AP600 that we felt that we had extra margin there, and we didn't have to increase the core makeup tank as much as the power went up.

And in our subsequent detailed safety analysis, and PRA analysis that confirmed that this kind of core makeup tank increase has put us in terms of success criteria into the same situation as AP600.

On the other hand, the ADS-4, which is very important in getting to low pressures and gravity injections, and recirculation, we have increased a little more than the power level, and the same with RWC injection capability, and recert capabilities.

So we have invested some time, money and design effort in scaling up and in actually improving the margins in some of what we feel were the really key passive modes of operations and features.

And as a result of that, for example, small break LOCA, we have maintained the AP-600 capability of low core uncovery for small LOCAs, something that is less or equal to a DVI line break. We have also maintained the capability of not requiring any operator actions following a steam generator tube rupture.

What we actually did to the passive RHR, it is exactly the same configuration, in terms of where the pipes connect, and the heat exchange location inside the IRWST, and were there pipes returned, and the valve alignments, and the types of valves.

The same elevations, and we did increase the pipe size from 10 inch to 14 inch to the heat exchanger, and back to the steam generator. This of course reduced the pressure drop so that we could get more flow.

We also increased the surface area, and put a few more tubes in, and increased the horizontal lengths of the tubes to give us some more heat transfer surface area. So in the natural circulation mode of operation, both the pressure drop through the heat exchanger, or through the piping system and more surface area, gives us the 72 percent or so increase in capacity.

MEMBER LEITCH: So a couple of questions about that.

MR. SCHULZ: Sure.

MEMBER LEITCH: First of all, the motor operated valve there at the top, that is normally open?

MR. SCHULZ: Right.

MEMBER LEITCH: And I guess I am wondering -- well, I am picturing this head exchanger as being something like -- something like a steam generator. In other words, it is sitting there, and exposed to the full reactor pressure.

MR. SCHULZ: Full reactor pressure, but cold temperatures.

MEMBER LEITCH: Cold temperatures, yes.

MR. SCHULZ: This is actually relatively realistic here, in that the motor valve is in the high point, and the piping does drop down into the top of the heat exchanger, which cold traps the heat exchanger.

MEMBER LEITCH: Okay.

MR. SCHULZ: The heat exchanger is obviously sitting in a cold tank of water also.

MEMBER LEITCH: So the in containment refuel water storage tank, it is vented to where it is internally in the containment?

MR. SCHULZ: Yes. Yes.

MEMBER LEITCH: So it is really looking at containment pressure then?

MR. SCHULZ: Yes.

MEMBER LEITCH: Okay. So you have got reactor pressure on one side, and containment pressure on the other side, and I guess what I am thinking about is there only one motor operator valve?

MR. SCHULZ: There is only one motor operator valve.

MEMBER LEITCH: So suppose you get a leak in that heat exchanger? That motor operator valve has got to close, right?

MR. SCHULZ: Well, it doesn't have to close. There are tech specs on the leakage through the steam generator or through these tubes like there are tech specs in the steam generators. Now, a steam generator tube leak, you obviously cannot isolate and there is a lot of tubes, and the conditions on these tubes is in our opinion more severe, in terms of flow, vibration, temperature, heat transfer.

Whereas, these tubes, although they do see high internal pressure, the other conditions are less severe. So we don't -- and the type of construction, in terms of tube material is the same.

The connection with the tubes to a flat tube sheet here is done the same way as the steam generator tubes are done. So we are taking advantage of our experience painfully gained on steam generators to design this heat exchanger to be reliable.

If it does develop a leak, then we have the opportunity of closing that valve. This is true, and if that valve is closed, then you have eliminated the possibility of an accident caused by a tube rupture in the passive RHR.

And of course you would have to shut the plant down right away.

MEMBER LEITCH: Right. Right. But say, for example, that --

MR. SCHULZ: Of course, these are normally closed, but that is normally open.

MEMBER LEITCH: But suppose you cannot close that valve? You have a leak in the heat exchanger and you for some reason cannot close that valve. Then what you have is an in-containment leak. In other words, that is vented to the containment and so such a leak is no a leak to atmosphere, but it is a leak to --

MR. SCHULZ: That's right, and so it is less safety important than a leak to a tube, which has a more direct path outside of a containment.

MEMBER LEITCH: Right. So there is no manual valve or anything else on that line? I mean --

MR. SCHULZ: That's right. There is no operator valve. So you would shut the plant down. It is a high point so that it would be relatively easy once you were shut down and you go to reduced pressures, even if you couldn't close that valve, the leakage would stop.

MEMBER LEITCH: Yes. Now, what about the chemistry in that heat exchanger? In other words, there is no blow down if you will, or small flow through that to keep that to keep it -- I mean, I am picturing that as being a spot in which solids may concentrate?

MR. SCHULZ: There is no mechanism that I would know of to concentrates, such as boil off or heating. This heat exchanger would see some flow during a refueling outage so that the water left in here would be reactor grade refueling water concentration.

And then it would be isolated, and then during power operation, you would not put flow through the heat exchanger intentionally. There is no bleed flow that we have, and we hope that these valves are leak tight.

MEMBER LEITCH: So assuming that they are a good run, it sits there full of cold water, and no flow, for 18 months?

MR. SCHULZ: Right.

MEMBER LEITCH: Or 24, whatever the case may be?

MR. SCHULZ: Right. Probably very much like a normal RHR heat exchanger in an operating plant does until you shut the plant down. Then you would put flow through it, but normally you wouldn't.

MEMBER SIEBER: You would have lower pressures then.

MR. CUMMINS: The chemistry of the water in the tank is refueling water storage chemistry, and so primary water with boron, or whatever, 2500 PPM, or something like that.

MEMBER LEITCH: So it would have that boron concentration associated with the beginning of the refueling cycle; is that right?

MR. SCHULZ: Inside the heat exchanger would also be, yes.

MEMBER LEITCH: So as the boron concentration goes down through the cycle, it just stays at high boron concentration and just sits there?

MR. SCHULZ: That's right, which is safe.

MEMBER LEITCH: I was just wondering if there was some kind of purge there, but there is no provision for doing that?

MR. SCHULZ: No.

MEMBER LEITCH: Okay.

MR. SCHULZ: The rest of the passive core cooling system, again we have maintained the same configuration in terms of the numbers of valves, and types of valves throughout the system. It is exactly the same as AP600.

Again, the same elevations, in terms of where the tanks are located, and where the pipes are located. We have maintained the accumulator capacity. So the size of the tank, and the water level, the injection line resistance is the same.

Now that ends up resulting in some increased heat clad temperatures for large LOCA, and in the PCD, those numbers actually are in an RAI response, and we have said those numbers are as high as 2100 degrees.

And as a result of that we have changed the success criteria for large LOCA in the PRA. AP600 could get away with one accumulator working because it had a lot of margin in peak clad temperatures. But for the AP-1000, we have to take credit for both accumulators working.

And you will hear more about that in the probablistic side of the discussion. As I mentioned, the core makeup tank has gotten 25 percent bigger, and we have increased the flow, but we didn't have to change the pipe size. We were able to just open up the orifice that we had on AP600, which was relatively restrictive to a bigger hole, and get 25 percent more flow without changing any of the piping.

The IRWST logs and the recirc lines in there here, we changed. They were basically 6 inches, and we went up to 8 inches, and that was one of the reasons why we could get more flow.

In addition, we made some changes, which I don't detail here, that increases the containment flood levels. So in a long term cooling situation, where we are depending on the water level and the containment to drive flow through the system, we have increased that water level probably in the range of 1 to 2 feet, which is pretty significant relative to the delta that we have.

So part of the reason why we have more recirc capability in AP-1000 is because of this increased water level. ADS stages 1, 2, and 3 are exactly the same as AP-1000, in terms of pipe size, flow capabilities, and so it is largely the same design.

We found from AP600 that what was really important was ADS Stage 4, and when you turned down ADS Stage 4, you in fact tended to starve flow through stages 1, 2, and 3. It almost stopped. And stage 4 was really the important thing, in terms of getting down to gravity injection and recirc capabilities.

And there again we increased pipe sizes and valve sizes so that the lines coming from the hot legs and out are bigger.

MEMBER LEITCH: I am always concerned about the nitrogen and the conflict with maintenance activities, and people getting exposed to a nitrogen atmosphere. Is there any situation here where you could -- in other words, I guess what I am saying is that during shutdown for maintenance, the accumulator is fully depressurized?

MR. SCHULZ: We don't require that. What we do require is that you close this valve, and this motor operative valve, which is normally open, has provisions to remove the power. It is required in fact by the tech specs.

And we do that at power mainly to make sure that this valve can't spuriously close or an accident. Now, during shutdowns, we do close the valve and also remove power so that it can't inadvertently open and then inject water rapidly into the reactor coolant system, which you know could possibly inhibit operations maintenance and whatever, and so that presents a hazard.

And this is no different for AP-1000 and AP600 than what we do on operating plants. But we don't require that the nitrogen be removed, the pressure.

MEMBER LEITCH: But it could be, right?

MR. SCHULZ: It could be.

MEMBER LEITCH: There is no reason why it has to be there.

MR. SCHULZ: Well, we basically with that valve being closed and locked out, we are saying that we don't need that feature and it is not going to be available on any rapid response time anyways. So it is not that important when you are in shutdown.

MEMBER LEITCH: Okay. I just -- you know, there has been some bad experience, and maybe not in the nuclear industry, but in other industries, where there is nitrogen used in that situation where people have succumbed to the nitrogen.

MR. SCHULZ: Well, of course, if you ever had to do inspection maintenance inside that tank, you would want to take the water out, and of course take the nitrogen out and be very careful with your breathing of anybody who would go into that tank.

MEMBER LEITCH: Yes. Okay. Thank you.

MR. SCHULZ: This is a picture of the long term cooling mode, and what you are seeing here is you are in recirculation, and water is coming from the containment through the -- you can't it very well in this picture, but there is a recirculation screen here, and water comes in, and goes back into the DVI line and back into the reactor, and the reactor coolant system is partially full of water.

This paints a kind of a picture where maybe there is a distinct water level which is probably really not accurate, in terms of what is going on, and in terms of boiling and two-phase mixtures in this part.

But in any case the density of this stuff inside the core and above the core will be a lot less than the density of the water outside, and there will also be a significant water level difference between there.

There are some accidents were you can have a pipe break, a DVI break, that is actually in this valve room. And if that is the case, there is actually two of these separate rooms for the passive core cooling system, a sort of A and B.

One of the rooms where it floods with a break, and that result in a little bit lower water level in the containment, and we account for that when we look at long term cooling both in design basis, and in PRA space.

MEMBER KRESS: The ultimate heat sync is the passive containment cooling system?

MR. SCHULZ: Right. So you don't see the whole thing here, but -- with the steel containment, but what you see with this little arrow is indicating that condensate would be coming down and normally corrected in the gutter, and the line to the waste sump would be closed as indicated, and the condensate would run into the IRWST.

So what wold be tending to happen is that coming out of the fourth stage, you would have a two-phased mixture, of water and -- and probably more water than steam. The water is going to tend to fall out into the containment water level, and that water will have to return through the sump screen.

The steam roll for the most part will go up into the area to be condensed, and the vast majority of that will come down as condensate to the gutter, and go back into the IRWST.

So even in long term cooling there will be a substantial portion of flow coming into the IRWST and continuing to come in through the DVI line. Now, typically when we do our long term cooling analysis, we make what we claim to be a conservative assumption and ignore this flow coming through the IRWST and in a sense force it all to come through the recert path, which increases the pressure drop through the sump screen and the recert line here.

Moving on to the containment, you see a picture here of how we have increased the height of the containment, and the diameter didn't change, and the free volume didn't change. The free volume goes up about 20 some percent, and the design pressure was increased.

An increase in the design pressure was a result of making the shell a little bit thicker. It still doesn't require post-weld heat treatment. We have changed the material, and which helps us with the design pressure.

So the combination of more volume and a higher design pressure actually increases the design -- the margins during design basis accidents. You will hear more about the capabilities of the system in the PRA and severe accidents.

MEMBER LEITCH: Does that increase the volume and improve the ease of maintenance in there?

MR. SCHULZ: Not really, because the diameter didn't change, and in essence below the operating deck is essentially the same, and that was one of the strong drivers from our commercial point of view, that we really wanted to maintain the design detail, because there is a tremendous amount of work that goes on in routing piping, and routing cables, and HVAC ducts, and making sure that all works.

MEMBER LEITCH: Sure.

MR. SCHULZ: Now, we did have to worry about some stuff, because you can see that the steam generators, they get fatter, as they need to because they have a lot more tubes in them. But it turns out that we were able to accommodate that inside the loop compartments.

The reactor coolant pumps get a little bit longer, and that had some perturbations in some minor concrete in there, but for the most part the concrete stayed unchanged, and the steam generator has got a bigger reactor vessel, and gets a little bit longer. But the bottom force was able to stay exactly the same.

MEMBER LEITCH: Can you change out steam generators? Does the containment accommodate that without cutting the containment?

MR. SCHULZ: Not without cutting the containment. For this design, I think like essentially all the combustion engineering tech designs, these steam generators are big in handling them, and trying to get them out through an equipment hatch is not very practical.

So what our intention is that we would actually take it out through this vent area, and so we wouldn't have to cut concrete, but we would have to make a hole in the steel containment in the center here and for the steam generator out through the top.

MEMBER LEITCH: I see. That area with the two X's on it there, I don't know exactly what that represents.

MR. SCHULZ: They represent some screens. So,both on the inlet and the outlet, we have some screens to keep large creatures from crawling in there.

MEMBER LEITCH: Okay. Thanks.

MR. SCHULZ: This shows you more of the passive core cooling system valve arrangement. The tank has grown in size, and we have a requirement as an AP-600 and in AP-1000 for that tank to last at least three days.

And after 3 days, we would normally provide water back into this tank. To get from 3 days to 7 days, we have on-site water in our ancillary water storage tank, and we have pumps and some small diesel generators which will allow us to put water back into that tank to go for 7 days.

And then after 7 days, we would -- and if we are still on passive systems, we would rely on other water supplies, either on-site or off-site.

MEMBER KRESS: When you analyze the cooling capacity of this, what outside temperature do you normally use for that amount?

MR. SCHULZ: Well, in design basis, it is like 115 degrees fahrenheit.

MEMBER KRESS: So it is not as high there then as the --

MR. SCHULZ: Very, very high temperatures, yes.

MEMBER KRESS: Do you assume that the water in the tank is at that temperature also?

MR. SCHULZ: I think so, yes. Which is not really practical because of the day and night air cycles, you would never get the water up that high. But just to simplify our analysis, we do that. When we do this air only cooling --

MEMBER KRESS: Without the water?

MR. SCHULZ: Without water, okay. For AP-1000, if we assumed like 80 degrees fahrenheit air and water, then air-only cooling is sufficient. It will stay below the rupture pressure of the containment.

If we do it so that the 115 degree air and water, and conservative decay heat, then there is a chance that the containment could rupture, especially in later times of frequency, and then there is an analysis in our PRA that looks at sort of the convoluted probabilities of --

MEMBER KRESS: When you say rupture that doesn't mean it less exceeds the design pressure. You have an actual failure rate?

MR. SCHULZ: That's right. And we have

put some probabilities on failure versus how much we exceed design pressure. So we have tried to look at that. Now, AP-600 had a little more margin here with the lower power density and the surface area of the containment that it had.

So it could be more conservative here, but it looks like that we have dealt with it in the PRA and you can hear some more about that.

MEMBER KRESS: You mean power or power density?

MR. SCHULZ: In this case power density doesn't mean anything.

MEMBER KRESS: Absolute power.

MR. SCHULZ: Absolute power, versus like surface area, that is important, yes. The flow rates are -- the initial flow rate is almost the same, or slightly higher, for AP-1000. It is not really related to power. It is more related to quickly covering the surface of the containment to establish cooling, and that is what really drives that flow.

We have got a little bit more vertical height and so we increase the flow a little bit, but not very much. Later on after we uncovered the first steam piping, we slow the flow down more to decay heat levels, and now we have increased the flow proportionately to power.

So as a result the tank gets bigger. Now, another thing that we did from a PRA point of view is that we added a third valve path. The top two paths is all that AP-600 has. Two valve open air operated valves to initial the water drain, and either one works and you are fine.

For AP-1000, we added a third path and we made the active valve a motor valve to make it different or diverse from the first two valves, to increase the reliability of water drain.

And one of the reasons that we did that was because of the fact that we had less margin in the air only cooling storage was a kind of compensation for that.

Here you see a summary of the safety margins' AP-1000, 600 and a typical plant, loss of flow, and DNBR margin. As I mentioned, AP-1000 is a bit better than AP-600, which are typically quite a bit better than the operating plants.

Feedline break margins that improve, and I mentioned the operator action, and no operator action for tube ruptures. For small LOCA, we have maintained the no core uncovery, and for a large LOCA, the peak clad temperature has gone up.

One thing that I would point out here is that we did a large LOCA analysis for the PRA, and the PRA -- and the reason that we did it was for this analysis, we had containment isolation work, because you assume that in the design basis.

There is a slight delay before you close valves, but basically you close off the containment isolation. For the PRA in many cases we look at containment isolation not working, and we try to show that the core can ride out that capability.

And so even though the number of accumulators is the same in both cases, two, we have to reanalyze the large break without containment isolation.

And because we were close to the 2200 degree limit, we wanted to make sure that we didn't go over that. We made one other change in that this number of design basis analysis assumes that loss of off-site power occurs at the time that the break happens or the reactor trips I should say, which is almost instantly with the break.

That has an adverse affect on the load, and electrical pumps start coasting down right way. It terms of that, if you take this same case and you do two things to it -- one, you leave the containment open, which tends to detract, and you leave the off-site power on for about 15 seconds until the electrical pumps trip anyway, this number drops down to less than 1900 degrees.

So this is a -- in the case of AP-1000, the probability of having this kind of thing happen is extremely low, because you have to lose off-site power instantly with reactor trip, and if it only runs for 15 seconds, then that number is 1900 degrees or less.

So even though this looks like it is close to the limits, we have really got from a safe probability point of view more margin. Hydrogen mitigation, design basis. We have maintained the use of the PARS, although we have reduced the safety classification of them.

Some of the operating plants are working towards taking out recombiners, and we weren't sure that you wanted to get because of the timing of that, especially when we submitted the DCD for AP-1000.

We were not sure that we wanted to go that aggressively. We are maintaining the igniters in an almost essentially identical design with the AP-600. They are important in the severe accident capabilities.

MEMBER KRESS: You used MAAP-4 to get the hydrogen iteration, right?

MR. SCHULZ: Yes, we looked at different sequences, and different release points, timings, yes. We did make one change to help us in the release points. AP-600, if you look at the IRWST vents, many of them are located close to the containment wall.

We tried to put some hoods on them so that vent flow would go away from the containment, and this was an attempt to minimize the potential of hydrogen standing flames to overheat the containment.

But there was a bit of a debate between Westinghouse and the staff on whether that was fully effective on AP-600. So on AP-1000, we have got more hydrogen, and so these flames can be a bit bigger and last a little bit longer. So the issue was becoming a bit more of concern.

MEMBER KRESS: You have more hydrogen because you have more circ?

MR. SCHULZ: More fuel.

MEMBER KRESS: More fuel?

MR. SCHULZ: Yes.

MEMBER KRESS: So that is how you got it down?

MR. SCHULZ: Yes. So what we did, and let me just finish this, is that we changed the vent designs so that the vents that are close to the containment are spring loaded so that they will not open in a case where you are just venting hydrogen.

These vents are designed to release lots of water and steam in a design basis kind of accident. If you are into a core melt severe accident, you are basically by the time that you are releasing hydrogen, you are not releasing water and steam.

And the amount of stuff that you have to vent is really rather little. So we have got some other vents that are located well away from the containment, and these ones will preferentially open because they are not spring-loaded and biased to open.

And from that we have moved to standing flames well away from the containment. So we think we have made a nice improvement in this story.

MEMBER KRESS: From heat sources being close to the wall?

MR. SCHULZ: Right.

MEMBER KRESS: How many total igniters do you have in there?

MR. SCHULZ: There are 64 igniters, and their are paired, and so that is like at 32 locations.

MEMBER KRESS: 32 locations? How did you decide where to put them?

MR. SCHULZ: Again, math analysis, and looking at -- Jim Scobel, when he talks about the hydrogen, can talk some more about that. I think he has actually got some pictures that he may be able to show, and he knows exactly why we put things where.

MR. CUMMINS: Dr. Kress, we do have backup slides on igniter location that shows where they are, and we could add that to the discussion tomorrow during the severe accident if you would like.

MEMBER KRESS: How are those igniters powered?

MR. CORLETTI: The same as the control system, the non-1EAC (phonetic).

MEMBER ROSEN: Does that mean in a station blackout that there is no power?

MR. CORLETTI: No, there is kind of like instrument power. They have a battery backed invertor for a period of -- a limited period in the case of non-safety, and we would expect that they would last two hours on that power supply, something like two hours.

All the loads would last something like two hours on that power supply.

MEMBER ROSEN: Is that long enough for the igniters to function if they were needed with station blackout?

MR. CORLETTI: I will have to defer that to Jim.

MR. SCHULZ: One thing to keep in mind is AP-1000, as in AP-600, station blackout is not a risk important event. It is very different from other operating plants, where a loss of -- where operating plants are dependent on AC power, very dependent on it to protect the plant.

AP-1000 isn't, okay? Passive systems don't need AC power, and so if you look at what causes coolant melt, and what causes severe accidents, it is not a loss of power. It is LOCAs or something like that.

So one of the reasons why we don't think that is so important is that if you get into a core melt, it is most likely that you will have AC power in this plant, which is different than operating plants.

I wanted to just say a few words about the non-safety systems. I had mentioned that they are typically redundant power by the on-site diesels. They are simplified from their, say, companion or cohort systems that would be in an operating plant.

So the start-up feedwater system has two motor driven pumps in this plant, whereas an aux heat system in an operating plant would have three or more pumps. The redundancy that we have put into the design is for more probable failures. We typically don't worry about pipe leaks or passive failures in these non-safety systems.

The equipment is a reliable experience-based, and not ASME code for the most part. One size may -- well, in some cases we have put based on our written evaluation of the safety importance of these non-safety, we have put some limited seismic wind capabilities.

Typically the equipment that we require to support post-72 hour operation, and we have a tank and a couple of pumps that we put some limited seismic and wind capability on those. But for the most part, we don't require this kind of hazard protection.

We invest that into the passive systems, with the full seismic wind and fire protection on those systems. We typically don't put tech specs on these equipment, but we have put on two many of them availability controls and this case out again of our RTNSS evaluations, the same controls that we put on AP-600.

MEMBER KRESS: Did you do or determine importance measures (inaudible) for these AP systems?

MR. SCHULZ: We have. We used those numbers mainly in determining whether they were in the D-RAP program, which we have listed those systems that captured that way. When we looked at the RTNSS. we didn't use the risk importance measures directly.

We did a more conservative evaluation, where we like took out all of the non-safety systems at the same time, and then recalculated the core melt frequency and large release frequencies, and if we could still meet the NRC safety goals without these systems, we said they are not safety important from that point of view.

And it turns out that in AP-1000 that we end up putting in some -- we need some DAS manual controls to meet that. So we put tech specs on the DAS manual controls, which is a little different.

MEMBER KRESS: And subjected them to Option 2 process? Which one of the boxes would they show?

MR. SCHULZ: I am not conversant in that, but I think our system is a little different than what people are talking about now.

MEMBER KRESS: Yes, and Option 2 is a risk informed process.

MR. SCHULZ: And I just wanted to show you the picture of the normal RHR system and this is what is normally used in a shutdown cooling mode for AP-1000 two pumps, but you see that there is some carbon piping in and out, and again this is a non-safety system, and it doesn't have to work to remove decayed heat in any accident.

It does have a connection to the IRWST and containment recirculation. So it actually can be used and the operators have instructions to line up and use this system in case ADS has been activated, for example. It is to provide a low pressure backup, and low pressure injection, just as it was in AP-600.

One difference is that the water supply in that case would be taken from the spent fuel coolant loading pit. We maintain that pit full of water normally and you do use this system to provide low pressure injection.

Water would be taken from outside containment, and we did this to minimize an adverse interaction that we found with AP600, where if you take the IRWST water and pump it, if you had a DVI line break, what you end up doing is pumping the water into containment, because of the way that these lines are arranged up.

If you have one of these lines broken, all the water goes there, and so you in essence pump down the IRWST and you get your recirc quicker. Now, the AP-600, we could tolerate that, although it may be absent at worse.

The AP-1000, it was going to be more challenging for us, and instead of trying to design for that, we have changed the plant design operations so that we would require the operators to take suction from this outside water supply.

So if this system works, instead of going to recirc sooner, we would go to recirc at the same time with real water. So you can't make the accident worse than, which we think is a nice improvement.

So we are always looking for adverse interactions and trying to make sure that the plant works good and better. The next couple of slides talk about the I&C systems in the plant, and there are basically three; a control system, safety, and a diverse system.

The safety control in a safety system are microprocessor-based software and multiplexed communications. The safety system is obviously a 1E system for the divisions, nicely separated and all of that.

The diverse system is also a

microprocessor-based system. It will use different hardware and software than a safety system to make it diverse. It has its own separate sensors, and so it doesn't have to have sharing and isolators between it and the other systems.

It has a limited scope, which we determined using the PRA, and on which functions was PMS most important and where did we need it, and where was its failure due to common mode failure most important in the PRA.

And where it was most important, and we put those sensors and capabilities into the DAS to protect us. Basically, the DAS operates passive safety systems, like passive RHR, core makeup tanks in a different way.

MEMBER SIEBER: What is the framework for the instrument system? What is it built on amongst the standard --

MR. SCHULZ: Are you talking about hardware design?

MEMBER SIEBER: Yes.

MR. SCHULZ: We are not licensing AP-1000 based on a hardware design. We are trying to design an architecture, a minimum set of instrumentations and functions, and then when we actually build the plant, because of the rapid, evolving nature of INC systems, we would use the latest design.

Now, that said, our current product line would be a common Q product, which Combustion Engineering used on System 80 plus or a similar design. AP-600 at that time was an Eagle product. But in a couple of years or five years, it will probably be something else.

MEMBER KRESS: So these are ITAACs then?

MR. SCHULZ: Yes, there is -- to certain minimum commitments that we make in the ITAACs, in terms of inventories of sensors and controls, of functions to perform. Exactly how it is done is more of a design process ITAAC kind of thing.

MEMBER KRESS: Your piping is an ITAAC also?

MEMBER SIEBER: Right.

MR. CORLETTI: The DAC, the design acceptance criteria, which is covered during the time of the COL application, this is a similar.

MEMBER KRESS: This is similar to AP-600?

MR. CORLETTI: Right. It is the same as the AP-600, the approach, as far as the licensing approach.. We have broadened our application to -- like Terry said, when we did AP-600, our product, our only product at that time for a 1E PMS was Eagle.

We have now expanded our application to include either an Eagle product or the common Q product, which is going through -- some licensing has been approved with the NRC as far as the application of the common Q, to an existing plant.

MEMBER SIEBER: Well, from the standpoint of the PRA then, since you really haven't said that this is the architecture, and that is the architecture, and that is the way that it will function, and here is what the equipment is, how do you estimate the error rates with any kind of accuracy, you know.

MR. SCHULZ: What we did was we in AP-600, we analyzed the Eagle product line in detail for the PRA. So the PMS failure rates were based on that.

MEMBER SIEBER: And who makes the Eagle product line?

MR. SCHULZ: Westinghouse.

MEMBER SIEBER: And where has it been applied? Do you have operating plants with this equipment?

MR. SCHULZ: Yes, we do.

MEMBER SIEBER: How many of them --

MR. SCOBEL: This is Jim Scobel, and I

think Sequoia and I think several others.

MEMBER SIEBER: Okay.

MR. SCOBEL: I think Sizewell as well.

MEMBER SIEBER: For their main control system and not this separate instrument loops?

MR. SCHULZ: That's correct.

MR. SCOBEL: For their protection system.

MR. SCHULZ: Okay. The control room would be a compact control room, with overview panel displays, and work stations, and a small number of dedicated displays, some of which are safety related to the PMS post-accident, and some of which are -- separate ones are related to the diverse actuation system.

And from a plant control point of view, we have soft controls which are part of the non-safety part of the plant for normal operation, and we have a small number of dedicated switches which are related to or connected to the passive safety system, or the I&C system that are 1E.

These are typically system level type switches, and we also have some switches related to or associated with the diverse actuation system. There is the advanced alarm management and computer based procedures.

MEMBER ROSEN: That small number of dedicated switches, do you have for example an analog SCRAM switch, manual SCRAM switch?

MR. SCHULZ: There is a manual SCRAM.

MEMBER ROSEN: That doesn't go through the computer system.

MR. SCHULZ: Right. Well, the DAS one does not go through the computer system at all. It goes directly out to --

MEMBER ROSEN: Well, something that opens the breaker. So on the --

MR. SCHULZ: Yes, on the PMS --

MR. CUMMINS: The PMS does not move over manual. It directly trips the plant.

MR. SCHULZ: The PMS goes to the breakers directly without going through the computer. The DAS --

MEMBER ROSEN: So this is a real switch, and not a mouse click or something like that that the operator can do?

MR. SCHULZ: Well, all of these dedicated switches are not soft controls. They are dedicated, and that's what I mean. They are sitting here on the board, and you can touch them, and they always do the same thing.

There is a reactor trip which goes directly to the breakers, and now the other ones, like SI, is a dedicated switch, but it goes through the computer because it goes and generates an S signal, which then have to propagate through the valves.

MEMBER ROSEN: I wa asking you specifically about manual SCRAM.

MR. SCHULZ: Manual SCRAM is directly to the breakers.

MEMBER KRESS: Normal operating plants nowadays have what, four operators in the control room, and a supervisor? How as it that you decided that one reactor operator, and one supervisor, was sufficient?

MR. SCHULZ: From a -- this was done as trying to look at the workload on the operators, in terms of what automatic controls they needed?

MEMBER KRESS: Is it some sort of task analysis?

MR. SCHULZ: Task analysis. Now, I think from a --

MR. CUMMINS: Can I comment on that? First of all, there are utility requirements documents that told us that that was our design criteria for the AP-600.

MEMBER ROSEN: What was your design criteria?

MR. CUMMINS: That the plant be able to be operated by a single operator and the concept of the utilities was a single operator and a supervisor who didn't operate. So that is our design challenge. The actual implementation and task analysis is similar to Terry's discussion on INC. It is an ITAAC.

We still have yet to prove that a single operator is adequate, but we certainly intend to prove that.

MEMBER KRESS: Would your control room accommodate more operators?

MR. CUMMINS: Yes, the utility requirements document also required that it accommodate at least three operators. So we are pretty well covered with our requirements.

CHAIRMAN APOSTOLAKIS: How many now are there in the control room?

MEMBER KRESS: I think normally they have about four.

MEMBER BONACA: Two not three.

MEMBER SIEBER: There are two licensed operators, and a supervisor, which is the minimum for tech specs that usually have more hands available.

MEMBER KRESS: Yes.

MEMBER SIEBER: But that would be the normal requirement.

MEMBER ROSEN: For a one-unit plant.

MEMBER SIEBER: For a single unit, yes. Two units sometimes -- some tech specs say you can have three if each has a license on both units. But in other cases where you have two units that are single licenses, two operators per unit, plus --

MEMBER ROSEN: And it is complicated by the fact that some dual unit sites have only one control room, and so they have a common control room for both. So you have a shift manager who manages the shift for both units, and then you have unit supervisors.

MEMBER SIEBER: Right.

MEMBER ROSEN: So you can't say a whole lot about it. The only real way to convince me that it is adequate is to do a task analysis.

MR. SCHULZ: And we have yet to prove that, and so that would be something that we would have to do.

MEMBER LEITCH: I think the more challenging thing there is perhaps not operating the plant under normal circumstances, but in the exercise of the emergency plan, for example, and making the necessary phone calls, particularly if you couple that with a fire, and so you have got fire brigade people, and not necessarily licensed operators.

But it is those kinds of situations I think where you have, say, a fire, and you are actuating the fire brigade, you need someone to make -- you need an emergency director to run the --

MEMBER ROSEN: And the fire causes a loss of coolant accident and opens --

MR. SCHULZ: What's that?

MEMBER LEITCH: And the fire causes a spurious ADS actuation. So you have a LOCA, a small LOCA, at the same time. Now, if you have enough people to handle that, you are going to be okay.

MR. SCHULZ: Well, we have tried to deal with that a little bit and to prevent the LOCA from being caused by the ADS fire. So that is a requirement. But, yes, you're right. We have yet to prove that and that has yet to be done.

PMS reliability features, and this is the safety I&C again for divisions completely separated, and improved isolation versus current plants for the use of fiberoptics. Each with its own independent batteries, and 2 out of 4 bypass logic when appropriate, like reactor trip and SI.

Typically we use different plant parameters to provide a functional diversity. Extensive verifications and validation and equipment qualification. Improved in-plant testing and built-in continuous testing, and manual and periodic testing, and extensive experience with these kinds of designs, and that we have upgraded on operating plants.

Similarly from a mechanical systems point of view, and why we think these systems will work, and why would they be reliable, you see a number of different elements, starting with conservative design, and equipment specifications, development testing, and this is largely the AP-600.

Conservative safety analysis, using the codes that are verified against this testing. Additional PRA and T&H analysis, which I will be talking about this afternoon, and in some cases using different codes, and looking at multiple failures, and we learned things from this that we don't learn from the design basis analysis.

The PRA itself and its probabilities is obviously a reliability input and measure. Emergency procedure T&H analysis. We do yet more analysis here looking at procedures and operator actions.

And again finally once the plant is built, there are things done in the plant there are things done in the plant. For example, start-up testing, and ITAAC verifications, in-service testing inspections, that all contribute to the overall reliability story.

MEMBER KRESS: Refresh my memory. How do you do a level 3 without a site?

MR. SCHULZ: We do releases, probability of releases, and maybe you should save that for the level-3 guys that are going to talk later, okay?

MEMBER KRESS: Okay.

MEMBER ROSEN: I have a question on development testing of the block on the right, where you talk about component testing, and system testing, and interval tests. My questions are specifically about testing of the 14 inch squib valves. Is there someone who is going to talk about what kind of data you have to support the spurious actuation estimates that are in the PRA, and the reliability of the 14-inch ADS valves?

MR. SCHULZ: Well, those are two separate questions. I had a back-up slide which would probably relate to the design and understanding of the spurious.

MEMBER ROSEN: Well, I don't want you to

that right now unless that is the right part, but sometime between the end of the day and -- between now and the end --

MR. SCHULZ: Are you talking about the valve design?

MEMBER ROSEN: Valve design and reliability.

MR. SCHULZ: The reliability part would be better handled later of the valve itself.

MEMBER SIEBER: These are the (inaudible) valves?

MR. SCHULZ: Right. You see a picture here of the valve design that we would use. This piece here is actually machined out of -- with an end cap on it, and it is all one piece, and it has got a sheer point designed into it at this point.

So that when the valve is actuated, and the valve is actuated with igniters that are connected in here, this valve design is actually three separate igniters, any one of which can actually actuate the valve.

Two of those are wired to -- each to a different PMS division, and the third one is wired directly to the DAS division. So the DAS -- and DAS has only manual ADS actuation. So those controls are hard wired from the control room in DAS, out to the stage-4 valves.

The PMS connections come through the I&C cameras, and once they leave the PMS division, they go directly to the valves. And in actually firing any one of those igniters, a two-stage circuit has to be activated, and it is basically an armed fire-type circuitry which has to work in series in a proper fashion for any one of those three to work.

And this prevents a failure within that circuit from causing actuation. So if the fire circuit inadvertently goes off, the valve won't work because there is not enough power to set off the igniter. The arm basically surges up additional power that is not normally available to the fire circuit.

So if either of these circuits spuriously goes off the valve will not open and cannot open. Now, in addition to that, you could -- well, you could get a false signal into the valve control cabinet that says fire.

Well, that comes from two kinds of things. One is automatic from the PMS. Now, DAS doesn't have automatic, and so only the PMS could automatically do this, and this is based on two other 2 of 4 logic, which starts with an SI signal, and also because 2 out of 4 signal (inaudible) also requires that (inaudible) tank low level signal, and with (inaudible) being less than 1300 psi.

So if all those things are in existence based out of 2 out of 4 logic, you can get a PMS signal. So we think that that provides a high degree of prevention capability of spurious automatic signal, obviously combined with the armed fire circuitry, the (inaudible) can come from POS soft controls, and you can do it that way.

But there is a two-step kind of armed fire thing that the operators have to do, and in addition the pressure has to be less than 1300 psi. So two of the soft controls, even if the operator goes through the right two step procedure, he can't get the water valves to open if he is at normal operating pressures.

The PMS has dedicated switches that would go to the four stage valves, and there is two switches, and they both have to be activated at the same time to get these valves to work.

And the same is true of the gas. So we have tried to do a lot of things to make it extremely difficult for these things to go off when they are not supposed to.

MEMBER KRESS: When the cap is sheared

off, where does it go? Does it lay down? The pole is left to right?

MR. SCHULZ: Yes, this is the high pressure and this is the outlet of the valve, and the cap is captured in a pin, and when the motor is energized, it sets off a charge propellant that builds up gas pressure above the piston.

And then there is a tension bolt here and it holds the piston back until pressure builds up to a high point, and then that shears as you can see here and this piston is driven down and hits and impacts the top of this assembly here, and shears off the joint here, and then the flow, the pressure, pulls that down, and then it is out of the way. So the flow can just exit the valve.

MEMBER KRESS: It can't sit there and flap then?

MR. SCHULZ: I won't close until you refurbish it out.

MEMBER SIEBER: You have to replace it.

MR. SCHULZ: That's right. You have to replace the internal.

MEMBER ROSEN: And is the 14 inches the outlet prevention?

MR. SCHULZ: No, the 14 inches is the pipe size coming into the valve here.

MEMBER ROSEN: Okay.

MR. SCHULZ: Now, this inlet is a little bit smaller as depicted here, and so this is the choke point in the valve.

MEMBER ROSEN: So it is bigger on the outlet?

MR. SCHULZ: It is bigger on the outlet, yes.

MEMBER ROSEN: And that is the one that just goes right to the containment right there?

MR. SCHULZ: That's right. So in our design there aren't actually using any piping or flanch connected to the outside of the valve. It just goes to the lube compartment.

MEMBER KRESS: Now, that thing laying on its side, it is held down there by the flow and the gravity; is that what holds it down?

MR. SCHULZ: That's right, and there is also a sensor here that will be connected back to the control room to tell the operators that this thing has opened up.

MEMBER ROSEN: How many times have you fired these things?

MR. SCHULZ: We have not built one of

these valves ourself. A company that we talked to built one and fired it several times for another company. These valves are -- squib valves are custom type designs.

They are not like an MOV. Each one of the valves is pretty much built to the specifications of the company that is buying it. The company has -- and the valves are obviously a very simple design. There is no packings, and there is no torque switches, and no electric motors.

There are very few moving parts. There is lots of margin built into the gas pressure that they generate. The performance of the propellant is something that has come out of ammunition explosive technology over the years, in terms of how do you control the materials that you mix together, and what kind of samples do you take when you mixed it up, and how do you test it in the field.

Do you take the charge out and you set it off to see if it would have worked. That whole process is very well understood from a design point of view, from a probability point of view.

And we would be buying this valve with a reliability specification, which is not something that we can do in other valves. The motor operator valve, and inner operative valve vendors will not quote you a reliability, in terms of your specification. These guys will, okay?

MEMBER KRESS: Based on testing umpteen dozen of them or --

MR. SCHULZ: Not the testing of this valve. The testing of the propellant and its design, and its reliability, and the igniter reliability, and the parts and pieces to assemble a calculated reliability based on actual reliabilities of components.

MR. CUMMINS: These valves are currently in use of nuclear power plants, and not Westinghouse plants, and not at this size, but in smaller sizes. But the squib valves are being used for safety applications by some of our competitors.

MEMBER ROSEN: What numbers did you use for the reliability?

MR. SCHULZ: Okay. You are talking about valve reliability and I would like to postpone that to a guy that is going to talk about probabilities, because I don't really know the answer to that.

MEMBER ROSEN: The question is what numbers did you use for reliability for actuation on command, and what numbers did you use for reliability or spurious actuation, and why do you think the numbers that you used from whatever source are appropriate to use for this 14 inch valve? That is the question.

MR. SCHULZ: Okay.

MEMBER KRESS: How is the gate there that blows off, how is it -- in the closed position how is the seal maintained there? What is the --

MR. SCHULZ: That is not a seal. That is a solid piece of metal. This sleeve and part of the -- the piece that flops down is actually a two-piece assembly that is screwed together and bolted together.

The part that is on the high pressure side is actually machined out of one piece of metal. It doesn't show it very well, but there is a narrow point, or I call it a shear point, that is a weak spot. It is designed to hold the pressure, but when it is impacted by this piston here, it shears at that point. So there is no seal, which is something that is very nice that the valve won't weight.

MEMBER ROSEN: What is it made of, that piece that is exposed to the coolant?

MR. SCHULZ: I don't know the exact -- stainless steel.

MEMBER ROSEN: Is that a guess, or --

MR. SCHULZ: I don't know. I'm sorry.

MEMBER ROSEN: Well, what I am thinking about is corrosion of that, and if it cracks in that. You know, you have a circular ring that forms the seal, and I don't know how thick it is, but I assume that it is fairly thin.

MR. SCHULZ: Yes.

MEMBER ROSEN: And if that cracks, and there are ways to crack materials in PWRs, especially materials that are under stress.

MR. SCHULZ: The specification of that material will be important yes.

MEMBER ROSEN: If it cracks during normal operation, you will have a spurious -- that thing will flop because it is under pressure.

MR. SCHULZ: If it is enough of a crack, yes.

MEMBER ROSEN: Right.

MEMBER KRESS: That tension bolt, is it required that you torque down to a certain point before it will fail under tension?

MR. SCHULZ: No. It is not -- I don't believe it is under tension initially. It is holding --

MEMBER KRESS: It is holding the thing up there.

MR. SCHULZ: It is holding it up there and I think it is just in contact with --

MEMBER KRESS: Is there a release path for the gas to go up around that bolt?

MR. SCHULZ: There is as you see there is an O-ring there under the head here, and around the cap, and also there is several O-rings around that assembly where you can take it apart.

MR. CORLETTI: Terry, this is Mike Corletti from Westinghouse. It sounds like we are getting into a lot of discussion on the details of the valve design, which I think maybe what we could do is if we have not resolved all the questions on the details of the design, we could bring that up at the plant meeting, and maybe we could even arrange to have the vendor participate.

MEMBER KRESS: We think that it is very important that the ADS 4 system work.

MEMBER SIEBER: Only when required.

MEMBER ROSEN: One of the key parameters is the reliability of this valve, but as Mike Snodderly reminds me, also the temperature of this valve, and so I don't know anything about what temperature this operates at.

Can you tell me, for instance, what the temperature is of that after normal operations?

MR. SCHULZ: Of the fluid in here?

MEMBER ROSEN: Yes.

MR. SCHULZ: It is going to be hot. We have a small cold trap, but it is not going to be fully effective and so that water temperature -- we have specified to the valve vendor that the water temperature in here can be hot leg temperature, 600 to 610. There is obviously metal pieces, and this part of the valve has a bunch of fins, and it is kind of depicted by this cut-out in this outer edge, and that maintains the -- the (inaudible) temperature sensitive really is the propellant up here.

So there fins around the top part and also along here, and you also see fins here.

MEMBER ROSEN: It is good to make sure that the propellant charge works.

MR. SCHULZ: Absolutely.

MEMBER ROSEN: But what I am worried about is that in this discussion right now is that the cracking of that small section that has the shear, but cracking during normal operation, which propagates around this seal in some way until the 2000 psi reactor pressure opens the valve and creates a spurious actuation.

MR. SCHULZ: Yes.

MEMBER ROSEN: And that is the question that we need to talk some more about.

MR. CORLETTI: Okay. I think we could probably discuss more of the details for the plant discussion meeting on the valve. Terry, you are out of time, but we could -- could you do in five minutes maybe one of your defense in depth to just kind of illustrate the defense in depth of the plant?

CHAIRMAN APOSTOLAKIS: Or another alternative is that I suspect that defense in depth is going to have some questions.

MR. CORLETTI: We can just keeping go and run over --

MEMBER BONACA: Or we can break now and come back. Is that a good time?

CHAIRMAN APOSTOLAKIS: You seem to be going into other topics, right?

MR. SCHULZ: Slightly different, yes.

CHAIRMAN APOSTOLAKIS: Right. Can we do that?

MR. CORLETTI: Whichever you prefer, yes.

MEMBER ROSEN: You are in charge.

CHAIRMAN APOSTOLAKIS: I don't think it is going to be five minutes. So we will recess until 10:25.

(Whereupon, at 10:08 a.m., the hearing was recessed and resumed at 10:27 a.m.)

CHAIRMAN APOSTOLAKIS: Okay. We are back in session. Let's see if we can finish this in 5 or 6 minutes.

MR. CUMMINS: This is Ed Cummins, and just one comment. Dr. Kress asked about how non-safety systems could be used to mitigate accidents, and I think that this set of view slides is a way to answer his question as you go in the presentation.

CHAIRMAN APOSTOLAKIS: So you skipped the defense in depth slide?

MR. SCHULZ: Yes. Yes, it basically said that AP-1000 has different ways of handling accidents. The first way is usually a non-safety means, and you see that here. This is a loss of off-site power event, and the first level of defense, and these things are ordered in their anticipated likelihood of use, okay?

We can't guarantee that it is going to be this way, but if you lose off-site power, you still have that feed water system will be actuated, and if it is actuated and works properly, passive RHR will not be actuated the way the logic and controls are set up.

And the start up feed water is a non-safety system, and it is two prompts, and it feeds the steam generators, and if it operates successfully decayed heat is removed, and that is the end of the event.

If it fails to work, both pumps don't work, and AC power is not available, or whatever, the passive RHR is automatically actuated. This is the level of defense that we take credit for in the DCD for a loss of off-site power event.

If that system is actuated eventually the passive containment cooling system will also automatically be actuated, assuming the heat exchanger runs for more than a couple of three hours, which is not necessarily going to happen.

But if it does, the PCF will also be operated, and again if those systems features work, then that is -- you know, you can go indefinitely that way. If the passive RHR completely fails, for example, then you can go into a couple of different feed and bleed type cooling mechanisms, using some different equipment.

The first one uses the core makeup tanks, and I say partial ADS, and this basically means one or two stage 2 or 3 ADS valves. If they open, there are sufficient to get the pressure down so that the low head RHR pumps can inject. They are not sufficient to get down to gravity injection, but they are sufficient to get to R&S. And if that system works, then again the core is cooled, and you have opened up your R&S.

Now, you can take some failures to some of this equipment. For example, if the R&S doesn't work, and you get full ADS, you can go through the full small LOCA protection kind of steam, where IRWST gravity injection and containment recirculation works with full ADS.

And full key here is 4 stage. We don't recall need any stage 1, 2, or 3 if you look at the PRA results. We do need stage 4, and we take credit here only for 3 out of 4 stage fours if we take a single failure there.

Again, if that works, we are okay. And then there is the case of what if the core makeup tanks don't work. Well, if the core makeup tanks don't work, and we get the accumulators available, then the operator in this case will have to manually actuate ADS, because the core makeup tank level is what normally actuates ADS.

And if the core makeup tanks don't work, you don't get that signal. So the operators would have to manually. Now, they have got 20 minutes to actuate ADS in this case.

So again you have got -- so the combination of these three things, which aren't completely separate, but do have separate pieces, adds up to a lot of failure tolerance, diversity, reliability.

So this kind of thing is specifically modeled in the PRA, in terms of the event trees. The PRA obviously specifically calculates how many valves have to work, and what are the reliability of the valves, and operator actions is automatic or whatever.

Another thing that is interesting to look at if that it is this same event, if you look at, well, what controls what. What support systems have to work, and you see here a matrix that is a bit complicated, and so I am not going to go over the whole thing.

But it basically on the left column, you see all the different features that were used in the previous slide. For example, for heat removal, the first feature listed on this table is start up feed water. That was in the first box in the previous slide.

Now, for start up feedwater to work, it is automatically actuated by the POS. The POS requires non-safety DCD power, and AC power is required for this start-up feedwater pumps.

The component coolant water and (inaudible) are both required. Now none of the other safety features are required, and so that has a bunch of non-safety features that have to work to make it work.

If it doesn't work, then the passive RHR can be actuated automatically from the PMS. Now, I actually don't list AC power being required there, because if AC power failed, the passive RHR has fail safe valves and the valves will open.

If AC power is available, then the PMS actually has to generate a signal using the DCD power that powers it. So that is a kind of quirky thing there the way it is shown.

If the PMS doesn't work, passive RHR is separately actuated by the DAS automatically. Now, the DAS actually requires non-safety DCD power, which makes it completely separate from PMS. You use different DCD supply.

And then you can go on and you can look at what the different feed and bleed features require. So this is a way of seeing some of the redundancy diversity that is a detailed model in the PRA, and it helps you understand I think a little bit the reliability.

Now, we have these for tube rupture, and again there tends to be fewer different things in operating plants, and in tube rupture, all of these levels of defense have operator action involved.

Operators have to do things to mitigate a tube rupture in operating plants. AP-1000, the first level of defense shown here is actually the non-safety, which is very similar to what is going on here, in terms of plant operations.

You feed the steam generators, and you isolate the faulty generator, and you cool down on the intact generator, and you reduce the RCS pressure manually. That is what is involved here.

If that doesn't work, then the automatic case, which uses safety, and is what is analyzed so far using core makeup tanks, passive RHR, isolation of CVS and start-up feed water which can adversely interact in this scheme.

Steam generator isolation and passive containment cooling operation, and that is all automatic. If that works, the leak is isolated, and the core decayed heat is removed, and everything is fine. If that doesn't work, then again the small LOCA type feed and bleed cooling schemes can protect the plant.

MEMBER SHACK: Now, is there anything that the operator can be doing with regard to (inaudible)?

MR. CUMMINS: It is hard, but he basically would have to block automatic signals, and then do things that are contrary to the emergency procedures.

What tends to happen is that if he is involved in this scheme here, some of these features may get turned on because of the nature of this event. You will probably get an SI signal, unless this is a really small break, and he kind of gets going manually before th reactor trips automatically on an SI signal.

One of the things that he is doing here are supportive of this, and so they are not in conflict, okay? So for him to really screw this up, he has got to do lots of things. You know, turn off passive features completely, and again things that are contrary to the emergency procedures.

MEMBER RANSOM: What is the bottom line given, say, a steam generator tube rupture, what is the difference in the probability of core damage in those two cases?

MR. SCHULZ: I don't have that. I have that number on another slide. Selim, I don't know if you know it, but you can look up what the AP-1000 tube rupture core melt frequency is from your data. Do you have anything on operating plants with you? I don't remember off the top of my head.

MR. CUMMINS: Terry, I have that comparison, and I can get it later.

MR. SCHULZ: Okay.

MR. CUMMINS: The comparison for operating plants, and --

MR. SCHULZ: We worked hard at pushing tube rupture down because if you get a core melt with a tube rupture, containment tends to be bypassed, okay? Because you have got this hole through the tube.

So it is a contributor to a large release in our models.

MEMBER RANSOM: I was just wondering how much these additional levels buy you in terms of reduction and its probability of occurrence?

MR. SCHULZ: Well, if you go back, for example, to the loss of off-site power, it is probably buying you somewhere in the order of three orders of magnitude, versus current plants, and again Mike can provide -- we have a table which looks at by initiating events the core damage frequency versus operating plants, versus AP-1000.

MR. CORLETTI: This is Mike Corletti from Westinghouse. Based on previous presentations we have made, steam generator tube rupture for a standard plant for core damage frequency is on the order of 1.7 E to the minus 6. And for AP-1000, it was about 4 E to the minus 9.

MEMBER SHACK: You have a higher number on the table.

MR. CORLETTI: Okay. You have got me on that one, yes.

MEMBER SHACK: When you are 10 to the minus, that's high.

MR. CORLETTI: Sorry. Yes, I read it from the wrong column.

MEMBER SIEBER: It is a rather considerable uncertainty in numbers that are around 10 to the minus 9.

MR. SCHULZ: Why don't I -- and maybe I will just point out that we also have looked at, for example, at shutdown conditions, and (inaudible) is from our PRA evaluations, and one of the risk important shutdown modes.

Current operating plants, typically if you lose power, you really need to get the normal HR back working, and that is really your only level of defense. There are some temporary things plants can sometimes do, but usually you have to get this back.

For AP-1000, the R&S automatically restarts, and instead of it having to be manually restarted. If it doesn't work, we have basically a feed and bleed pulling system using R&S IRWST injection.

In this case the operator is opening some manual MOVs, which we can get water into the RCS through, and then backing that up is the squib valve IRWST injection path.

CHAIRMAN APOSTOLAKIS: Yes, let's keep going.

MR. SCHULZ: Basically we have used PRA and AP-600 and we have taken credit for that evolution, and added to it for AP-1000, and we have done a lot of changes in improving AP-600 based on the PRA. Some of them are operational, and some of them are analysis, and some of them are design changes.

We have continued doing that in AP1000, and here are some of the things that we have done during the development of AP-1000 as we interacted with the PRA that we did. A lot of these I have already mentioned.

MEMBER ROSEN: You also at the fourth stage ADS, is it the same, or is it just larger in AP-1000 than it is in 600?

MR. SCHULZ: The same number of valves are in the design. The capacity is larger. Now, AP-600, the final PRA quantification assumes 2 out of 4 stage 4s are required. Near the tail end of AP-600, when we were looking at TH uncertainty, there was some low probability cases that we came up with where that would not work 2 out of 4.

So we did a sensitivity study for AP-1000 and said, well, if it was 3 out of 4, the core damage frequency would only go up a little bit. Now, for AP-1000, we said we are not going to cut it that finely. We are just -- we did the PRA from the start, with 3 out of 4 being required.

So it is a more conservative or robust success rate criteria that we have used for stage 4. Even though stage 4 is actually bigger relatively speaking to power per megawatt on AP-1000. So we have actually gotten more margin, but we don't have enough margin to comfortably make to be always successful.

MEMBER ROSEN: So you went to three, and the valve is much larger, and it gives you more capacity if it opens properly?

MR. SCHULZ: Yes.

MEMBER ROSEN: And of course the thing that we just talked about is the question about its reliability and service condition, and corrosion, and what not --

MR. SCHULZ: Right.

MEMBER ROSEN: -- will be dealt with later.

MR. SCHULZ: Yes. And I think that is the more AP-1000 changes, and so we can move on to what you really wanted or came here to hear and that we came here to tell you about the PRA.

MR. CORLETTI: The next speaker will be Selim Sancaktar from Westinghouse.

MR. SAMCALTAR: My name is Selim Sancaktar, and I work for Westinghouse, in the Reliability and Risk Assessment Group. We actually started this presentation a couple of months ago in front of all of you, or almost all of you. Are there new people here that were not there before? I mean, am I repeating?

I don't want to repeat if everybody is

here today if they were here before.

MR. SNODDERLY: Selim, this is Mike Snodderly. This is a subset of the people that you presented to on November 7th, and so you can use that to start.

MR. SAMCALTAR: Well, if I repeat the same things, just tell me that you know it and I will skip that or something else. I don't want to bore you, because I am trying to figure out how to optimize.

I have two hours to give you a synopsis, the goods, and I will be happy to, plus answer specific questions, because remember I have two hours. So you choose how you want to use it. I am happy with whichever way you want to do it.

Most of these slides are the slides that you had before. So you can --

CHAIRMAN APOSTOLAKIS: Then you can go to slide 43.

MR. SAMCALTAR: Could I?

CHAIRMAN APOSTOLAKIS: Yes. 43, yes.

MR. SAMCALTAR: So this is like basic --

CHAIRMAN APOSTOLAKIS: Yes, 43. Okay.

MR. SAMCALTAR: I tried to discuss this before a little bit, but we can go again back to this. To put this in perspective, as I mentioned before, we used AP-600 models very heavily. However, we had to find a balance between totally doing something new, versus rubber stamping something that is done (inaudible) unacceptable.

The event tree that has changed most dramatically is this one, and so I am using this as an example. And already Terry discussed this, the design reasons that kind of led to this. This also brings us to geography a little bit, you know. Flow field design and flow field PRA, and how do you try to balance these.

One of the funny things that happened here is after a large LOCA, what is the success rate of the other accumulators? It was 1 out of 2 in AP-600, and it gave us a certain frequency for this sequence, and this is the most frequent one in this particular event tree.

In this plant, you should try to retain that success rate criteria, or tell me that you lax it a little bit, and not try to increase the accumulator size or numbers, or whatever directly to a place where we can say we have 1 out of 2.

And here we deliberately chose after discussions that we can (inaudible) 2 out of 2 success criteria. Both are needed. Both accumulatives are needed.

And what that does to us as you can see here is that get a condition probability of 1 times 10 to the minus 2 about.

CHAIRMAN APOSTOLAKIS: You see that there? That confused me, because when it says AC both --

MR. SAMCALTAR: Right, you need both.

CHAIRMAN APOSTOLAKIS: Well, this is an event, and so going down means failures.

MR. SAMCALTAR: Right.

CHAIRMAN APOSTOLAKIS: And so I thought it meant both accumulators fail.

MR. SAMCALTAR: Okay.

CHAIRMAN APOSTOLAKIS: You are saying that is not what it means?

MR. SAMCALTAR: Right.

MEMBER RANSOM: He says that's right, that both accumulators fail? Is that right?

CHAIRMAN APOSTOLAKIS: No, he says that both are needed, so that if one fails, you have failure.

MR. SAMCALTAR: Right.

MEMBER SIEBER: That's right.

MEMBER RANSOM: Really?

CHAIRMAN APOSTOLAKIS: Whereas, if I look at this without talking to Selim, I would assume that both had failed.

MR. SAMCALTAR: And that's why you need people to interpret it.

CHAIRMAN APOSTOLAKIS: We need humans. There is no question about it.

MR. SAMCALTAR: Okay. Basically, this mode is defined. Accumulators inject, and as I mentioned, you need four accumulators to inject. If one doesn't inject, then we declare it a failure.

Well, in the AP-600, it was not a failure. So the probability here is that you consider about 10 to the minus -- 1 times 10 to the minus 2. This gives us the worst sequence, and almost determines the whole --

CHAIRMAN APOSTOLAKIS: Wait a minute. Wait a minute. The large LOCA frequency is 5 times 10 to the minus 6. So if I divide 4.26, 10 to the minus 8 by that, I should get the condition of failure probability of the accumulators?

MR. SAMCALTAR: Right, 1 times 10 to the minus 2.

CHAIRMAN APOSTOLAKIS: I get 8 times 10 to the minus 3. Can I divide? You said 1 times 10 to the minus 2. We are close enough.

MEMBER ROSEN: Now, the initiating event frequency, 5 times 10 to the minus 6 includes the spurious actuation?

MR. SAMCALTAR: No. We have in AP-600 --

MEMBER ROSEN: Spurious actuation of ADS 4.

MR. SAMCALTAR: Right. Now, in AP-600, they are together in one category. Here we separated them, and there is another category specifically for spurious actuation of the ADS 4.

MEMBER ROSEN: So for the total CDF, I have to add some --

MR. SAMCALTAR: For the ADS 4.

MEMBER ROSEN: For the ADS 4, plus a whole lot of other things.

MR. SAMCALTAR: Yes.

MEMBER SHACK: Now, what is different about that event tree? Can you handle that one with one accumulator? Why did you separate that one out?

MR. SAMCALTAR: Oh, yes, good question. This large LOCA basically assumes the worst kind of LOCA; whereas, we know exactly where the spurious ADS actuation is. So we can handle it with one accumulator.

So we don't have to punish ourselves for the sins of some other limited failure for ADS actuation.

MEMBER SHACK: Now, it is curious to me, and the staff had an RAI on this, too; that even when you take that one out, your large break LOCA frequency is about a factor of 10 lower than it was for the AP-600.

MR. SAMCALTAR: Right. Absolutely.

MEMBER SHACK: And you say industry data.

MR. SAMCALTAR: Yes.

MEMBER SHACK: There is not a whole lot of industry data on that.

MR. SAMCALTAR: Yes, I can tell you exactly where that came from.

CHAIRMAN APOSTOLAKIS: That is a 5750, right?

MR. SAMCALTAR: First of all, that number came from one of the recent (inaudible) from the NRC, and when I say recent, we are talking about 1999 time frame, and you know which one.

And we also know I'm sure, or if you don't know, I am telling you, the recalculations for that number being done. Somebody in Germany is doing something, et cetera, et cetera, et cetera. That number is so big, and we are well aware of that.

And where it falls out, we will suffer the consequences as they come out. But the point when we were doing this PRA, which we had started about a few years ago, is what to do with the initiating (inaudible) frequencies.

I mean, there are various options, you know. We can totally redo the initiating events analysis. We can just say we are going to keep exactly the

AP-600 assumptions.

And we said that we will look at the important changes. Like we really didn't worry too much about the frenzy of the initiating event frequencies, because things in general are getting better, and what they use is a slightly on the conservative side, very slightly.

It doesn't gain anything, and your insights are not affected, but if you look for things that might have changed, either the industry is looking at things differently, or something else happened, and so we try to look for those.

And we are initiating our frequency for a large LOCA. You know, it is a fictitious number, whatever you say is true. We all support a number, and I shouldn't say a fictitious number, but a number well supported.

So from the Rasumssen time, there are people using 1 times 10 to the minus 4, and then people started saying, yes, 1 times 10 or 20 percent, and some distribution, and play with it, and somebody is 5 times 10 to the minus 4.

The point is that whatever you do, it was an expert opinion, and that is the kind of number that we used before, and (inaudible) it is something that we can refer to that is presumed, and those by the NRC since it is a NUREG.

So I have no basis to tell them that they should retain a design requirement if a large LOCA is not seen as a limiting event of the frequency space. So that is the best advice that we could find.

And next year the new efforts might have a considerably different number that we might have to revisit our assumptions, and I am not shy to do that.

CHAIRMAN APOSTOLAKIS: Now, this is actually a factor of 20 lower than what you used in AP-600.

MEMBER SHACK: Yes, but half of that is the DVI and the spurious actuation is separated out.

MR. SAMCALTAR: Right. Yes. And 5 times 10 to the minus 5, is 5.4 times to the minus 5 is a spurious ADS actuation, which was lumped in with a large LOCA before, because the success rate was the same. So 1 out of 2 accumulators.

So what we are saying here is that if you look at just the pipe breaks, the random pipe breaks, which are really not seen as a threat much anymore as they used to be, you don't have to set your design against them anymore as was done in the past.

MEMBER ROSEN: The difference is that pipes are designed not to fail. The relief valves are designed to open with high reliability, which if you do that when you don't want them to is a failure.

MR. SAMCALTAR: Certainly.

MEMBER ROSEN: So there is a very big difference.

MR. SAMCALTAR: Certainly, and we are focusing on that. I mean, the ADS portion is separated out, and we are focusing on it, and we also have a larger -- an order of magnitude larger initiating event frequency for that, compared to past pipe breaks.

MEMBER ROSEN: I think that is a good move.

CHAIRMAN APOSTOLAKIS: Now this is your number two dominant sequence isn't it for a large

LOCA?

MR. SAMCALTAR: Yes.

CHAIRMAN APOSTOLAKIS: To a CDF.

MR. SAMCALTAR: Yes.

CHAIRMAN APOSTOLAKIS: So it is about 40 percent.

MR. SAMCALTAR: Yes.

CHAIRMAN APOSTOLAKIS: So the NRC or the people who are reevaluating the frequency of a large LOCA, increase this, I doubt it will go back to the original numbers.

MR. SAMCALTAR: Currently the contribution of large LOCA is 4.5 to the minus 8.

CHAIRMAN APOSTOLAKIS: Yes.

MR. SAMCALTAR: And if later on people come in here and say it is not 5 times to the minus 6. It is now 5 times minus 5. This is going to go up by a factor of 10, to 4.5 to the minus 7, which will be almost a 130 percent increase in our estimate of core damage.

CHAIRMAN APOSTOLAKIS: Right. So you will start approaching 10 to the minus 6 then in our estimate of core damage frequency?

MR. SAMCALTAR: Right. Yes.

CHAIRMAN APOSTOLAKIS: How conservative is this assumption that you need both accumulators?

MR. SAMCALTAR: Well, at this point, I would like to pass the baton to Terry or Jim.

MR. SCHULZ: This is Terry Schulz. Now the large pipe breaks are obviously made up of cold leg breaks and hot leg breaks. This assumption is extremely conservative for hot leg breaks. Hot leg breaks probably should be lumped in with the spurious ADS success criteria of one accumulator.

But the cold leg breaks, I explained to you that we did an analysis for the PRA and filled the containment isolation with off-site power being available for 10 seconds, or 12 seconds, and we got like 1800 degrees fahrenheit.

That is with two accumulators. Now the question is if you had one accumulator, and that is also with uncertainty, and so that is a conservative DCD-type number, there is about 200 and something degrees -- 250 degrees uncertainty in that number. So the best estimate number is that much lower.

On a best estimate basis, I think we would be okay with one accumulator. With conservative basis, we would probably be very close to the 2200 degrees. I don't know. We might be under it, and we might be over it.

So hot leg breaks, which are probably a large portion of that number probability-wise, are overly conservative. We could split those out and use 1 out of 2 success rates area. Cold leg breaks, it is -- we are not sure if we really could or not.

CHAIRMAN APOSTOLAKIS: Thank you. Now, do you know why this number is being reevaluated? Were there any objections to it?

MR. SAMCALTAR: The basis, and if you look at the NUREG --

CHAIRMAN APOSTOLAKIS: Yes, I did.

MR. SAMCALTAR: It says Appendix J or something like that discusses it, the argument is rather limited. I mean, there isn't a database and one point that is remotely related to a large LOCA, and you can extend from that into an estimate.

And I think that it was reflecting was -- and it is still -- this how do you form this large LOCA really, or what is a large LOCA. And people were relaxing a little bit for the last few years that large LOCA is not really the limiting event, and even redefine the basis, and maybe design basis can be redefined and so on.

And you know about these activities. So there is a better perception and how people are more relaxed about how bad it is.

CHAIRMAN APOSTOLAKIS: But are you saying then that the reevaluation will lead to a lower number because --

MR. SAMCALTAR: I don't know honestly. The reason why --

CHAIRMAN APOSTOLAKIS: You talked about the numerator, and you said that they had one point --

MR. SAMCALTAR: Well, let me answer that by saying this. I think one of the reasons that people are reevaluating it is that there are some cracks and so on in some domestic plants, and so that kind of started to bother people a little bit about what can happen, and that's why they are reevaluating it, I think.

I am not an expert on the subject, and I am telling you my opinion.

CHAIRMAN APOSTOLAKIS: But it seems to me that they lump all the reactor years together and they came up with a number like 500.

MR. SAMCALTAR: Yes, but they are looking for a reason.

CHAIRMAN APOSTOLAKIS: Why are we looking at plant to plant variability kinds of things, which weakens the evidence and pushes the number up? Maybe we will review the NUREG at some point. I don't know.

MR. SAMCALTAR: You don't usually reevaluate unless it is going in a bad direction, and so I don't think we were reevaluate if things go down.

CHAIRMAN APOSTOLAKIS: Well, 3900 reactor years is pretty strong evidence.

MR. SAMCALTAR: It is.

CHAIRMAN APOSTOLAKIS: And actually that assumes all pipe sets everywhere in the world that are identical, and that may not be the case.

MEMBER ROSEN: You know that's not.

MR. SAMCALTAR: So you can see that we are struggling with this, and we are going to find a fine line between what is the latest perception, and how fast should we push it, and how much we should depend on it.

And you see here that by doing this that we are trying, depending on that this number is not going to be 5 times 10 to the minus 4 after people have finished with it, which I don't think so. I doubt it based on a lack of otherwise.

But can it go to 5 times 10 to the minus 5? Just because of calculations again or reevaluation, and not because of an event. Yes, and then we will just bite the bullet at that time. So that is possible risk assessment, and I don't have a problem with that.

I mean, it constantly should be reevaluated. We shouldn't just tack a number on.

CHAIRMAN APOSTOLAKIS: What was the core damage frequency for AP-600? Do you remember?

MR. SAMCALTAR: Yes, AP-600 is 1.7, 10 to the minus 7. This one total is 2.4, 10 to the minus 7. So the significant figure there is 2.4, and 1.7. It went up.

CHAIRMAN APOSTOLAKIS: It went up.

MR. SAMCALTAR: Yes.

MEMBER SHACK: It will go up a lot more if you use the same pipe breaks.

CHAIRMAN APOSTOLAKIS: If you use the same pipe breaks, yes.

MR. SAMCALTAR: Right, there is no doubt about it.

CHAIRMAN APOSTOLAKIS: This number was used in AP-600?

MEMBER SHACK: AP-600 is a --

CHAIRMAN APOSTOLAKIS: Yes, and so why would it go up for the AP-600?

MEMBER SHACK: it wouldn't go up as much.

CHAIRMAN APOSTOLAKIS: I don't think

(inaudible) if you use the wrong number.

MR. SAMCALTAR: It would go up like this.

CHAIRMAN APOSTOLAKIS: Yes. So you may end up with almost an order of magnitude difference in the core damage frequency.

MR. SAMCALTAR: Yes. If I believe that within a reasonable time frame, for the next 5 years or 10 years, that this would have gone back to 5 times 10 to the minus 4, I would have strongly advised them to go and push this to add a little bit more water and whatever it takes to go with the uncertainly.

MEMBER SHACK: But what they are arguing, George, is that if you used the same frequency in the AP-600 than this one, you will end up probably in the same place.

CHAIRMAN APOSTOLAKIS: But how can --

MEMBER SHACK: You know, if you use -

CHAIRMAN APOSTOLAKIS: The AP-600 used the old number.

MR. SAMCALTAR: Yes, that's right.

CHAIRMAN APOSTOLAKIS: So the only number that will go up is this.

MR. SAMCALTAR: You are correct.

CHAIRMAN APOSTOLAKIS: The only thing that struck me about this is that it is a significant impact on the CDF, and it doesn't come about because you did something to the design. It is because somebody did some calculation and reduced the number.

MEMBER ROSEN: But that is the Baysian update.

CHAIRMAN APOSTOLAKIS: It wasn't Baysian.

MEMBER ROSEN: You can think of it as an update of the knowledge base.

CHAIRMAN APOSTOLAKIS: Not all updates are Baysian.

MR. SAMCALTAR: This is not.

CHAIRMAN APOSTOLAKIS: This is not, especially lumping all the reactor years together as one.

MR. CUMMINS: I happen to think that the order came from the NRC though, the data that we used.

MEMBER ROSEN: We are part of the NRC, but we did not generate that data.

CHAIRMAN APOSTOLAKIS: I don't even recall it, but unless somebody tells me that I did. Okay. Good. That was very clear what is happening.

MR. SAMCALTAR: This number personally doesn't bother me. I think is a fair number to represent this. If it goes up because people have concerns, then it goes up and what can I do. I mean, I can't change it.

But I don't believe this is a reckless number to use at this point, and we have recognized the potential impact and I think we can more or less -- and we don't believe that this is going to change drastically. The order of magnitude would still be an absolute change, but I don't think that it is going to go back to an order of magnitude.

MEMBER ROSEN: What it says is that large breaks in these plants are very unlikely, and that is what our experience is telling us.

MR. SAMCALTAR: And we should not force the designers to do extra things because of that. Besides that, as Terry mentioned, really we are almost there with the success rate. It could be 1 out of 2, but then we would have all kinds of difficulties with the uncertainty business and success criteria.

So actually they are taking one step back and covering that angle.

CHAIRMAN APOSTOLAKIS: So the frequency then, if it was 1 out of 2, the condition operability would affect the core damage another two orders of magnitude, right?

MR. SAMCALTAR: Maybe an order of magnitude. So this would be like 9, minus 9.

CHAIRMAN APOSTOLAKIS: Yes.

MR. SAMCALTAR: Now that was interesting, and now just a little something that will be different and also gives you a glimpse of what we are struggling with and what we are thinking, and how we are approaching it.

And just to touch base on the subject of a spurious ADS. It just -- well, now this is tricky. Just since you touched upon them and that interests you also, the part that we talked about, the spurious ADS, the issuing event is 5.4 minus 5, an order of magnitude higher.

And here we can live with one out of two success criteria. So I just wanted to --

MEMBER ROSEN: Because this is a 14 inch break, rather than a bigger break for the --

MR. SAMCALTAR: It is a hot leg.

MEMBER ROSEN: A hot leg break.

MR. SAMCALTAR: The site of this location is also favorable, as opposed to cold leg.

MEMBER KRESS: But they cancel each other out.

MEMBER ROSEN: They cancel each other out, yes, but it ends up being 12 percent.

MR. SAMCALTAR: Right, it still is not

trivial. It is kind of compensated, You lose around 90 degrees here, and you gain approximately an order of magnitude here. So there is no loss.

CHAIRMAN APOSTOLAKIS: Okay.

MEMBER ROSEN: And that 12 percent, we will talk a whole lot more about that.

MR. SAMCALTAR: Okay.

MEMBER ROSEN: Because we will talk about the details of the valve and all the stuff like that, at a later time.

MR. SAMCALTAR: Okay.

MR. CORLETTI: Selim, did you want to talk about the probability basis for the spurious ADS, as far as what we have done?

MR. SAMCALTAR: Let me proceed as much as possible, and then see how we work that out.

MEMBER ROSEN: But my point as I understand it, even though we are boring in on the details of that ADS 4 valve, we are boring in on 12 percent of the risk. That is how it is calculated.

CHAIRMAN APOSTOLAKIS: On the large LOCA?

MEMBER ROSEN: Of the ADS.

CHAIRMAN APOSTOLAKIS: Of the total? A large LOCA is about 19 percent.

MEMBER ROSEN: No, I am talking about

spurious actuation.

CHAIRMAN APOSTOLAKIS: Oh, spurious actuation.

MEMBER ROSEN: 12.28 for the significant large LOCA. I am very impressed (inaudible).

MR. SAMCALTAR: When I started in the PRA business 20 some years ago, I looked at the tables they had created, and they had four significant figures. I said, come on. I mean, we have a hard time defining one significant figure, and how can you write four significant figures.

So I said let's round them off to two significant figures at least. We did that for a while, and what happened is that we have chop notes and people come and people come and review them afterwards. It is calculation notes on QA business and so on.

And these people are very, very strict. You round something up or down for a perfectly justifiable reason, and they come and said that this number is not the same as that number. They look at the computer output and it is 3.217 and you round it off to 3.2, they jump at you.

Sometimes we have different or that is one reason. Another reason is that we have different versions of calculations, and sometimes instead of specific figures, we round them off, and we lose track of which -- when we look at the pile, we lose track of where it came from, you know, for practical every day usage, because it is rounded off and we can't tell the difference.

So there is so much minute headaches, and so we decided that the criticism of reporting a four significant figure is less than the headaches that you get if you don't round it off. So that's why we don't round them off. But I certainly agree with you, and I hope there is no problems with those.

CHAIRMAN APOSTOLAKIS: The most honest PRA analyst that I have seen or heard. Let's talk about this. We don't have to talk specifically about that, but common cause failures. How can you do a common cause failure analysis for a plant that has not been built?

I mean, if I look at what the NRC, and EPRI, and everybody else has produced -- as you know, there was a common effort the last several years, and their main advice is that they can develop a common cause failure database, and they are saying that for your own plant that you should go down the list of the incidents that we have identified, and make a judgment if they apply or not apply, or partially apply to your plant, and then calculate the multiple Greek letter parameters.

Now, you are doing it here in a generic way, and I don't understand how you can do that.

MR. SAMCALTAR: Well, what else are we going to do?

CHAIRMAN APOSTOLAKIS: Well, I mean, something may have to be done later when actually somebody decides to built it.

MR. SAMCALTAR: That is-- I can't argue. I mean, I am not going to object to that statement.

CHAIRMAN APOSTOLAKIS: But if you get the certification, and maybe the staff can help me here, and then you get the combined basis later. Can they claim that, boy, this was certified and approved, and you shouldn't ask us to do a common cause failure analysis (inaudible)?

MR. SNODDERLY: You would have to make it part of an ITAAC, or help me out, Mike. Would it be an ITAAC?

MR. CORLETTI: Certain ITAACs say you have to do a common cause failure. There is a requirement to do a plant specific PRA after the plant is built to verify that the PRA that you used for design certification is still applicable.

CHAIRMAN APOSTOLAKIS: Because the same observation may apply to human reliability.

MR. SAMCALTAR: Although one step further, and I will tell you that in my opinion the same consideration applies to failure rates and others.

CHAIRMAN APOSTOLAKIS: Not so much. Not so much.

MR. SAMCALTAR: You cannot say that a PRA might today necessarily will have the same prospective of a PRA to be done in 10 years, or 5 years, or 29 years.

CHAIRMAN APOSTOLAKIS: Well, certainly, yes, but some are more important.

MR. CORLETTI: With AP-1000, like AP-600 and the other certified designs, there is a list of COL items that the COL applicant must perform, and one of them is plant specific.

CHAIRMAN APOSTOLAKIS: But does it single out common cause failure.

MR. CORLETTI: It doesn't specify, but I would assume that we would do it to the same level that we did the PRA for the design certification. It does not specify common cause failure.

CHAIRMAN APOSTOLAKIS: But still though --

I mean, if the fundamental premise of this effort that the NRC sponsored in EPRI is that you will go down the list of incidents and decide what applies. What do you do? Do you use all of them?

How did you get these numbers? You are using betas and gamas.

MR. SAMCALTAR: They are numbers that basically are picking up from the URB, the EPRI requirements document.

CHAIRMAN APOSTOLAKIS: And that requirements document has been approved by the NRC?

MR. CORLETTI: Yes, and reviewed by the committee. But to answer your question, George, I think that unless it specifically identified as an ITAAC, or as a DAC, what the certification is approved, you would not go back and reopen common cause failure unless it is identified now.

CHAIRMAN APOSTOLAKIS: Well, let's make a note of it. Maybe we will want to think about it.

MEMBER KRESS: We looked at the utility requirements document, and there was no basis or no reason for us to approve. There is no approval --

CHAIRMAN APOSTOLAKIS: And also the requirements document as I remember it, and it has been a few years since I read it, said to do it this way, and these are your goals. You never said beta is .10 and gamma is .02.

We looked at the numbers for guidance, but in fact we had a measured debate here with the NRC staff one day when they presented generic numbers, and we told them that generic numbers in this particular case don't mean much. And they agreed finally as I recall.

So this is something that probably has to be singled out for something that needs to be done specifically for the --

MEMBER KRESS: I thought the idea was in the utility requirements document that these are numbers for common cause failure that you would like to have and are going to shoot for, and you take your design and make it such that you think you can arrive at those.

MR. CUMMINS: This is Ed Cummins. I believe at the time of the utility requirements document various vendors were beating each other by a factor of 10 in the PRA by just changing things like the common cause failures, and they wanted a uniform comparison basis and therefore we would have been criticized by them if we -- certainly if we used any number that was better than what was in their tables.

Maybe you could have used numbers that were worse than what were in their tables, and so they specified a common basis for all the new plants to use.

CHAIRMAN APOSTOLAKIS: Right, but again this was never really approved by the NRC.

MR, BURKHARDT: This is Larry Burkhardt from the NRC staff. We don't use it as a review standard. This is an interesting subject, and my input on it is that if we don't have PRA requirements for operational plants, we go far in Part 52 as we should requiring a plant specific PRA.

Mike said that there is an ITAAC, and once that would transition into a COL application, I would say ideally that it would be nice if we had -- and this is just my opinion, but some sort of PRA regulation, and maybe, and maybe not.

But I am not so sure that this isn't something that can be resolved at the design certification stage other than -- and it is a good subject to talk about, and it is not -- I haven't really thought about it, and I am not really sure how we would address this issue at the design certification stage.

CHAIRMAN APOSTOLAKIS: Well, the thing is that a major lesson that we learned from all the PRAs that the industry and the staff have done in the last 25 years is that they are very plant specific.

So here, you know, we have a sort of generic PRA, and at this point it is of course appropriately to do it that way. But we should be aware of this fact, and say several things that would make it really plant specific have to be done when there is an actual plant, and not say it is certified now and you shouldn't CCF later and so on.

MR. BURKHARDT: Yes, I guess I would just have to think about it. I am just not certain how we would attack that issue and resolve it, which I guess we are starting right now in this kind of discussion.

MEMBER ROSEN: You know, you don't have to know the answer in regulatory space right now. But just from a 50,000 foot level point of view, we are comfortable we think with core damage frequencies in the 2 E to the minus 7 range. That is what they predict.

Now, in a plant specific case, something changes due to site specific characteristics, or common cause failure aspects that changes that result. Now we don't have 2 to the minus 7. We have 2 to the minus 6, or something like that. Then there has to be a way for us to register some degree of angst about that.

What we are saying now is when you get all done with the plant specific thing, it ought not to be very different than this, because this is the basis upon which we are proceeding.

CHAIRMAN APOSTOLAKIS: Yes, but he thing is that in order for it to change to become 2 to the minus 6, really have to be aware of things like that, and go back and do the calculations correctly.

MEMBER ROSEN: But I think that also implies the need for a confirmatory staff in the ITAAC.

MEMBER KRESS: And there lies the concept that the PRA plays essentially no role in the regulation. If they need to design based on design basis accidents, then they are okay, no matter what --

CHAIRMAN APOSTOLAKIS: Well, if there is a requirement to do a plant specific PRA --

MEMBER KRESS: Sure, but there is no requirement for it to be at a certain level.

MEMBER ROSEN: And there is no requirement for them to read it, or do anything with it. It is resolved.

MEMBER KRESS: That's right.

CHAIRMAN APOSTOLAKIS: So what does that mean?

MEMBER ROSEN: It's nonsense, is what it means.

MEMBER KRESS: Yes, that's basically it, you know.

MR. SAMCALTAR: When this plant is built, in 10 years, let'S say, I don't think that a utility can go to the NRC and say remember 10 years ago this PRA existed? This is my PRA. I don't think they can do that.

MEMBER KRESS: No, you're probably right.

MR. SAMCALTAR: I can't imagine that.

CHAIRMAN APOSTOLAKIS: It is in the books, they might say that.

MR. SAMCALTAR: They may try. That's why we have to look at them.

CHAIRMAN APOSTOLAKIS: And also there is this --

MR. CUMMINS: Just as a matter of general comment. The three past certified designs took exactly this approach, AP-600, and System 80 Plus, and ABWR.

CHAIRMAN APOSTOLAKIS: You are doing now exactly what I am afraid will happen in the future.

You guys looked at it before, and so don't raise any concerns. Now, this -- I can't imagine that the requirements document from EPRI had a table with a simplification of the 2 KQT equations that you have here.

You must have taken it from some other report, and so you really went beyond what is in the utility requirements document and that was a fairly high level document.

MR. SAMCALTAR: No it's not.

CHAIRMAN APOSTOLAKIS: It's there?

MR. SAMCALTAR: I can show you pages from it. The Utility Requirements document has tables for initiating frequency which you don't have to use, but they have tables for random failures probabilities; and they have tables for common cause parameters. They will tackle it as multipliers for convenience, and so you can use them if you want to.

And then they also have appendices that show you where they got these from, and they are kind of outliners how they reached these numbers.

It is very, very clearly. I mean, explicitly, and I will be happy to fax you the pages, or I mean you can just get a copy of it, and look at it.

MR. BURKHARDT: I have a copy in the library and I will bring one over. But again we don't use that as any sort of review standard.

MR. SAMCALTAR: The NRC has pushed us to the limit and beyond in cases where you use some of those numbers. They pushed us for justification wherever they thought that some of those numbers were not what they thought they should be.

And we had long, long discussions that are documented by RAIs and other things.

CHAIRMAN APOSTOLAKIS: Well, let's look at it a different way. That particular project cost the agency and EPRI a lot of money. Now if the major conclusion really is not used and we can say, well, we can have generic numbers that are on a table, I wonder why the NRC spent all this money.

The second issue where the same observation applies or a variation thereof is the human error analysis. You use that, which as you know -- what, 20 years, 25 years-- are 20 years old. And here we have the Agency spending all sorts of money developing ATHENA.

Now, if 30 is acceptable when we make real decisions like this one, why then are we developing ATHENA. I don't understand that. Because then of course if we certify and approve this, somebody can come back two years later and say, oh, I don't care what ATHENA says. I mean, you guys approved this.

So it is these kinds of things that maybe don't both you, but they bother me. Either we should say that 30 is good enough and go with it, or say it is not good enough and we still need some development.

Because ATHENA was a pretty expensive project, and it was not -- and they talked about error forcing context, and all this, and you guys go back to Swain (phonetic) and do a nice job.

So this is what bothers me, and I wonder again whether the human error analysis should also be one of the analyses that will have to be revisited when the plant specific PRA will be done, whenever it is done.

Because one of the things that you learn here is that you have to be careful what you approve. Okay. Let's go on. I think they did a fine job given the fact that you had to do it. If I had to do it myself, I don't know. I am not sure I would be using ATHENA because ATHENA doesn't give me any probabilities.

And you have to come up with some probabilities, but I hope you see my problem, too.

That we are also reviewing the research efforts of the agency, and we are approving other things, and we had the same problem with power uprates.

If we were not using the latest in there, there is no way we could approve it.

MR. SAMCALTAR: We use what they used here, which is a different form that we used in AP-600. In fact, we have not touched anything if we don't have to.

CHAIRMAN APOSTOLAKIS: I understand.

MR. SAMCALTAR: I am just going to give you a couple of examples of some pieces of fault trees. We have like 400 to 500 pieces of fault trees for the various missions of the front line systems, and their support systems.

And then we have another 400 pieces for PMS only, and so these are just a few numbers that I just picked up. These are fault tree names, and I went to the PRT fault tree, whatever that is, and a certain mission of passive RHR under certain conditions.

There is just not reliability for a passive RHR. It depends upon what it is reacting to. So this is just one number, and I have another, but I don't know exactly what the success criteria is. But

I want to give you some sense of what is coming out of it.

CHAIRMAN APOSTOLAKIS: So what is the message here, Selim?

MR. SAMCALTAR: The message is --

CHAIRMAN APOSTOLAKIS: When I look at the numbers, 10 to the minus 4 and 5, and 3, I think that it is within reason.

MR. SAMCALTAR: Yes, that is the point.

CHAIRMAN APOSTOLAKIS: So that is your message?

MR. SAMCALTAR: Right.

CHAIRMAN APOSTOLAKIS: So the 10 to the minus 7 and 6 there, I don't know.

MR. SAMCALTAR: I pulled them out on purpose, okay? I didn't have to put those because the system is like one train before a common cause and so on comes in. The important thing is that it is actually happening here with this.

CHAIRMAN APOSTOLAKIS: If you didn't have to put them there, then why did you? Maybe the stage was not crowded enough?

MR. SAMCALTAR: Well, I can be as funny as you. Remember that this is a table that we gave the NRC, okay? I am just repeating it.

CHAIRMAN APOSTOLAKIS: You don't want to give us that.

MR. SAMCALTAR: It is perilous for me to show you this, because this is where the systems come in, but the only system here that is of importance here is passive containment coolant.

And as Terry mentioned, we had to do something to it to push it to this level. It wasn't here before. It was down here if you look at AP-600, because it had --

CHAIRMAN APOSTOLAKIS: I'm sorry, go ahead.

MR. SAMCALTAR: These are just notes of it, and this is just a piece, and I said a module, and it is not a system. The systems you can see here. The higher system that you see here is passive containment coolant, and we are saying that, and we are on paper saying that this thing is reliable on demand to the level of 2 times 10 to the minus 6.

It was not there in the AP-600. It was here in this range if you look at the corresponding table. And because the dominant theory there is common cause failure to error of operator (inaudible), they ought to open.

And here we have it and we wanted to raise up the liability because we need it, this design. So we added one more line with a different MOV, and so it is comes out to an order of magnitude plus. It doesn't give us like (inaudible), but I think it is another order of magnitude, because it is still constrained by signals. When we do this, we use signals. So we are always constrained by signals at some level.

CHAIRMAN APOSTOLAKIS: So the difference between -- I mean, which is an important difference, between what you are presenting and what I would see in a PRA of an existing LWR, is that you had your numbers, you developed your numbers like the existing LWR would do, but then you actually did things to the design to eliminate some of the annoying numbers.

MR. SAMCALTAR: Right.

MEMBER ROSEN: George, of course the way to -- the later plants did that, too, the plants that were designed.

CHAIRMAN APOSTOLAKIS: Yes.

MEMBER ROSEN: There were features added to the plants that I am aware of based upon the PRA during the early construction and late design phase.

MR. SAMCALTAR: So I did this for my own satisfaction, because I wanted to see if there was something that was out of line, like when I look at the year increasing and decreasing this way, just to give myself a warm feeling that nothing jumped at me.

For example, hydrogen control is 90 percent and its failure is 10 percent. That is pretty lousy for a system, but this is a manual system, and it is not safety and so on, and that is where it belongs, and we are making that, and it is not by accident.

If you wanted to make it more reliable, we would have made it more reliable by putting more redundancy and making it automatic, and so on.

CHAIRMAN APOSTOLAKIS: Well, that is where the advantage comes into it. So I want to give you a feeling and see if you see anything here that bugs you. If you look at it, these are the ones in my opinion of course.

We have like (inaudible) favorite ones, and we say that in this particular mission that there are like 16 or 17 of these for different missions. ADS here is one mission of it, and I don't know exactly what it is, but it is one of them, and it is like 9 times (sic) minus 5, and it is almost 1 times 10 to the minus 4, including operator actions, critical operator actions.

So it is not like, oh, look at it, and I say okay. It doesn't look too bad to me. So when you take the critical operator action, I think this is when they initiate the CMT?

MR. SAMCALTAR: Offhand, I am not sure.

CHAIRMAN APOSTOLAKIS: How bad is the CMT?

MR. SAMCALTAR: I don't know. I can make a table, but at this moment I don't know.

CHAIRMAN APOSTOLAKIS: That's okay.

MR. SAMCALTAR: Passive RHR, for example, is 2 times 10 to the minus 4, and range is 10 to the minus 4 range. This is actual --

CHAIRMAN APOSTOLAKIS: Okay. Okay. Let's go to the next one. We will be here until midnight at this rate.

MR. SAMCALTAR: Okay. Okay. This is the CDF, and the CDF from AP-1000, internal event set power, we calculated to be 2.4, 10 to the minus 7, and again just for comparison purposes, it was 1.7 for the AP-600.

Here are the initiating events, and there are 26 of them. Are they the same? Almost. The difference I will point out to you. We have spurious ADS throughout, and so if you look at AP-600, you will see that numbers 2 and 3 combine into initiating event, and in the AP-600, we have removed one initiating event, which is intermediate LOCA.

It was something in between medium LOCA and small LOCA. We absorbed it in medium LOCA. And so this medium LOCA includes what was before two categories, medium and intermediate. So the number of initiating events categories is the same by accident.

Here the initiating event frequencies, and here are the ore damage frequencies, and this is the commission of CDF, which is CDF divided by initiating frequencies.

CHAIRMAN APOSTOLAKIS: You have similar tables with LERF, or actually LRF?

MR. SAMCALTAR: Not with me unfortunately, but we have it in the RAI.

CHAIRMAN APOSTOLAKIS: Has the order changes significantly?

MR. SAMCALTAR: I don't remember offhand.

CHAIRMAN APOSTOLAKIS: The first two, for example. the (inaudible) line break and the large LOCA, these are different plant damage states, right?

MR. SAMCALTAR: Yes. And these are not just contributed to LERF, whereas, this will go up and so on. I don't have another table for it with me unfortunately.

CHAIRMAN APOSTOLAKIS: Okay. Next.

MR. SAMCALTAR: Oh, by the way, the total number of initiating events and the way we are modeling it, it comes out to be about 2.4. So nowadays it is driven by transients, you know, and nowadays the plants are running like 1 to 2 transients per year. So this is a reasonable total.

MEMBER ROSEN: The total are what?

MR. SAMCALTAR: The number of initiating events.

CHAIRMAN APOSTOLAKIS: Per year.

MR. SAMCALTAR: Per year is 2.4.

CHAIRMAN APOSTOLAKIS: That you anticipate?

MR. SAMCALTAR: Yes. It is a sanity check, and it should not be .l. I mean, in some initiating frequencies, I get 10, 10 per year, and that is very conservative for today's --

CHAIRMAN APOSTOLAKIS: And that doesn't mean --

MR. SAMCALTAR: So .1 would also be unbelievable. So I am just pointing things out to you.

MEMBER ROSEN: One of the other sanity checks that makes a lot of sense to me if you go back, is to look at whether or not there is anything that sticks out, and the one that sticks out here is safety injection line break.

I would be more comfortable with -- that is 70 percent of the risk right there in the first three lines -- if it was more evenly balanced.

MR. SAMCALTAR: Certainly. If you could do anything about it that is like modually available, we would do it. I mean, we feel the same way, but it is not -- I mean, there is really no hard safe area, and here if you are feeling good, you distribute them evenly or close to.

CHAIRMAN APOSTOLAKIS: That is not in the EPRI utility requirements documents?

MR. SAMCALTAR: No.

CHAIRMAN APOSTOLAKIS: Feeling good is not there?

MR. SAMCALTAR: Feeling good is.

MEMBER ROSEN: Well, it says that if you get them about even, it says that you can't work on any one of them and make one -- you can't pick one to work on, because they are all about the same, and you basically stop at that point.

But this is not -- they have not quite achieved that here. The safety injection line break is in fact a standout here.

CHAIRMAN APOSTOLAKIS: Yes. Of course, you have to combine that argument with the absolute value, and --

MEMBER ROSEN: Anyway, I was asking if you thought that thought, and you said yes.

MR. SAMCALTAR: Yes, this is a plant specific, you know, initiating event basically. This is happening because of the way that things are arranged, and where this is happening is a design basis accident.

CHAIRMAN APOSTOLAKIS: Do we need this to talk about? We talked about it already.

MR. SAMCALTAR: Yes, comparisons.

CHAIRMAN APOSTOLAKIS: Yes.

MR. SAMCALTAR: These are some dominant CDF sequences, like the first one, and so you can see what kind of tables we are generating. This is for information, and like the first one is safety injection line break occurs, and CMT injection is successful, and full ADS occurs, but we are failing 1 of 1 IRWST injection line.

You can see why we are getting what we are getting. I mean, this is it. This is the guide that is doing it for us.

MEMBER ROSEN: You only have one injection.

MR. SAMCALTAR: Right. And we also have a worst break in the worst place with the worst wall.

MEMBER ROSEN: It creates the break and it takes out one of the injectors?

MR. SAMCALTAR: Yes. Here again the other culprit, we discussed this before, and so on, and here is spurious ADS showing up, and it is equal to this in some way, and so on.

CHAIRMAN APOSTOLAKIS: So these were the two that were lumped in AP-600?

MR. SAMCALTAR: Before, right. And there is more.

CHAIRMAN APOSTOLAKIS: Okay. Let's look at this.

MR. SAMCALTAR: And then we did a bunch of sensitivity analyses on various subjects, and one of the things that we did, and I didn't mention it, and I will show you the picture here.

The AP-600 was proven to our satisfaction that you don't have to have the passive containment cooling water actually coming down over the containment shell for the success of containment cooling. Air cooling is sufficient for long time periods with a good margin.

In this plant, when we started the PRA, it was not obvious that it will be successful or not. We weren't sure. So we said that we are going to collect these sequences where everything works, but water from the passive containment cooling does not come down and flow down over the surface of the containment.

MEMBER ROSEN: What happens then?

MR. SAMCALTAR: We don't know at that point whether it will be a success or core damage, or containment failure that leads to core damage. So we collected them, and these are these states that we named as LCF, late containment failure.

If the passive containment cooling fails, containment may not survive after the 24 hours, may or may not, and that is the initial question. We collected them just in case, and if we cannot prove it, then we will declare them core damage. If we prove it is okay, then they are no never minds.

Now, with that information, I can now go back to this first -- now, this first sensitivity display here says what happens if everything else is successful, and water doesn't come down, and I assume it is containment failure which leads to core damage.

MEMBER ROSEN: Wait a minute. I having a

problem with this index. Containment failure leading to core damage. Usually core damage leads to containment failure.

MR. SAMCALTAR: Well, in this case, containment failure leads to core damage because the containment is for some reason that after 24 hours that it severely compromises, and something opens up and the water or the steam goes out, and so the water levels, the head of the passive systems, the flow gets lower, and lower, and lower.

MEMBER ROSEN: Okay. Now I understand. It actually proves an accident in which the core was not damaged.

MR. SAMCALTAR: Not damaged.

MEMBER ROSEN: And everything else is the same, and the only thing that happened was that you had a big pipe break, and it fills up the containment with steam, and everything was going along fine, and the core stayed covered. But the containment failed and then you lose the steam, and then it goes to core damage.

MR. SAMCALTAR: Right.

MEMBER ROSEN: Thank you.

MR. SAMCALTAR: If all these sequences also went to core damage, then the increase would be a factor of 1.3, or 30 percent, or it would be 2.4 times 1.3, whatever that number is.

Of course, we looked at initiating event importances, and sequence importances, and in-state importances, and these are listed here, and common cause failure importances.

CHAIRMAN APOSTOLAKIS: When you say initiating event importance, are you referring to --

MR. SAMCALTAR: Just to the two tables before when I listed them. Like the SI line break is --

CHAIRMAN APOSTOLAKIS: Oh, so you are just telling us again that 39 percent is good and you are not referring to the standard of importance measures?

MR. SAMCALTAR: No. And then from these, you can find out what happens if I --

CHAIRMAN APOSTOLAKIS: Did you use any of the standard importance measures?

MR. SAMCALTAR: Yes. We have tables for those.

CHAIRMAN APOSTOLAKIS: Are those a separate table?

MR. SAMCALTAR: Yes, that is where these come from, the components. All of these come from (inaudible) values. You have one of these tables reporting lows and (inaudible) for all the components, and human errors and common cause.

MEMBER SHACK: And the number is 60,000?

MR. SAMCALTAR: Yes. Maybe he forgot. We did some human error probability, and like we sent in all the human errors to one area, and we set them to zero, and then we set them to .1 just to see something in between.

CHAIRMAN APOSTOLAKIS: This includes errors as you say there to diagnose those things and everything?

MEMBER ROSEN: It's all the models of human actions.

CHAIRMAN APOSTOLAKIS: Everywhere where you have a human error probability (inaudible)?

MEMBER ROSEN: The human fails.

MR. SAMCALTAR: Right.

MEMBER ROSEN: So you say here it is 57, a factor of CDS --

MR. SAMCALTAR: A factor of 57. It says 2.4 multiplied by a hundred, and you have to divide by two to make it good, and so it will go from 2.4 minus 7, to 2.4 minus 5, divided by two; and 1.2 minus 5 approximately. I am just roughly estimating. It is going to go up by a factor of 50, and multiple it by a hundred and divide by two.

There are a couple of ones here that we long discussions with the NRC about, the reliability of check valves, and I know we had long discussions about explosive valve reliability. So we did a few -- we did some sensitivity analysis on this to see what happens if we increase --

MEMBER ROSEN: You see, this is very interesting to me, because we were talking about the spurious failure of the ADS 4, and now you are telling me that even if it turns out that all my fears are correct, failure of the ADS 4 will work when commanded is a factor of three on CDF.

MR. SAMCALTAR: Right, but let me quality if so that there is no misunderstanding. I don't want to mislead you, you know. In that case, we are past the initiating frequency, and just responding to the initiating frequency.

MEMBER ROSEN: Right.

MR. SAMCALTAR: So the ADS spurious --

MEMBER ROSEN: No, this is when it is commanded, it doesn't work, and it is a factor of three?

MR. SAMCALTAR: Yes, because these were points that required a lot of back and forth with the

NRC.

MEMBER ROSEN: Well, that is very helpful to me.

CHAIRMAN APOSTOLAKIS: Now the passive systems that were handled separately, you don't have any importance --

MR. SAMCALTAR: Oh, the system importance is coming up in the next one.

CHAIRMAN APOSTOLAKIS: Okay.

MEMBER ROSEN: And the reason that it is only a factor of three is because it is only 12 percent to begin with.

MR. SAMCALTAR: Yes. It is not a major contributor. The RCP is -- oh, this is the reactor trip breakers, and it should be RCT. Those are the reactor trip breakers. and then the last one, sensitivity to standby non-safety systems.

This is when we turn off five systems at once, and these are truly standby systems. They just sit on safety standbys, as opposed to alternating systems. Like some systems are charging, and (inaudible) safety works every day. I mean, it is tested by just working.

These guys are sitting basically and doing nothing for long time periods, and they are non-safety, and so we said let's send them to failure and see what happens.

These are system importances. Here by the very next slide has a description of what these acronyms mean in case you wonder what the acronym is. So it is on the next slide.

CHAIRMAN APOSTOLAKIS: What does PMS stand for?

MEMBER KRESS: Post-menstrual syndrome.

MEMBER ROSEN: Protective safety margins.

MR. SAMCALTAR: So what I do is I had this table before, and I grouped them so we could focus on what this is really saying and took away the minute details to show you what it is really saying.

So if you look at the increase in CDF, and if you turn it off, the systems listed here increase the core damage less than a factor of two. So these are truly important, whichever way you look at them.

MEMBER ROSEN: Which is a level of not risk significant than option two.

MR. SAMCALTAR: As defined, yes.

MEMBER ROSEN: By option two, we were in that discussion of component importance, and we had a long discussion with the staff, and it became two on the risk achievement was the level at which you said it was not risk-significant.

MEMBER KRESS: Yes, but that was for a plant that had CDF like 10 to the minus 4.

MEMBER ROSEN: No, it was actually for a plant that had 10 to the minus 5.

MEMBER KRESS: 10 to the minus 5, and not 10 to the minus 7.

MEMBER ROSEN: Right.

MEMBER KRESS: So I think we would change the two.

MEMBER ROSEN: It might be higher than two is what he is saying.

MEMBER KRESS: Well, yes.

CHAIRMAN APOSTOLAKIS: And that would be the second from the right.

MR. SAMCALTAR: I mean, it can be higher than two. Now, these breaks are not traditional, okay? I kind of look for places where they punched up, and these are forced upon me, and I did not choose them. So don't tell me why this is 50, but not hundred.

CHAIRMAN APOSTOLAKIS: That still doesn't get you off the hook. So why is it 50?

MR. SAMCALTAR: And then the next one was --

CHAIRMAN APOSTOLAKIS: That it was a natural break.

MR. SAMCALTAR: So, again in putting this here, and I am looking back at it and saying that doesn't make sense, you know. Do I see anything that jumps at me. That is the reason why we are looking at it.

But if something jumps at me, because it is an insight, and it is telling me something, and it is wrong. And in both cases, we want to know. So if you look here now, non-1E diverse actuation system, AC power, which is a non-safety grade.

PLS is control system, and what we know as control system now in other plants. In the next range, CMT, accumulator (inaudible), these are the most important ones. PMS 1E-DC, IRWST recert mode, AVS, IWRST injection mode.

And the two most important ones are these, and they are related to each other, and this actually is a support system for this. They have an umbilical cord.

MEMBER SHACK: Supposed I looked at the squib valve by itself? Where would it --

MR. SAMCALTAR: Here is a table that has every basic event, and a single squib valve will not really show up, but squib valve common cause will show up.

MEMBER SHACK: Squib valve common cause?

MR. SAMCALTAR: Well, if you look at the top of the table, it is just populated by common (inaudible), and if you say what is the importance of one squib valve, it is nothing.

CHAIRMAN APOSTOLAKIS: But it makes the common cause failure --

MR. SAMCALTAR: Right.

CHAIRMAN APOSTOLAKIS: So that jumps out at me.

MEMBER ROSEN: What that says in layman's terms is that you don't want someone to mess up all of your squib valves.

MEMBER KRESS: At the same time for the same reason.

CHAIRMAN APOSTOLAKIS: Even without this, I wouldn't want that to happen, but that is exactly what it says.

MR. SAMCALTAR: And PMS and DC-1E power, because of its relation to the PMS basic weight, are the most important systems. They increase your core damage in orders of magnitude, 3 or 4 orders of magnitude.

And PMS is very variable, and Terry tried to give you a taste of it this morning by telling its basic design features and the thought that went behind it.

CHAIRMAN APOSTOLAKIS: Well, let me understand this a little bit. Maybe I am missing something. 30 percent of this table on slide 24 where he said that there is a diverse system, DAS, right?

MR. SAMCALTAR: Right.

CHAIRMAN APOSTOLAKIS: So even with that, we would get this kind of importance for PMS.

MR. SAMCALTAR: Right. Remember, the importance -- if you take the --

MEMBER SHACK: That is because the power to the DAS goes out.

MR. SAMCALTAR: No. The DAS is there. It works. The change -- remember the orders of magnitude that you go up when you (inaudible) a system? If you take the inverse of it, one over that, that is like the general reliability.

It is a measure of the general reliability of that system in a formal sense. Like if I go three orders of magnitude in CDF and if I fail a system, and system failure probability is approximately 10 to the minus 3. That's what it means roughly as an average.

Can you relate to that? I don't know if you can visualize it that way.

MEMBER KRESS: That is some sort of contribution for that thing for sequences that dominate?

MR. SAMCALTAR: Yes. If you had an initiating event, one, and if PMS failure takes me to 1 times 10 to the minus 5, and then down failure, and then I have DAS failure, 10 to the minus 2. And then let's say control power is 10 to the minus 1. And then I get core melt, let's say, and I have lost everything now.

So it is going to be a magnification of those numbers. Now, if you have the sequence, and squib PMS, and maybe it is one, anything (inaudible) 10 to the minus (inaudible) orders of magnitude.

And you can say, yes, this is a lot. Yes, it is a lot because it is a reliable system. Now we can say what can I do. There is nothing that you can do, except to make it less reliable, because if you increase the reliability of that, and again visualize what I have just told you.

Transient, PMS failure, and DAS failure, 10 to the minus 2, let's say; and control power, 10 to the minus 1, and I go to core damage. So now I want to say I think it tends to make DAS more reliable, 10 to the minus 3, and PMS will still go up five orders of magnitude, right?

MEMBER KRESS: Yes.

MR. SAMCALTAR: You can't change that.

CHAIRMAN APOSTOLAKIS: Yes, more or less.

MR. SAMCALTAR: So the higher the raw value is, it means more reliable that system is, you know, originally is. It is more reliable.

CHAIRMAN APOSTOLAKIS: Now, we really don't know, and there is no universally accepted for calculating the reliability of software.

MR. SAMCALTAR: You are absolutely right.

CHAIRMAN APOSTOLAKIS: Yet, you have a CCF.

MR. SAMCALTAR: Yes.

CHAIRMAN APOSTOLAKIS: Now, I don't recall the utility requirements document having anything to do with that?

MR. SAMCALTAR: No, they have nothing.

CHAIRMAN APOSTOLAKIS: And yet it is very important.

MR. SAMCALTAR: Yes.

CHAIRMAN APOSTOLAKIS: Can you remind us how you did that?

MR. SAMCALTAR: Okay. We were in this room five years ago or so, and you were here, and you were here.

MEMBER ROSEN: No, I was running --

MR. SAMCALTAR: Okay. John Wiseman, our expert in PMS --

CHAIRMAN APOSTOLAKIS: You see, that is the problem. Now you are telling me that I approved something five years ago.

MR. SAMCALTAR: No, no, I am not going to say that. Absolutely not. Absolutely not. I am not a precedence man.

CHAIRMAN APOSTOLAKIS: You don't want to do it, but you did it anyway.

MR. SAMCALTAR: No, I want to tie it to something.

CHAIRMAN APOSTOLAKIS: Okay.

MR. SAMCALTAR: But I don't want to do an injustice to it. I have a totally different reason to tell you. Not a precedent, and I am not a precedence man if you didn't figure that out.

CHAIRMAN APOSTOLAKIS: Okay.

MR. SAMCALTAR: We had a meeting here and these are electrical engineers who relate to this and I am not, but I am going to tell you that in the third person thing.

There are certain things I know in the first person, second person, and third person. I am here as a third person in this subject. He was the first person, and he tried to explain all this stuff for about -- it took like 2 hours, and it was only for 45 minutes, but it felt like it was two hours.

And it was back and forth, and the point is this. PMS is so reliable because of its redundancy. We superimpose on it various checkpoints by common cause. We insert common cause among (inaudible) at the level of 10 to the minus 5.

CHAIRMAN APOSTOLAKIS: But that is a judgment though, and is not based --

MR. SAMCALTAR: It is based on expert opinion, and it is based on some equation that was made years ago, and it is like a factor. You say what about this aspect of it, and it contributes this much, and you kind of find things out.

But the bottom line is it is an expert opinion, and you can get out of it 10 to the minus 3, and 10 to the minus 4, and 10 to the minus 5, or anything that you want. And people do.

And actually I remember one of your comments at the end of this discussion, and I hate to place it in your -- and I hate to misquote you, but you said then why did you put it there.

I mean, if this is such an expert opinion and so it is really damaging. It really hurts our reliability. But we put it in enough places that it makes physical sense.

I mean, later on it is in the model, and so you can say, hey, I limited my reliability in import cards, and I limited my reliability to output cards. I limited my reliability in sensors separately, and not with one box, but different boxes.

And so if later on somebody can go in there and say, oh, maybe I can do sensors better this time, you know. Now, if you have 10 to the minus 5, and if you say it is 10 to the minus 4, I cannot sit here and argue with you. I have no basis to argue.

CHAIRMAN APOSTOLAKIS: Now I remember that meeting, and I think at the end why the committee went along was that you did a sensitivity analysis I think, where you started setting things to the same state, and you still showed that the core damage frequency was very low. Is that correct?

MR. SAMCALTAR: It might be. I don't remember.

CHAIRMAN APOSTOLAKIS: I remember sitting over there to the right and saying that if they did that, then what else can you do.

MR. SAMCALTAR: Yes.

CHAIRMAN APOSTOLAKIS: I think that is what you did. It was a scientific analysis of safety.

MR. SAMCALTAR: But it was more than that. Not only was it (inaudible) among like objects, like the cards, and the sensors, and the cause again could be separately.

But we also put in a common cause of 1 times 10 to the minus 6 between the PMS and PLS. So that we never can go beyond that barrier. Whatever we do, we will stop there.

Moreover, it was one more checkpoint. We put 1 times 10 to the minus 6, or like operators have no information coming into the room. Everything goes blind, whatever that means.

So that you can never multiple numbers and signals, and operator actions. You could never go beyond that barrier, and it stops you. We tried to limit those and these things showed themselves. So you can look at them separately, and say what does this mean.

Other than that, I don't know what else to do if --

CHAIRMAN APOSTOLAKIS: Well, PMS is very important.

MR. SAMCALTAR: Yes.

CHAIRMAN APOSTOLAKIS: You talk about a factor of 50,000.

MR. SAMCALTAR: Yes, at that range. If you take one over that, it is like 2 times 10 to the minus 5 and the reliability is variable and not as far as individual same systems. So, 2 times 10 to the minus 5.

CHAIRMAN APOSTOLAKIS: But we do a very gross bounding analysis, and say it is gone, you are still -- the core damage frequency is what?

MR. SAMCALTAR: If it is (inaudible), you go to 10 to the minus 3.

CHAIRMAN APOSTOLAKIS: So CDF is now 2 times 10 to the minus 7.

MR. SAMCALTAR: Right. And 50,000 is a big number.

CHAIRMAN APOSTOLAKIS: And you go 10 to the minus 3 is only what I can think of. I thought you were going higher.

MR. SAMCALTAR: No, just 10 to the minus 3, and also that 66,000 --

CHAIRMAN APOSTOLAKIS: Well, I think that is what happened with the AP-600.

MEMBER ROSEN: This is not unusual. You have very reliable systems, and in current day operating plants, like essential cooling water, or the 7300 processor system, they have very high raws.

I agree that they are very reliable, and we rely on them to be very reliable.

CHAIRMAN APOSTOLAKIS: I agree, but what I am trying to do here is have an argument on why I don't have to worry about actually quantifying this, and if I do the worst case, like core damage frequency is still low, then as soon as the system is gone, which I know is extremely important.

And maybe you can argue about the CDF being 10 to the minus 5, or 4, or 3, but it is 4 to 1. But even if it is one, my CDF is too low. It is less than 10 to the minus 2, and that gives me --

MR. SAMCALTAR: The only way to do that is --

CHAIRMAN APOSTOLAKIS: It is not about hitting one, and you see that is what -- I mean, even people who are dead set against putting probabilities of software reliability in performance, I think that would be crazy to say that a probability failure is one, which automatically of course makes them put a probability number and so then they are crazy. But that is okay.

And I think that was the argument in AP-600. Now I remember that meeting. It was late in the day.

MR. SAMCALTAR: Yes, it was a long day.

CHAIRMAN APOSTOLAKIS: So why are you sitting down? Are you tired?

MR. SAMCALTAR: No. No, I'm not.

CHAIRMAN APOSTOLAKIS: Are you planning to finish before lunch?

MR. SAMCALTAR: I am at your service.

MEMBER ROSEN: What was lunch time?

CHAIRMAN APOSTOLAKIS: What was the plan? But the question is if we let you go to 12:20, you will be done with the whole PRA presentation?

MR. SAMCALTAR: I can go through them very fast, very slowly, according to what you want to see.

CHAIRMAN APOSTOLAKIS: Yes, because after that we start with the seismic criteria, right?

MR. SAMCALTAR: I can go very fast.

MEMBER ROSEN: Let him go.

CHAIRMAN APOSTOLAKIS: Okay.

MR. SAMCALTAR: Okay. I have this slide for uncertainly analysis. We did uncertainty analysis and it is a numerical exercise, and I don't have a lot of -- well, I don't get it at least, but we do it to make sure that it has been performed.

To me it is more meaningful to look at sensitivity analyses, and the importances, and so on, rather than a numerical uncertainty analysis.

CHAIRMAN APOSTOLAKIS: But this uncertainty analysis though, we just said that the software reliability is highly uncertain. So how can you come up with another factor of six for core damage frequency? Shouldn't it be higher?

MR. SAMCALTAR: I will tell you what. Our basic assumption is that every data point in our database has a mean value, and that is very important. And whether you agree with it or not is a different story.

We use mean values, and that is the next simplest assumption we have is it is not normal. Now, we don't have to make that. Now we have very powerful software that you can do anything that you want.

And when you say I have a mean value, whenever a high error factor you have assigned, it came out normal. The mean is either 70 percent, or 75 percent, 80, 90, but the mean is never at 5 percent or 10 percent. With this normal distribution, it is not that flexible.

CHAIRMAN APOSTOLAKIS: So your assumption for their mean value is more to the left.

MR. SAMCALTAR: Right. So even if my range is 10,000, only a factor of 10 is here and the thousand is actually --

CHAIRMAN APOSTOLAKIS: But how an you say that about the highly uncertain common cause failure probability of software? Do you even assume the mean value there?

MR. SAMCALTAR: Right. I always do the mean value.

CHAIRMAN APOSTOLAKIS: Well, it is medium, and what do you mean what else can you do?

MR. SAMCALTAR: 1 times 10 to the minus 5 is the mean, and that is my assumption, and I am telling you what it is.

CHAIRMAN APOSTOLAKIS: Okay. So the uncertainly is in that assumption then.

MR. SAMCALTAR: Yes. And it would certainly make a big difference if you said I have 1 times 10 to the minus 5, and I have an error factor of a hundred, and it is a big difference.

CHAIRMAN APOSTOLAKIS: Because it is a skewed distribution.

MR. SAMCALTAR: Right. Exactly.

CHAIRMAN APOSTOLAKIS: Well, that is pretty serious.

MR. SAMCALTAR: But you normally have that information from the previous sensitivity analyses and component importances. You already know what is important. So to me this is an exercise in calculation.

CHAIRMAN APOSTOLAKIS: Well, especially after what you just said.

MR. SAMCALTAR: With what I just said, yes. These are little details of it for individual sequences, and so they will just follow naturally. The crux of the matter, you got it. I told you the crux of the matter.

Shutdown. We did a quantitative shutdown risk evaluation, and notice we are saying evaluation. We did not go back and exercise the model to the nth degree. We just used the results on the AP-600, and looked for differences, real differences that were implemented.

And basically the bottom line of this is that we have an increase of 18 percent in the shutdown core damage frequency, and it is now standing at 1.2 times 10 to the minus 7, which is about half the value for power.

And the 18 percent increase is basically due to the fact that we went from 24 months refueling to 18 months refueling, and the AP-600 had 24 months refueling and this plant has 8 months refueling.

So the initiating event frequencies went up because we exercised shutdown events moreover, and that is why it increased. I mean, it is not a worst plant or --

MEMBER ROSEN: Let me focus on another piece of this, and that is 1.2 compared to 2.4. These are additive. If you want to take the total risk for operations cycled risk, operation and shutdown, 1.2 and 2.4, 3.6.

So then it says that shutdown risk is one-third of the total.

MR. SAMCALTAR: Yes, so far. Yes.

MEMBER ROSEN: Yes, so far. Now, let me tell you that my rule of thumb for plants that do mid-loop evolutions in shutdowns, is half the total. So why does this out come so low compared to my rule of thumb?

MR. SAMCALTAR: Okay. First of all, I will try to answer the question, but it is not that low, and do you have an answer for that?

MR. CORLETTI: I can't address it from a system point of view. The passive safety systems are actually designed to mitigate events that can occur during shutdown, and in fact our tech specs require them to be available during shutdown modes.

So we have taken shutdown in the design process, and we have tried to address as Terry pointed out the loss of RNS, and loss of normal residual heat removal at shutdown can be mitigated by the passive safety system. So they do or have contributed to we think a higher level of safety in shutdown.

MEMBER ROSEN: Okay. Go on. Let's hear some more of the story.

MR. SAMCALTAR: One thing that he said that I thought was very important is before going to plant shutdown that could lead to a mid-loop and so on, we require support systems to be available, and that nothing is out of service on purpose.

MR. CORLETTI: Yes.

MR. SAMCALTAR: Is that what you said?

MR. CORLETTI: Well, I was saying that we actually require passive safety systems.

MR. SAMCALTAR: But what about the others?

MR. CORLETTI: Yes, they are also, yes.

MR. SAMCALTAR: Now, we don't go into a

plant shutdown with one diesel generator output, and I don't want to say anything wrong, okay? Is that correct?

MR. CORLETTI: Yes.

MR. SAMCALTAR: And one component cooling drain out, or one surface water drain out. There are precautions taken to address the mid-loop issue.

MEMBER ROSEN: But this does not explain it to me, because you are comparing two things, and the thing that you are comparing it to also takes those precautions.

MR. SAMCALTAR: Fair enough. Then his other point might be, a very important point, that mainly passive systems that are left operational on purpose to address this, because everybody knows it is important now, and so the design tries to address it as much as possible.

The three events dominating the CDF are loss of component cooling or service water during drain conditions. Loss of offsite power during drain conditions, and then loss of normal RHR during drain conditions. It is a comparison of CDF with AP-600 shows that these two designs are not very different.

And 18 percent is basically due to what we call the frequency change. The 12 dominant accident sequences basically make up 77 percent of the level 1 shutdown CDF.

And they contain the same culprits as I just mentioned namely sequence associated with loss of component cooling or surface water, and then much less is normal RHR and loss of off-site power, and all draining events, whatever that is.

Okay. That is all that I have for shutdown really, unless you have questions. Okay. Internal flooding, never mind. I mean, this plant is designed to predate and is not susceptible to internal flooding.

However, to me, the true internal flooding can only be done at a walkdown and so on when the plant is built. So this is a design exercise showing that it is not a big --

CHAIRMAN APOSTOLAKIS: And fire, too.

MR. SAMCALTAR: However this shows us that there is nothing that is obvious somewhere and that water won't accumulate there and go from room to room or something like that.

However, again, the bottom line is plant specific walkdown and so on. Otherwise, this is, no, never mind. Flooding, the same stuff. Now, fire and the PRA. Usually when we submitted the PRA the first time, the AP-1000, we didn't really have a fire PRA. We just had a discussion.

And the NRC said no, and so we actually went through the full exercise from scratch, and not really taking the AP-600 and looking at things, but truly looking at what is happening here.

Basically, my general impression is this. If you have a newer plant with Appendix R conditions already met, it is very, very difficult to really find things for fire PRA.

And it is true with this plant, and the most interesting thing here was this spurious hot-shorts that was called spurious ADS. That was the only thing that was really worth discussion.

Now, the design people did everything I think that can be done to minimize that, and the question is how do you quantify it. The problem has been defined from a long time ago, and we understand it, and we don't disagree with it.

The design people did something and how do you assign numbers to it, and that is always a controversy. We assigned what we thought was reasonable numbers, and they are still giving us -- the bulk of this comes from LOCAs, spurious ADS openings or something that are induced by fire.

Otherwise, there is nothing.

MEMBER SIEBER: Well, let me ask a question. It says that design features were incorporated to address hot-shorts. What were they? What did they do?

MR. SAMCALTAR: Well, let me see.

MR. CUMMINS: This is Ed Cummings. I think Terry got the essence of it with that arm and fire sequence. If you have an arm and fire sequence that are separate cables, then anyone -- fire can actuate one of the other of them, but not both of them.

So that helped us very much with the PRA part of it.

MR. CORLETTI: This is Mike Corletti. In the fire PRA that we submitted, in the back is Attachment 57D, where we go through about 10 pages of discussion of the design features in the plant that were aimed at addressing the issue of hot shorts.

I think you have the fire PRA and I am not sure whether you have seen -- if you made your way to this Attachment 57D.

MEMBER SIEBER: That is pretty far back.

MR. CORLETTI: Yes, it is pretty far back. But I have a copy of it here, and I would be glad to make copies for you all.

MR. SAMCALTAR: So we really tried to look into all the interesting scenarios that can come up, including scenarios in the containment, which normally people will say, oh, inside containment and ignore it. That is less probable. So we looked at them in detail.

That brought us incredible difficulties, because by definition they are large fire zones, but not areas. If it was a fire area, then it was 3 hour or 5 hour boundary; and if it is a zone, it doesn't.

And we were arguing with the NRC that if you have a cable right here, and another cable, say, a hundred feet away, but they are in the same zone. They don't have a 3 hour barrier, and can you have a fire there, and somehow this will affect this.

And from a pure common sense or engineering or whatever you want to call it, you said come on, where is your limits. Where do you draw the line.

And yet unless you officially have a 3 hour barrier, somehow --

MEMBER ROSEN: There is another option now with NFDA05, and that is to do fire modeling.

MR. SAMCALTAR: Right. You have to go to

the next step, yes.

MEMBER ROSEN: And you can prove, and if your engineering intuition is correct, you can prove it with a fire model.

MR. SAMCALTAR: Yes.

CHAIRMAN APOSTOLAKIS: What does it mean, the last line, for internal events? You mean for power?

MEMBER ROSEN: No, fire that is induced by earthquakes.

MR. SAMCALTAR: Right.

CHAIRMAN APOSTOLAKIS: Or earthquakes induced by fires?

MEMBER ROSEN: No, no, no.

MR. SAMCALTAR: That's possible, too, I guess in some scenarios. I don't know.

MEMBER ROSEN: Well, I think this is important before you get to seismic. What this says is that you went back and looked at fire, and you did a fire PRA, and you improved the fire protection of the plant.

MR. SAMCALTAR: Yes, and we have tried to show it also by looking very carefully into different scenarios, and another interesting thing is there are almost no operator actions here that we had to take credit for. There were only two that we credited.

We didn't have to rely on operators to go and close doors, or do things, and press things, and so on, other than what they would normally do. There were no special things, except two.

CHAIRMAN APOSTOLAKIS: Does this plant have --

MR. SAMCALTAR: No.

MEMBER ROSEN: I didn't get to my bottom line yet. If you go back to this Slide 63. Now, you have done these things to improve, which is commendable, and where you end up is .5 E to the minus 7, right?

MR. SAMCALTAR: Eight.

MEMBER ROSEN: .5.

MR. SAMCALTAR: Oh, I'm sorry, .5.

MEMBER ROSEN: I am doing something. .5 E to the minus 7, which is included in the 2.4 or not?

MR. SAMCALTAR: No. It is additional, right.

MEMBER ROSEN: Okay. So now we are getting a picture here. We have got 2.4 for internal events at power, and we have got 1.2 for shutdown, and we have .5 for fire. Fire is 10, 12, 15, or 20 percent, something in that range of the total?

MR. SAMCALTAR: Yes. And it is driven by the assumptions in hot shorts. That's it.

MR. BURKHARDT: This is Larry Burkhardt, and I am sure that you will hear more about this later, but I think what we are trying to do now is looking at the RAI responses and some of the numbers you may not agree with, am I safe to say, and the issue that you brought up, Dr. Rosen, about the modeling, the fire modeling.

That you have not done, and that is one of the issues that we are talking about, too. The zone issue, the combustible material, et cetera and so those are some of the subjects of the RAIs. I don't know if you have had a chance to look at it.

At least right now we are in discussion with Westinghouse on trying to expand the RAI responses and completely resolve it. But there are some areas where we are not on exact agreement, and I am sure that you will hear about that this afternoon.

MEMBER ROSEN: But I am just getting the sense that -- I am just thinking in terms of is it reasonable. This is why our PRAs are disciplined, and so usually we get numbers, but then you sit back and use your intuition, and say is this reasonable, does it make sense, that fire should be 20 percent maybe of the total risk in a plant.

And it sounds to me like it ought to be higher, or I mean lower, but then I realize that the overall total is very low. So this piece, which tends to be resistant to being lower than even more, tends to stick up more and more, because you have lowered the internal events so low that this piece, in a modern PWR, you would expect it to be quite a bit lower.

But not in a PWR, and not in any future PWR, like AP-1000, if you have substantial internal events CDF. Whereas, here you have lowered the internal events CDF so much that this tends to stick out a little bit. Also, it is reasonable, and when you get down with all that rationale, it seems reasonable.

MR. SAMCALTAR: Well I can say this. It is not unreasonable. Moreover, it is driven by a single issue. What is really the probability of hot shorts, you know. A single hot short cannot do anything to this plant, and even probably multiples will happen before it can actuate anything.

So the whole question is what are the assumptions, modeling assumptions and probabilities assigned to this issue about hot shorts. And I believe that what we did is reasonable under the conservative side. I would think that if we were a little bit more pushy that we would have probably used more realistic values, but it would make us further apart, and it would only make things even last longer, you know, the discussions.

So I would say in reality that it is probably a little bit less percentage wise, but we weren't uncomfortable with settling at this number, because it is one of those things that is expert opinion driven on what you should do.

But engineering wise, we recognize it. I mean, it is recognized, and it has been addressed engineering wise. We are comfortable with that.

Seismic margins. Previously, we did seismic margins on this plant, and we just evaluated it and we looked at it, and we were looking for our magic number, which is .5 g HCLPF.

CHAIRMAN APOSTOLAKIS: Even with the tank on top of the container?

MR. SAMCALTAR: Excuse me?

CHAIRMAN APOSTOLAKIS: Even with the tank?

MR. SAMCALTAR: Oh, with that tank, there has been a lot of fun. Yes, the tank is always there. It should be somewhere in here. This is tank failure.

It used to be .58 g, and we made it larger, and it slipped down to .51.

And so it is at the border. So these are the guys who were the major culprits, you know, and it is there. Whether it is down here or up there, there isn't a big difference. But these are the major contributors.

Not the first one. The first one is there for completeness sake. It doesn't really do any harm. But the new few are at the border and I put this as a comparison to see if there is a new actor coming in.

Steam generators are larger and so I guess that is why it went down a little bit here. There is not really anything new here. We had previously a set of actors, and they didn't really change, and this kind of summarizes this story.

There were no frequencies calculated or anything. We are good for .50 and that is the bottom line. The rest is the normal stuff; no credit for operator actions, and assumes a loss of offsite power for all sequences, and there is nothing new there.

MEMBER ROSEN: But you make a good point that at a future meeting that we get into some detail about the structural side and analysis of the seismic response of that structure.

MR. SAMCALTAR: Yes, absolutely.

MEMBER ROSEN: But not on the PRA conduct.

MR. SAMCALTAR: Not on the PRA side. Comparison of AP-600 and AP-1000 PRA results. We quantified the PDF at 1.7; and quantified yes at 2.4; LERF, 1.8; and here it is also quantified.

CHAIRMAN APOSTOLAKIS: Why did you use that E? You said LERF. Why? What are you proving here that the --

MR. SAMCALTAR: Why was it LERF?

CHAIRMAN APOSTOLAKIS: To make it pronounceable. Please identify yourself and speak with sufficient clarify and volume.

MR. SCOBEL: Yes, sir, this is Jim Scobel from Westinghouse. Because actually we just lump all the large release into one number. There isn't a whole lot of late release. Everything is early. So we just kind of call it LRF, large relief frequency, and it includes everything.

CHAIRMAN APOSTOLAKIS: Late release, can you tell us why?

MR. SCOBEL: Well, the containment, long term is so good with containment cooling and all the real severe challenges to the containment are early during the core melt process.

So your challenges from high energy events are really the contributors to large release. Otherwise, the containment stays intact, or else you have a containment bypass.

CHAIRMAN APOSTOLAKIS: Okay.

MR. SAMCALTAR: And forgive me if I say LERF, you know, and I might say LERF out of habit. We are talking about any large release. So it is a quantified yes.

CHAIRMAN APOSTOLAKIS: Is there any particular interest on the part of the committee on this comparison?

CHAIRMAN APOSTOLAKIS: The first part was interesting, but let's move on.

MEMBER SHACK: Well, the fire, is that because you don't have the two-stage ADS squib valve in the AP-600?

MR. SAMCALTAR: For fire?

MEMBER SHACK: Yes.

MR. SAMCALTAR: That is a totally different thing. For AP-600, we really didn't do a fire analysis for best estimates PRA model. We did it with a focus PRA, where all of the non-safety systems were already taken out.

So these two numbers are not comparable

really.

MEMBER SHACK: Okay.

MR. SAMCALTAR: And that's it.

CHAIRMAN APOSTOLAKIS: Any questions from the members? Okay. Thank you very much, Selim.

MR. SAMCALTAR: Thank you.

CHAIRMAN APOSTOLAKIS: We are recessing until 1:35.

(Whereupon, at 12:27 p.m., a luncheon recess was taken.)

A-F-T-E-R-N-O-O-N S-E-S-S-I-O-N

(1:37 p.m.)

CHAIRMAN APOSTOLAKIS: We are back in session. The next title is the PRA Level 1 Success Criteria, and Mr. Schulz will have the floor once again.

MR. SCHULZ: Thank you. What I am going to try to cover is talk a little bit about what the success criteria is, in terms of the number of components and I think I am going to use ADS as the talking point, and some changes versus AP-600.

And then the bulk of the time for my talk, we will talk about the justification of that success criteria, in terms of the T&H analysis done, including some T&H uncertainty evaluations, which are part probability and part T&H.

So the success criteria ends up being very similar to AP-600, and the reasons of course are that the designs, the configuration, in terms of the number of valves, components, is the same. The capabilities are very similar. Not exactly in all cases.

We talked about the large LOCA and accumulator, and that is kind of an exception in most other cases. The capacities are equivalent so that we need the same number of components. The verification approach is the same as AP-600, where we have conservative DCD analysis that applies to the accident, and the components that we are using. We of course use that, because that is a very detailed analysis, and conservative analysis. For example, passive RHR being successful in the case of loss of power, and loss of feedwater, and steam generator tube ruptures.

Those accidents are all analyzed in the DCD and so we don't reanalyze them for the PRA.

MEMBER ROSEN: Remind me if you will what the DCD acronym is?

CHAIRMAN APOSTOLAKIS: Design control document. I have learned my acronyms.

MR. SCHULZ: It is equivalent to the SSAR, in this context anyways.

CHAIRMAN APOSTOLAKIS: I just looked it up. That's why.

MR. SCHULZ: Where we performed special analysis is typically where we are taking more than a single failure, which of course we do consider in the PRA, but what we don't consider in the design basis or DCD type analysis.

So when we start talking about failing both core makeup tanks, and one accumulator in a small

LOCA, that is well beyond the single failure, and something that we don't analyze in the DCD.

So we in that case perform special analysis for the PRA. In some cases the AP-1000 success rate criteria is in fact more conservative or robust than AP-600.

I mentioned the ASD Stage 4, and in AP-600, it was 2 out of 4; and for AP-1000, it is 3 out of 4 valves have to work. And the reason for that is not due to the fact that there is less margin in Stage 4. It is just that we are being more conservative.

And that reduces the T&H uncertainty that we have to deal with ultimately. When we look at success criteria, we consider the key safety functions that typically we consider. It is not that we don't know that, and I didn't remember to write it down when I was making the slide.

The containment service level C pressure, the design pressure is 59 psi, and the service level C pressure is I think 91 psi; and that gives you a very low probability of failure, maybe one percent or something.

A 50-50 percent chance of failure pressure is more like 150 psi. So that gives you a feeling for what kind of containment pressures that we looked at.

CHAIRMAN APOSTOLAKIS: What do you mean by less than emergency stress limits?

MR. SCHULZ: Well, the service level C deals with stress levels, and in that case this would be 91 psi. We do consider in some cases going above emergency stress limits up to rupture points, and then you will start talking about probabilities of failure that are significant.

This is the full -- we call it full ADS. This is sufficient ADS to get you down to gravity injection. You need a lot less ADS valves to get you to RCS pump injection, and there is a matrix here based on what equipment is available, versus the accidents.

We do require ADS for large LOCAs. This was not required in AP-600, and so this is again where we are being more conservative. This relates to long term cooling needs. So in long term recirculation, and you really don't need it in the short term because the break is big enough to get your IRWST injection.

But as the containment floods up, in the long term your pressures go down, and we still need ADS.

You see that when the core makeup tank is on or available, then ADS tends to be automatic.

When the core makeup tank is assumed not available and an accumulator is available, then ADS of course has to be manual, and that is again because of automatic signals come from the CMT level.

But basically we need 3 out of 4 ADS stage 4s throughout this. Now, this details some of the changes that we actually made in that success criteria, and I think I talked about 3 out of 4. Partial ADS, we went up from one stage, 2 or 3, on top of the pressurizers, to two, and that strictly had to do with that we did not increase the size of those valves, but we did increase the pressure power of the reactor, and so this is a power related thing.

The difference in reliability is not very much between 1 out of 4 and 2 out of 4, and so we just used the 2 out of 4 in the probability calculations. This was an interesting thing. For medium LOCAs, when we first started analyzing AP-1000, we did it just like AP-600, which means that we did not require passive RHR to be available.

AP-600 did not require it to be available. However, we had difficulty allowing or providing 20 minutes for the operator to take action, which is what we did end up justifying in AP-600.

And the issue has to do with the higher

power level versus the volume of the reactor coolant system being similar to AP-600, but the power being higher.

CHAIRMAN APOSTOLAKIS: Speaking of the 20 minutes, and since we made such a big deal on the utility requirements, I remember vaguely that one of the requirements or goals was that in the new plants that the operators wouldn't have to do anything for what, 24 hours?

MR. SCHULZ: Ye.

CHAIRMAN APOSTOLAKIS: So here we have 20 minutes?

MR. SCHULZ: That statement applies to design basis accidents.

CHAIRMAN APOSTOLAKIS: Only?

MR. SCHULZ: Only, yes. And here we can meet that, okay?

CHAIRMAN APOSTOLAKIS: Okay.

MR. SCHULZ: We only get into trouble when you start having multiple failures. And in this case, this is a medium LOCA with no core makeup tanks, which if it is a hot leg/cold leg break, that is four failures, because each core makeup tank has two valves.

If it is a DVI line break, then it is two failures. So it is still beyond design basis to get into this situation.

CHAIRMAN APOSTOLAKIS: Well, for the current fleet, if I look at the LOCA as a design basis accident, I require action within 30 minutes? I thought it was only in severe accident --

MEMBER ROSEN: No, for the current fleet, 10 minutes.

CHAIRMAN APOSTOLAKIS: For design basis?

MEMBER SIEBER: Right.

MEMBER ROSEN: You have to be able to not do anything for 10 minutes.

MR. SCHULZ: And typically in our current plan, if you start talking about two or more failures, with some accidents, you are out of luck.

MEMBER ROSEN: And real accidents, as one of our consultants has said, have little respect for the single failure criteria.

MR. SCHULZ: That is one of the reasons why you look at PRAs, right?

MEMBER ROSEN: Right.

MR. SCHULZ: Another thing that we did is as Selim showed you in the large break LOCA event tree, we have put in containment isolation and passive containment cooling, into the level one entries. The

AP-600 did not have either of those in level one. They were in level two only.

And one of the things that we did is that required more containment recirculation flow paths to be available if containment isolation fails, and that is a recognition that containment isolation fails, and the containment pressure is going to be lower, which is making the LOCA performance more difficult from a T&H point of view.

And you also lose some inventory from the leak before you stop the leak with the passive containment coolant system. So the water level will be a little bit lower, and I will show you some analysis of that.

So in order to provide some more margin in the design, we are requiring more flow paths to be available to get water back from the containment back into the reactor in the case where containment isolation fails. I talked about the last point in the previous slide.

This is just over the different size LOCAs and how we divided up the LOCA spectrum I should say in the PRA. And there is nothing magic about it. It really -- we did it to relate to the success criteria, and when we needed more or less equipment.

So we have found through our analysis that up through about 9 inches, we don't need two accumulators, cold leg breaks. Above 9 inches, we start to need accumulators for cold leg breaks.

For spurious ADS and all the way up through 4 ADS valves opening simultaneously, which is almost incredible, but we analyzed that as a limiting spurious stage four, one accumulator is sufficient for that. And one CMT together.

And when you get down to medium LOCAs and smaller, then we only need one accumulator, or one CMT. And that helps us with redundancy and diversity in these systems.

When you get RCS leaks, the pump CDS make up the deficient. Obviously passive systems also work down there. And the difference between small and medium, a medium LOCA is big enough to get you below the stage 4 pressure interlock, and a small LOCA is not big enough to get you below 1300 psi, and you need something else, like passive RHR, will drag you down below that, or a stage 1, 2, or 3. Any one of those.

CHAIRMAN APOSTOLAKIS: What is the diameter of the largest spike?

MR. SCHULZ: In the RCS?

CHAIRMAN APOSTOLAKIS: Yes.

MR. SCHULZ: The hot leg is 32 inches, or 31 inches. That is a hot leg break, and the cold legs are 22. There is obviously two cold and one hot. This is a summary of the different classes of accidents.

CHAIRMAN APOSTOLAKIS: I was wondering, you know, and I don't know if you follow the developments here about risk informing 5046 (inaudible). Would your numbers justify in removing the large LOCA from the design basis accident? Have you thought about it? If you haven't that's fine.

MR. SCHULZ: I haven't. We have in AP-1000 generally not wanted to take on challenging licensing.

CHAIRMAN APOSTOLAKIS: Yes, I understand. I am not saying that you should do it, but I am wondering whether the numbers justify it.

MR. SCHULZ: I don't know.

CHAIRMAN APOSTOLAKIS: Okay.

MR. SCHULZ: You see here a list of different accidents, and the primary protection. So transients are being protected by passive RHR, and DCD analysis, with lock train analysis. So this analysis is -- we didn't do anything for the PRA.

The same thing for the tube rupture. For the rest of them, we did special PRA analysis, T&H analysis. The success criteria for the small breaks, up through medium LOCAs, was based on MAAP, many, many, many MAAP runs.

And for the large break, MAAP is not adequate for that, and so we used WCOBRA-TRAC, and for -- well, for both of these, and then for ATWS, we also did some specific PRA analysis, using LOFTRAN.

I will also talk about T&H uncertainty, where we bounded like 98 percent or so of the success -- of the risk, using conservative T&H analysis, with using design basis codes.

There has been a lot of discussion about the use of MAAP and the adequacy of MAAP. Our approach in AP-600 is --- on AP-1000, is the same as AP-600. We use it for defining success criteria where we have multiple failures in LOCAs, and feed and bleed cooling sequences starting from transients and failures of passive RHR, and start up feed water.

And it provides us an integrated reactor coolant system containment response. It runs very fast and very reliably, which is important when you are making hundreds of runs, as opposed to 10 runs like you make for maybe the DCD.

We have to make so many runs because we

are looking at a spectrum of break sizes, and locations, and compounding that many different kinds of failures that we don't have to look at in design basis analysis.

MAAP 4 was benchmarked against NOTRUMP for AP-600, and NOTRUMP has been shown to be application to AP-1000. I know that there is some issue on entrainment that is still being discussed, and if something happens there that throws or requires a modification to NOTRUMP, then that may upset this logic.

But right now we are assuming that they end up being successful. So NOTRUMP being applicable to AP-1000, and MAAP being benchmarked against that, we think that provides a reasonable assurance that MAAP 4 can do the success criteria.

In addition, as I mentioned just previously, we have this separate T&H analysis, where we take the low margin risk importance sequences, and then analyze them with the DCD codes.

CHAIRMAN APOSTOLAKIS: What do you mean by low margin?

MR. SCHULZ: Low margins are basically sequence where we get core uncovery.

CHAIRMAN APOSTOLAKIS: So there are risk

importance sequences?

MR. SCHULZ: Well, that doesn't make them risk important by themselves. Risk important is where it is an important fraction of the total core melt frequency.

CHAIRMAN APOSTOLAKIS: Okay. So they can be below margin, but extremely unlikely?

MR. SCHULZ: Yes. Yes. And we do both the probability and the margin part to try to pick a case as we eventually analyze this way. We have gained something in this whole process by making the success criteria at least in some cases a little more conservative.

Okay. I am headed toward showing you some of the success criteria results now, and I am going to concentrate on the LOCA feed and bleed type cooling analysis, which ADS and the injection systems are key factors in that.

We had a large number of different initiating events and timings to look at between LOCAs and the different sized LOCAs, and the feed and bleed cooling sequences, and the available equipment.

Because AP-600 and AP-1000 are still very similar plants, we used our experience with AP-600 in this area to reduce the large number of cases that we had to look at.

CHAIRMAN APOSTOLAKIS: So this is not a small LOCA?

MR. SCHULZ: What I am going to show you is a spectrum from zero up to about 9 inches, and is the different sized LOCAs.

CHAIRMAN APOSTOLAKIS: And for that size you can bleed and feed?

MR. SCHULZ: Oh, bleed and feed starts from a transient with no LOCA, and the feed and bleed type cooling is where you use start up feed water and main feed water, and in our case, passive RHR.

CHAIRMAN APOSTOLAKIS: You're right. You're right.

MR. SCHULZ: And you have a steam generator inventory, and you eventually -- and then we go to ADS and some kind of makeup; accumulators, C&Ps, and that kind thing. So that is what I am talking about here. So for feed and bleed there is no LOCA starting.

And there is four kind of groups of analysis that we look at. The first two are automatic ADS, and one with gravity injection, and both with core makeup tanks that provide you the automatic ADS.

The first one is with a full ADS and IRWST gravity injection, and the second one is what we call partial ADS, and pumped injection. So we look at both of those.

And then separately we look at the manual ADS, with just an accumulator, just one accumulator in this case, and either IRWST gravity injection, or RNS pump injection.

Now, I am going to touch upon those four groups of analysis. So the first one is automatic ADS with IRWST injection. We looked at the limiting success criteria. So it is the worst combination, and it is no ADS Stage 1, 2, or 3; and three stage 4s, and that is pretty well outlined here.

And one core makeup tank, and no accumulators, and one valve and one path from the IWRST injection line. Now, for the very small breaks, we do need something else to get us down to the 1300 psi. So that is included.

And in addition containment isolation fails, and so the containment back pressure is always atmospheric pressure in these analyses. So we looked at with those conditions a spectrum of half-inch breaks up to almost nine inch.

We looked at what the core uncovery, depth, and duration was sequence by sequence, and generally what we see is that the performance is better in AP-600.

And this is related to especially ADS 4 capacity, and IRWST injection capacity helps us here. So our conclusion is that that success criteria was verified. Now, I am going to show you a little bit more about why we think that.

This is sort of a summary chart which looks at depth of core uncovery, and this above here is no core uncovery, is a function of break size. And the solid line is the minimum level before ADS goes off, and the dotted line is the minimum level that occurs after ADS.

So what you see here is that before ADS goes off, you get no core uncovery in these sequences, with one core makeup tank and no accumulator. You do see some core uncovery, not very deep, in the smaller break sizes after ADS goes off.

And what is happening here is that normally in a design basis accident the accumulator will help going to ADS blow down to keep the reactor full of water.

But here you don't have an accumulator. You only have one core makeup tank. So sometimes you will run a little shy in terms of injection during the

ADS blow down. Now, what I would also like to show you is one particular case, and which is a two inch --

MEMBER ROSEN: If you could just go back to that prior one for just a second. Give me a feel for how long your core is uncovered for 4 feet? Well, 4 feet is kind of little.

MR. SCHULZ: I was going to show you this 2 inch break case in the next slide.

MEMBER ROSEN: Okay.

MR. SCHULZ: So see if it answers your question. So here you see several of the interesting plots for a 2 inch break case, which from the previous slide is like one of the worst ones.

And you see compared here AP-600 in the solid line against AP-1000 in the dotted line. And the key is the core uncovery, and the core uncovery depth is a little bit less for AP-1000, and considerably shorter.

So in this case, it is 300 seconds or something like that for duration of uncovery.

MEMBER SIEBER: Yes.

MR. SCHULZ: And you can see the core makeup tank injection behavior, and ultimately the IRWST injection. The IRWST injection is what provides the recovery.

MEMBER ROSEN: And during that 300 seconds what sort of fuel events do you get?

MR. SCHULZ: I don't -- you get some heat up in this case, but not very much. We don't typically calculate peak clad temperatures for MAAP. Well, it outputs some temperatures, but for this kind of a thing, it is going to be -- there is a T&H uncertainty case, which is one of the last ones that I show, which has a longer and deeper uncovery, and you get to maybe 1500 degrees. So I think that this would be less than that.

MEMBER ROSEN: So how much core damage do you get?

MR. SCHULZ: None.

MEMBER RANSOM: One thing. You mentioned uncertainty associated with the use of these codes on the thermal hydraulic analysis. Does that include like the epistemic uncertainty inherent in the codes themselves, and did you evaluate that in some way?

MR. SCHULZ: The MAAP analysis is done on a pretty much best estimate basis. Decayed heat is ANS-79, plus no SIGMA. We do typically use conservative line resistances, and normal plant parameters. So that is what this is based on.

MEMBER RANSOM: So when you determine uncertainty, you mean in terms of the inputs?

MR. SCHULZ: Well, no. Let me finish, okay? When we look at the T&H uncertainty analysis, we take the design basis codes that we use in the DCD, and so for a small break LOCA, that would be NOTRUMP, one in an Appendix K fashion.

So it is extremely conservative decayed heat, and every plant input parameter is conservative, and the code models are conservative.

CHAIRMAN APOSTOLAKIS: Is it a correct understanding that the way that you handle at some kind of level the thermal hydraulic uncertainties is by going to more conservative success criteria, and see if you are still successful?

MR. SCHULZ: No. But what we look at in qualitative words, we try to take -- if you look at the success criteria, and in all the failures that we can tolerate, if you calculate and use all of those worst, worst, worst failures, the probability of that sequence is incredibly small.

CHAIRMAN APOSTOLAKIS: Right.

MR. SCHULZ: It is meaningless in terms of our core melt frequency, okay? So what we did is -- and I will show you, is that we expanded the event trees, and instead of just looking at zero core makeup tanks, or one core makeup tank, we also looked at two, in culmination with zero to two accumulators, and calculated all the intermediate probabilities, and then put the results into low margin-high margin success paths.

And low margin being core uncoveries. And we looked at those low margin success paths and figured out what is the most probable of those.

CHAIRMAN APOSTOLAKIS: So you have to do core makeup times, right, in the plant?

MR. SCHULZ: Yes, we do.

MR. CUMMINS: If I could say something here. This is Ed Cummins. I think there is a little bit of a definition confusion on what we mean by thermal hydraulic uncertainty, and if I could try to help that.

What happened in the AP-600 was there was considerably consternation from the NRC staff regarding the reliability of MAAP to predict passive plants, and so they were saying that we would like you to verify that the MAAP results are the same as your DCD analysis results with NOTRUMP, and with COBRA-TRAC, and we titled this whole issue thermal hydraulic uncertainty.

The issue was really that we are not really certain -- and I don't know who we is, but someone is not really certain that the MAAP results are valid for these analysis.

And we want you to confirm the validity by some checks with your design basis codes, and that is really the story that we are trying to pursue here.

CHAIRMAN APOSTOLAKIS: The core makeup times, and I am sure that I don't understand you. You can have zero, or one, or two?

MR. SCHULZ: Yes.

CHAIRMAN APOSTOLAKIS: Okay. So in some cases, and let's say you need -- you decide that your best case is that you need one of the two. Now, you are using a code to do the calculations and so on, and you say, gee, I have uncertainty here.

MR. SCHULZ: Uncertainty?

CHAIRMAN APOSTOLAKIS: Uncertainty in the result, and that in fact it is one that you need.

MR. SCHULZ: Okay. In terms of the core cooling?

CHAIRMAN APOSTOLAKIS: Yes, the core cooling capability. So I don't think that you went back and did what Dr. Ransom suggested, to look at perhaps the correlations that you have used for other models in the code and assign uncertainties, and you didn't do that?

MR. SCHULZ: No.

CHAIRMAN APOSTOLAKIS: But what is not clear to me is why did you do? I thought -- is it that you are saying that instead of assuming one core makeup time at a certain flow rate, I will have something less than that, and prove that it is still adequate, or do you do something else?

MR. SCHULZ: I did something else, and I think it would be better to in the last half of this presentation --

CHAIRMAN APOSTOLAKIS: If you are going to address it later, that's fine, but this question is unclear to me, and it is not clear to me how it was handled. But I know that it was not handled the way that some academic in the clouds would do it.

MR. SCHULZ: Yes, I agree with you. Hopefully the last part of my discussion will clarify that, and if it doesn't -- but right now what I was trying to talk about here is the success rate criteria analysis done with MAAP.

And we had considered this to be a success rate for the AP-600 with this longer core uncovery for AP-1000.

CHAIRMAN APOSTOLAKIS: So it was considered a success, and I think that comes back to Mr. Rosen's question.

MR. SCHULZ: Yes.

CHAIRMAN APOSTOLAKIS: It was a success, even though you uncover, you know, 2 or 3 feet of the core, because the temperature never reached --

MR. SCHULZ: Yes.

MEMBER ROSEN: And there is no fuel damage?

CHAIRMAN APOSTOLAKIS: And there is no fuel damage?

MR. SCHULZ: Yes.

MEMBER SIEBER: But they didn't calculate the temperature, right?

CHAIRMAN APOSTOLAKIS: Well, they said they did.

MR. SCHULZ: We got temperatures out of MAAP. They are not as precisely calculated as we do for design basis analysis. But it gives you a good feeling for if you are going to have damage in the core, and core melting.

MEMBER SIEBER: But they had enough margin, right?

MR. SCHULZ: Yes.

CHAIRMAN APOSTOLAKIS: So the criterion then for core damage is not core uncovery?

MR. SCHULZ: That is correct.

MEMBER ROSEN: But there is still plant cooling going on, right?

MR. SCHULZ: Yes.

MEMBER ROSEN: And in that circumstance, when you have uncovered the top, there is steam cooling going on?

MR. SCHULZ: Yes.

CHAIRMAN APOSTOLAKIS: So what is the order of magnitude of the duration of the uncovery in order to see some problem? I mean, Terry mentioned that it is about 300 seconds in those other problems. If it was a thousand seconds, would that have a problem?

MR. SCHULZ: Three is two kinds of issues. One is that there are relationships between depth and timing. Obviously if you have a large LOCA and you completely uncover the core very early in the transient, things heat up rapidly.

If you only uncover a little bit of the core much later, things heat up very slowly. That is one issue. So you can calculate based on depth, timing, duration, what the peak clad temperatures are.

MEMBER RANSOM: But wouldn't it be a good idea to use COBRA-TRAC and see if it predicted any heat up?

MR. SCHULZ: Well, this is why we look at -- it is not a good idea to try to do that for 500 transients.

MEMBER RANSOM: Well, I know that, but --

MR. SCHULZ: And that is why we use MAAP for these hundreds of events, okay? We did do benchmarking against -- MAAP results against NOTRUMP, and using LOFTRAN to calculate peak clad temperatures for those same transients.

And to ensure that MAAP was reasonable/conservative relative to the design basis codes.

MEMBER SIEBER: You actually have to try out part of the core in order to get core damage, right, as long as you have vapors going through there?

MR. SCHULZ: I can't really answer that question. You may need more than just the vapor.

MEMBER SIEBER: Okay.

MR. SCHULZ: But again there is times and durations; timing after a shutdown, and depth and duration of uncovery, all relate to that.

MEMBER SIEBER: Okay.

MEMBER ROSEN: But then you said that you also went back with the low margin risk sequencing presumably with your better codes?

MR. SCHULZ: That's right, and I will be talking about that in the last part of my presentation.

CHAIRMAN APOSTOLAKIS: So which one is a better code?

MR. SCHULZ: For the small break LOCAS, we repeated the analysis with NOTRUMP, which is what we used in the design basis analysis for our justification, with then being successful.

This is the Category 2 o f these events, the se same as the previous one, except that instead of requiring ADS-4 and gravity injection, we are using a couple of twos and threes, and an RMS pump injection.

So this is a mixed slice of active system operation, and look at the same spectrum, depth duration, again is a little better than AP-600, and we think that this is successful. You see here that this is again a spectrum of breaks.

And for very little ones, we get a little bit of uncovery after ADS, and for the bigger breaks, the break plus this ADS, Stage 2 and 3 get the pressure down fast enough that RNS injection happens relatively quickly, and the core stays covered.

Now I would like to talk about the manual ADS cases. This is with one accumulator and no core makeup tanks. The previous cases were with the opposite.

We are requiring a passive RHR to be available to bide the operators time to 20 minutes at least to do the manual ADS. Again, we look at the same spectrum of break sizes, and we got as good or getter performance than AP-600.

MEMBER SHACK: Do you have some emergency operating procedure that tells --

MR. SCHULZ: Yes. To do what?

MEMBER SHACK: To manually blow the valve.

MR. SCHULZ: Yes. Yes, the way we end up evaluating operator actions is in accordance with our emergency procedures. The operators have to have procedures, and they have to have indications of instrumentation or whatever.

And then we use that to figure out how much time, and then based on that time, reliabilities and probabilities of the operators actually doing that in that time or calculating.

This is the spectrum of break analysis and what you tend to see here is that initially you get no uncovery, but afterwards, you tend to get some. And what happens in this case is the accumulators don't run very long because of their nature.

Core makeup tanks run like 20 minutes all the time, and accumulators, it is variable depending on how fast the pressure goes down. And so what you tend to see is gaps between the end of the accumulator injection and the beginning of IRWST injection, which results in some core uncovery.

The passive RHR operation is beneficial right in this area here. What is happening in these cases is the break big enough to start challenging core uncovery, but not big enough to get down to accumulator injection.

But with these bigger breaks the pressure comes down fairly rapidly just because of the break and accumulators start injecting. So you don't get an early core uncovery. You get more of a late core uncovery.

This is looking at the 3-1/2 inch break case, which is probably the most critical from a passive RHR operation and operator timing. And you can see that the AP-1000 with the passive RHR is considerably better than AP-600.

AP-600 we did not require the passive RHR to be available. So it was not in the success criteria, and so we didn't include int in this analysis.

If we had, it would have significantly improved this early, and this thing is due to the fact that you have no makeup from your core makeup tanks, and the break is not big enough to get you down to accumulator injection, and so you just sit there for 20 minutes or so with no injection.

Once ADS goes off here, then the accumulator injection -- this is an accumulator wire mass, and so the accumulator is not draining at all, and then once ADS goes off, it empties pretty quickly.

And then sometime a little later, the IRWST injections starts. So again the AP-1000 performance, we get no core uncovery early. We get a shorter core uncovery later.

MEMBER ROSEN: Now, this is an analysis artifact, this core uncovery early before 20 minutes, because in reality operators would have enough information would they not to manually initiate ADS?

MR. SCHULZ: They would. Okay.

MEMBER ROSEN: In other words, they would not let the core go uncovered like that. They would see this all happening, and they would have adequate time to say we are not going to let that happen.

MR. SCHULZ: Right.

MEMBER ROSEN: And they intervene and mess up your analysis in saving their plant.

MR. SCHULZ: Right, they would, but what we are doing is we are saying is that the operator could be delayed, or he could wait as long as 20 minutes and still be okay.

MEMBER ROSEN: That's what I m saying. It is an analysis artifact. We impose a restraint on the operator, who really isn't there, and who really would not be there.

MR. SCHULZ: Oh, we are not saying that the operator should wait. Certainly not.

MEMBER ROSEN: When you say core mixture level is that a collapse level, or --

MR. SCHULZ: It is a mixture level and not a collapse level.

MEMBER RANSOM: If you mean a mixture level and it actually declines much above the top of the core, then you do dry out presumably the upper part of the core.

MR. SCHULZ: Not with a mixture. There is still a mixture going through the core. So as long as the mixture level is above the top of the core, the core is not going to heat up.

MEMBER RANSOM: Is there a flow through the core?

MR. SCHULZ: Oh, sure, yes.

MEMBER RANSOM: What, the pumps are running?

MR. SCHULZ: No, you are venting out the break. There is not really significant flow. There is steam being generated, which is going up through the core.

MEMBER RANSOM: Steam cooling.

MR. SCHULZ: Well, not use steam cooling. The steam is carrying water with it, and so there is water also going.

MEMBER RANSOM: Well, you said the mixture level is down about six feet below the top of the core, and that would imply --

MR. SCHULZ: That is AP-600, first of all, and this is AP-1000.

MEMBER RANSOM: It would be a lot more meaningful to calculate core temperatures and then show those, and it would answer the question do you damage the core or not.

MR. SCHULZ: Yes, we could present that.

MR. CUMMINS: This is Ed Cummins again. I think that most people are skeptical of MAAP calculated core temperatures, and that is why we don't show them.

MR. SCHULZ: The fourth class is again the same as the last one, with one accumulator, one core makeup tank, but with pump injection, and no stage 4 and 2, stage 2 and 3.

MEMBER ROSEN: Is this still the same 2-1/2 inch break?

MR. SCHULZ: Well, we look at a spectrum in all four categories, from .5 up to 8, and in this case we get no core uncovery at any time for any of these breaks. So this is not so challenging with the RNS pumps.

So I would now like to move on to large break LOCA success criteria. For cold leg breaks, the success criteria is two accumulators, just like the design basis, the DCD analysis. So initially we actually didn't do a special PRA analysis for AP-1000.

But we eventually noticed that the success criteria also requires that we consider no containment isolation, which is a little more conservative, and would tend to increase PCP above the design basis, numbers which were already pretty high, 21 something degrees.

So we reanalyzed the event using COBRA-TRAC, which is our design basis code, and running it the same way because it was easier to do that, and we calculated an even lower temperature.

Now, the reason that went down was that we assumed the availability of off-site power for 10 seconds, which we thought from a probability point of view was justifiable. The chance of losing off-site power that quickly we were not worrying about.

MEMBER ROSEN: Well, I agree a hundred percent, but that is not the standard analysis. The standard analysis, you take off-site power off the instant of the break.

MR. SCHULZ: Right, which is appropriate DCD analysis. Now this is PRA analysis. So what I am saying is that we should use this in the DCD. I am just saying that for the PRA that we didn't make that super conservative assumption.

MEMBER ROSEN: Now, for the PRA, you could just leave off-site on, period, because there is almost no instances of SCRABS, for instance, or loss of an energy source from a plant causing an off-site power loss. I mean, it has happened, but not usually.

MR. SCHULZ: And all I am saying is that

for this analysis, it is only important as far as how it affects the large break LOCA until you trip your reactor coolant pumps, which we automatically do in an S signal, plus the time delays.

So it really only has to run like 10 or 15 seconds, for off-site power to be available, and after that, we could lose it and it won't affect this result.

CHAIRMAN APOSTOLAKIS: Now, what does without uncertainty mean?

MR. SCHULZ: When you look at the DCD, the methodology for large break LOCA includes a calculation of DCD, and then it separately accounts for plant uncertainties, and it adds up a number that is in the AP-1000 case something like 230 degrees, which would get added to this if you wanted to look at with uncertainty.

CHAIRMAN APOSTOLAKIS: So 1850?

MR. SCHULZ: Yeah, and so when you look at the T&H certainty evaluation that we did for large LOCA, we put that uncertainty, we added that on. But for the success criteria --

CHAIRMAN APOSTOLAKIS: Well, the 2200 degrees that is not a best estimate is it for the failure criteria?

MR. SCHULZ: You absolutely have to stay below that.

CHAIRMAN APOSTOLAKIS: But that is a regulatory requirement.

MR. SCHULZ: Yes.

CHAIRMAN APOSTOLAKIS: But in terms of uncertainty --

MEMBER ROSEN: If you did a realistic estimate, it would be more, but not a whole lot.

CHAIRMAN APOSTOLAKIS: Okay.

MR. SCHULZ: We also did a spurious ADS for large LOCA, where we opened all four stage four valves at the same time after the initiating event. We used one out of the accumulators, and we analyzed this with COBRA-TRAC, and we got a very low PCT, and hot leg breaks just tend to be a lot less severe than cold leg breaks.

You don't get that flow reversal and initial heat up, and the core cools down much better at the end of blow down, and so there is a lot more space and temperature to heat up before you get into trouble.

ATWS analysis. The first thing to thin about here is AP-1000 has what we call a low boron core, which means that the beginning of core life just after refueling the maximum boron concentration is probably a thousand PPM, instead of 11 or 1200 PPM.

This gives us a more negative moderator temperature coefficient, which makes it easier to ride out the transients. The current AP-1000 is able to ride out transients over about 98.5 percent of the core life, or the UET is 1.5 percent.

We have analyzed the two cases, and shown them in the PRA. One of them is the beginning of equilibrium core cycle, which has an MPC that is at least minus 12.5, and we also looked at the first core, which tends to have less negative MPCs, and about 40 percent of life, we have got about minus 10, and at this point we bump up against the pressure limit post-ATWS.

So I think these are the peak pressure transients, and this is the beginning of like equilibrium core cycle, which stays below 3000 psi. The first core cycle goes right up to 3200 psi, and this is actually psia and the limit is psig. So this is right at the limit.

We have some discussions with the staff going on whether 98.5 percent is enough, or whether we need 99 percent or something, and we are still talking to them about that.

Okay. Now I would like to get into the T&H uncertainty stuff. We have already talked a little bit about this, and hopefully the rest will paint a real clear and easily understood explanation. We have provided evaluations that are actually in a response to the RAI, where we went through and implemented a process like we did on the AP-600, which I am going to explain here.

The whole process is trying to calculate the high risk, low margin cases from a probability point of view, and we have used the MAAP success criteria analysis to pretty much tell us when we get core uncovery, and any time we get core uncovery, we are considering that to be a low margin case, no matter what the temperature is.

We take the event trees that Selim showed you that we did for the core melt level one analysis, and we expand them to include intermediate failure cases. Well, not failure, but success equipment availability cases.

And then we connect those expanded event tree branches to whether they are low margin or high margin success paths. In the end, we think we have bounded about 98 percent of the core melt sequences with the conservative T&H analysis we have done.

CHAIRMAN APOSTOLAKIS: Again, you say you have expanded the --

MR. SCHULZ: Let me show you. Just hang on.

CHAIRMAN APOSTOLAKIS: You have to explain what that means.

MR. SCHULZ: I was qualitatively doing that. We ended up from this identifying the limiting analysis cases, which were three small LOCAs, two large LOCAs, and two long term cooling cases, and if we analyzed these seven events with DCD codes and methods conservative with Appendix K --

CHAIRMAN APOSTOLAKIS: These are high risk and/or low margin?

MR. SCHULZ: That's right. That's right, and it showed successful core cooling for those cases.

CHAIRMAN APOSTOLAKIS: Okay.

MR. SCHULZ: We pretty much talked about this, and let me go on here to this, and hopefully this will help you. What you see on the left is a kind of event tree structure in the PRA, when you are just trying to figure out whether the core melts or it doesn't melt.

You are not trying to differentiate anything else. So what we do when we expand the event trees, is we take, for example, the core makeup tank, and instead of it being just zero or one, it could also have two tanks available, and so that is what we do here.

So we have zero, one or two, or two. So actually these three things, zero, one, or two. And the same for the accumulator, zero or one. Now, what we do is that we then look at the end points, and we try to figure out, well, is that like a design basis case?

Well, in this case it is design basis, and we have got two accumulators and two core makeup tanks, for a medium LOCA. That is what we would normally have for a design basis.

We also called this design basis in the sense that we have analyzed DVI line breaks with one core makeup tank, and one accumulator, because the other two spilled, and so we consider this to be design basis.

This case here has no accumulators, but two core makeup tanks. We have put this into these categories that are UC are like uncovery. They are low margin.

So the okay ones are high margin in our terminology, and things where we put UC something is a low margin case. And it can have two core makeup tanks, or if we take this one and expand it just like this, and so this tree really grows.

CHAIRMAN APOSTOLAKIS: So UC-3 does not exist on the left.

MR. SCHULZ: That's right. It is a subset of one of these, and you can't figure out the probability of UC-3 here, because this one only takes the extreme failure conditions.

CHAIRMAN APOSTOLAKIS: So the logic, and again at the high level, is that we are getting into a little bit of trouble by going with the minimum from a success criteria point of view. So let's look at the actual case where I need only one CMT, but I really have two.

So there are some cases perhaps where I will get both of them?

MR. SCHULZ: That's right. And when we do expand these trees, we go through and calculate the probabilities of all of these different branches.

CHAIRMAN APOSTOLAKIS: Which again is an expansion of the probability that you have on the left.

MR. SCHULZ: That's right.

CHAIRMAN APOSTOLAKIS: And what does that do now? Is that a bounding case?

MR. SCHULZ: It provides you more detail.

CHAIRMAN APOSTOLAKIS: More detail.

MR. SCHULZ: In terms of the probability, and what we ultimately want to do is figure out what is the highest probability of getting these UC things. These we really don't care about so much, because we are saying there is T&H uncertainty really with these guys. We are not getting core uncovery, and we have lots of margin for cooling.

CHAIRMAN APOSTOLAKIS: But all you are doing -- if I expand the middle one there -- yes, that one, and if I expand that one, I will end up with --

MR. SCHULZ: You will end up with three more branches like this.

CHAIRMAN APOSTOLAKIS: Exactly, and one of the sequences will be what I have on the left won't they?

MR. SCHULZ: Yes. In fact, it will be --

CHAIRMAN APOSTOLAKIS: But what happens now is the probability is lower?

MR. CUMMINS: The whole objective of this is to find out which of the uncovery cases have some impact on the PRA.

MR. SCHULZ: Yes, I understand that.

MR. CUMMINS: So you are looking for the ones that are risk important. We are going to find a whole bunch of uncovery cases, some of which have some PRA value, and some of which don't, and we are going to throw away the ones that don't.

MR. SCHULZ: Let me continue here a little bit. I think it will become clearer. This is just a listing of how we group the different okays and these UC categories with sort of different kinds of equipment being available.

CHAIRMAN APOSTOLAKIS: So can you point here to the sequences that correspond to the ones that you had on the left in the normal case in the slide before?

MR. SCHULZ: Oh, the normal case?

CHAIRMAN APOSTOLAKIS: The way that you do the standard PRA.

MR. SCHULZ: Well, the standard PRAs don't relate to these. They are just okay, period. They are all mushed together. We don't differentiate. The success paths intend to be extreme, in terms of that they have multiple failures in them, and you can't differentiate this, and you can't get this detail out of the PRA level one event trees. They are not that detailed.

In the expanded event tree, we have used all these detailed branches to differentiate between uncoveries, and --

CHAIRMAN APOSTOLAKIS: Let's go got he previous slide, and maybe that will help. You are doing -- and you call it normal, too, your normal event tree. And you have core melt when you have no core makeup tanks and no accumulators, right?

MR. SCHULZ: That's right.

CHAIRMAN APOSTOLAKIS: And you have core melt because you have uncovered the core and for a period there is no high pressure injection?

MR. SCHULZ: Right.

CHAIRMAN APOSTOLAKIS: Now, when I expand the tree, what happens to that sequence, the 00 sequence?

MR. SCHULZ: The 00 sequence will be a core melt still.

CHAIRMAN APOSTOLAKIS: It will still be there?

MR. SCHULZ: It will still be there.

CHAIRMAN APOSTOLAKIS: Have I bounded it in any way?

MR. SCHULZ: What do you mean by bounded?

CHAIRMAN APOSTOLAKIS: Well, I mean I have a frequency here--

MR. SCHULZ: We are not trying --

CHAIRMAN APOSTOLAKIS: You are doing it to the others, to the successes.

MR. SCHULZ: It is the successes.

CHAIRMAN APOSTOLAKIS: You are doing it to the successes.

MR. SCHULZ: Yes.

CHAIRMAN APOSTOLAKIS: So now I take the first success from the bottom, where I don't have a CMT, but I have one accumulator.

MR. SCHULZ: Yes.

CHAIRMAN APOSTOLAKIS: And somebody says, well, how do you know the accumulator is good enough and so on, and that is what you are addressing now?

MR. SCHULZ: Eventually. Right now I am trying to calculate probabilities of these intermediate states, and then I am trying to figure out --

CHAIRMAN APOSTOLAKIS: But you will still have a sequence on the right that says no CMT and one accumulator?

MR. SCHULZ: That's right. It will be here and have a certain probability.

CHAIRMAN APOSTOLAKIS: So that is what

bothers us now and we have to try to find out what to do with it.

MR. SCHULZ: Yes. The next question. So we expanded eight event trees in AP-600, and we didn't take all 26, okay? We looked at ones with ADS actuation, and not the ones without ADS actuation. Now for AP-1000, we expanded five trees.

Now we lost the intermediate LOCA because it does not exist in AP-1000, and we added the spurious ADS, because that did not exist on AP-600. But we didn't do the small LOCA transients with ADS to rupture with ADS that we did do in AP-600.

And the reason for that is that these three events, expanded event trees, did not produce any limiting risk important cases. They all came out of the other events, and generally what happens is that these events result in later ADS actuations, so that the timing of uncovery is later, and it is delayed. So it tends to be less severe.

So we looked at five event trees that we expanded, and this is just a summary of that, and what we did in AP-600 and what we did in AP-1000, and as an example, this is a DVI LOCA, and you actually are seeing half of it here. The other half is on the next page.

And so you see the full thing here, and you were asking about, for example, one -- well, one of the characteristics of a DVI LOCA is that you lose half of the systems.

So you don't see two core makeup tanks or two accumulators anywhere here.

CHAIRMAN APOSTOLAKIS: Zero, one.

MR. SCHULZ: Zero, one, and so that looks a bit more like the normal event tree. However, in ADS land, you see a lot of intermediate states. And then we go over and we plug in what these end-states are; okays, okays, and there is a core damage, and there you start seeing some uncoveries, and uncoveries.

Now, all of these events here are with containment isolation, which is the first question on the tree. The next page is without containment isolation, and the same story. So after we set this tree up, we calculate it and then we sum up the potential core damage events that were treated as success in the base PRA.

So these are all the UC, these low margin, coolant recovery things. If you calculate all of those, and we don't worry about core damage.

CHAIRMAN APOSTOLAKIS: So sequence number six, is a sequence of appearance of the normal event tree?

MR. SCHULZ: No. It would be a subset of one of the ones. It is covered by and bounded by the normal base line PRA.

MEMBER ROSEN: I would say included in.

MR. SCHULZ: Included in. It is included in there, but it is a subset of one of the branches.

CHAIRMAN APOSTOLAKIS: Success branches.

MR. SCHULZ: Success branches, yes. So we end up calculating all these intermediate success states, and we move them all into a big table, and we sort them, and figure out which are the most probable ones, to try to figure out this is the bottom half of that same tree.

Now, where do we draw the line? Which ones are -- you know, we have this big table from higher probability to very, very low probability situations. So we -- okay, this is still before that.

When we talk about large release, we didn't really calculate it like we do in the base PRA. We used a constant 6 percent of the core damage events, and this is with containment isolation now, and we go to large release, and the same thing that we did with AP-600. Here we talk about the criteria.

So we basically take any of these potential core damage events which were a success on the baseline PRA, and we say that all of those that are within one percent of the total core damage frequency for AP-1000, we will consider to be risk important.

MEMBER ROSEN: Give me that again. Within one percent?

MR. SCHULZ: Yes.

MEMBER ROSEN: Meaning?

MR. SCHULZ: That they are greater than or equal to one percent of --

MEMBER ROSEN: Of 2.4 E to the minus 7.

MR. SCHULZ: Yes.

MEMBER ROSEN: In other words, anything greater than 2.4 E to the minus 9?

MR. SCHULZ: Yes. We will consider those to be low margin, because all of these are low margin, risk important sequences, and we should consider them in the T&H uncertainty.

CHAIRMAN APOSTOLAKIS: Risk important?

MR. SCHULZ: They will be risk important --

CHAIRMAN APOSTOLAKIS: I thought these were successes?

MR. SCHULZ: They are successes in the base PRA, but there is a question about --

CHAIRMAN APOSTOLAKIS: But here they are successes.

MR. CUMMINS: Excuse me, but the question is a MAAP success a real success, and our answer is, well, I don't know. We will have to prove it with our DCD code. Well, rather than do this a hundred times, we are trying to figure out a way to do it 5 or 6 times, and so we are going to explain how we pick the 5 or 6 winners out of the hundred in order to run your DCD code and prove that MAAP predicted correctly.

CHAIRMAN APOSTOLAKIS: You do that later, but at this stage --

MEMBER SHACK: He has first got all the ones with uncovered, and so they are by definition low margin. How he is sort of looking at the probability that he will actually get one of those, and he is going to pick the most frequent ones of those, and so those become his dominant sequences.

MR. SCHULZ: And some of those sequences are 3 or 4 orders of magnitude less than the core melt frequency, and so --

MEMBER ROSEN: But the dominant sequences, I am sure that you are confusing George. When you said that, he went into outer hyper drive. This is simply a technique for Westinghouse to be able to pick important sequences, even though they were successes, to do some detailed calculations to show that the temperatures with steam cooling do not exceed or do not cause core damage.

CHAIRMAN APOSTOLAKIS: So a success means that you may have some uncovery for a while, but the temperature --

MEMBER ROSEN: The temperature stays low enough that the uncovered portion of the core, that the fuel, although it gets hotter than you would like it to, it never gets so hot that it is damaged.

CHAIRMAN APOSTOLAKIS: Okay. And then you are looking at those, and you have their frequency occurrences.

MEMBER ROSEN: Right.

CHAIRMAN APOSTOLAKIS: This frequency is not part of the base line DCD.

MEMBER ROSEN: No, because these are successes.

CHAIRMAN APOSTOLAKIS: but now you are saying that I arbitrarily will consider those success sequences that have a frequency and look at all of them and decide whether I should move them down to failure.

MR. SCHULZ: No, what we are considering is the potential core damage, and we are going to look at them very closely from a T&H point of view.

CHAIRMAN APOSTOLAKIS: So a very negative review and so you are going to look at it?

MR. SCHULZ: Yes.

CHAIRMAN APOSTOLAKIS: And to convince yourself if it is a success?

MR. SCHULZ: Right. This is one page of about four of the total sequences that come out of expanded event threes, and you can see for each of them the sequence CDF.

Now, this is a potential, and these were all success in the base PRA. So this is potential. So obviously this is a 10 to the minus 7 kind of sequence. So that is more than a core damage.

So the ones that are boxed in here are ones that meet the one percent criteria. So you see that you are starting to get down below 2 times 10 to the minus 9 here.

And we looked at large release as well against core damage, and we picked up a few large releases down here. Here you can see what kind of failures went along with these sequences, just for your information.

In addition, now there is 13 of these cases, and there is none on the lower pages, and so you see all of the risk important low margin sequences here, 13 of them.

MEMBER ROSEN: Because you sorted it by --

MR. SCHULZ: Right, they get lower, and lower, and lower as you go down.

MEMBER ROSEN: -- the most important.

MR. SCHULZ: That's right.

CHAIRMAN APOSTOLAKIS: Okay.

MR. SCHULZ: Now you also see on the right, and I am getting a little bit ahead of myself here, is that we selected seven cases to analyze; five of them short term, and two of them long term cooling cases.

And you see here two columns; short term, long term, cooling. And these letters relate to one of the cases that we did analyze. So we think that we have analyzed with these seven cases more than -- and you see these cases here, and these two cases, for example, are not. They are 10 to the minus 9, and 10 to the minus 11 cases.

And it happens that in order to or instead of analyzing 13 cases, we smooshed them into 7 cases, and because of that, we ended up with a little bit of conservatism, which then covers a few more cases. There are 102 cases here total, and 13 of which are risk important, are cases bounded by 56 of the 102, which ends up being 98 percent or so of the risk of the plant, are bounded by these conservative T&H analysis cases.

Now, let me show you which cases those are. This is the 13 pulled out of that big table just to summarize for you how much they would contribute to core melt and large release if they were core damage, and obviously you don't want that to happen.

It also shows you what we call the residue, and if you take all of the cases that aren't in these 13, how much does that add up to be compared to these cases.

So these cases add up to be 10 to the minus 6, and these other cases add up to be 10 to the minus 8. So they are small relative to the total. So we ignored those other cases, although again we covered many of them off.

Here are the seven cases that we picked for candidates for the detailed T&H analysis. Three of them are small LOCAs, and two large LOCAs, and short term, and then two long term analysis.

And you can see here which equipment availability we selected, and this indicates which of the dominant cases are bounded by them. So for these first two, and for example, no core makeup tanks and accumulators, one of them actually has two accumulators. They both have four stage fours.

MEMBER ROSEN: That means four fails stage fours.

MR. SCHULZ: No, four working.

MEMBER ROSEN: Oh, four working stage fours?

MR. SCHULZ: That's right. All of these cases rely on passive systems only. We did not include in the expansion of threes any active systems because the issue of T&H uncertainty seems to be focused on passive system performance, and this whole issue of low Dts, and uncertainty, and newness of passive systems, and so again, just like AP-600, we did not expand active system branches, only passive system branches.

So all of the success criteria here and equipment availability is passive system.

MEMBER ROSEN: Yes, but what does this table mean now? It says CMT, zero.

MR. SCHULZ: That is available. Those

CMTs are available, and one accumulator is available, and this is available equipment.

MEMBER ROSEN: Available equipment. Okay.

CHAIRMAN APOSTOLAKIS: You keep talking to risk guys. So I am dying to go to the meat of it.

MEMBER ROSEN: He is preparing us.

MR. SCHULZ: This is very similar to the previous page, and it shows you the code that we used to analyze each of the cases, and as I said, we used NOTRUMP for the small break COBRA-TRAC for the large breaks, and the COBRA-TRAC long term cooling model for the long term cooling. These codes were run like they were in the DCV analysis.

CHAIRMAN APOSTOLAKIS: This is now considered what, a conservative analysis?

MR. SCHULZ: Yes. Appendix K, decayed heat, and limiting plant parameters and limiting --

CHAIRMAN APOSTOLAKIS: And the argument that you are making is that if I show that even with these conservative analyses, this is a success, that I don't have to worry about Dr. Ransom's concern about the uncertainties? That is the essence of your argument.

MR. SCHULZ: It is bounds of uncertainties.

CHAIRMAN APOSTOLAKIS: That is the essence?

MR. SCHULZ: Yes.

MEMBER RANSOM: Going to an Appendix K type approach.

MR. SCHULZ: Yes.

CHAIRMAN APOSTOLAKIS: Which is admittedly conservative though.

MR. SCHULZ: Yes, it says that they are not so important.

MEMBER ROSEN: And this covers most of the risk of the plant. okay.

MR. SCHULZ: So you can see from this that A and B get no core uncovery, even with these conservative analysis. C does get core uncovery, and the PCT is like 1500 degrees or 1600 degrees. Large break LOCAs, and I have actually talked about these, but these are with the DCD uncertainties.

So that if large break LOCAS were done not Appendix K, but the best estimate, DCD type analysis with separately calculated uncertainties.

CHAIRMAN APOSTOLAKIS: Let me understand the first two. You are saying no core uncovery.

MR. SCHULZ: Yes.

CHAIRMAN APOSTOLAKIS: What did you have

originally with NOTRUMP?

MR. SCHULZ: Well, this is with NOTRUMP. With MAAP?

CHAIRMAN APOSTOLAKIS: With MAAP.

MR. SCHULZ: Well, what I showed you was more limiting cases. The cases that I showed you would be, for example, disbursement would be no containment isolation, and this would be the same, and this would be the same, and but it will be 3 ADS. So I didn't show you one of these cases.

CHAIRMAN APOSTOLAKIS: You didn't?

MR. SCHULZ: I mean, we typically didn't analyze such cases. In our MAAP analysis, we were looking for the limiting cases. So we didn't analyze cases which had more things working.

Now, we did that on AP-600 just to make sure that more things didn't make things worse, and it doesn't. So when we did AP-1000, we didn't look at more things with MAAP, because we were focusing on the limiting success rates area.

MEMBER SHACK: This is one of the sorted sequences, which means that MAAP's end state was uncovered, right?

MR. SCHULZ: That we would say that it was either uncovery, or potential uncovered, because we didn't necessarily analyze with MAAP some of these lesser sequences for AP-1000. The next three slides show you the results of the events A, B, and C, or cases A, B, and C, showing the RCS pressure, core mixture level, and then you see here that we just barely dip to the top of the core.

The accumulator, which there are no core makeup tanks, is supposed to inject both -- just before ADS was off for 20 minutes, and then injects very rapidly after that until it empties. Then IRWST starts up some little time after the accumulator is empty.

But the core mixture level is popped back up again, and doesn't dip below the top of the fuel throughout that. So again NOTRUMP, Appendix K, analysis.

CHAIRMAN APOSTOLAKIS: All of the sequences that you analyzed, did you declare them a success or did you find some problems?

MR. SCHULZ: Yes. In some earlier cases where we hadn't, for example, put the passive RHR in, when we first started trying to do this, and it didn't work. So then we backtracked and changed the success criteria so that it would come out to be successful.

And in all seven cases that we have now

performed are all successful, with the seven cases that we have analyzed that cover 98 percent of the risk.

CHAIRMAN APOSTOLAKIS: So this kind of analysis made you change some success criteria?

MR. SCHULZ: Yes.

MEMBER ROSEN: And require passive RHR?

MR. SCHULZ: Yes, that was the only real change that came out of this, but it did. This is Case B, which is a CMT line break case, two accumulators, no core makeup tanks, 4 out of 4 ADS with containment isolation being effective.

And everything is very good on this case, and not that challenging. In this case we do get core uncovery, and this is a DVI LOCA, one core makeup tank, and no passive RHR. 3 out of 4 ADS, no containment isolation.

So we get near the top of the core here, and then as the core makeup tank empties about in this time frame here, then we don't get injection from the IRWST 4 sometimes, and so we deplete the inventory from the reactor, and then we start getting injection, and we get some recovery here.

And we analyze the peak clad temperature for this and it is 1570 degrees. So again we said that is okay from a core damage point of view.

MEMBER LEITCH: I'm not sure I am reading that right. Is that minus 18 feet, or is it minus 4 feet?

MR. SCHULZ: Well, the mixture level is on an absolute scale and the top of the core is 20.5 or something feet.

MEMBER LEITCH: Okay. I see.

MEMBER ROSEN: This is a revelation.

MR. SCHULZ: It is about two feet.

MEMBER ROSEN: Maybe the light is beginning to dawn on me, and maybe the for the old guys who run BWRs. We have always thought of containment as a good thing to protect the public's health and safety, in the sense that if you had an accident that stuff doesn't get out and get to a potential member of the public.

Here it does that function, too, but it is much more important because it makes these, and without the ECCS may not work in certain cases. So that is another whole deal that is new in the sense of these passive plants. Now maybe some BWRs need to back pressure to have enough MPSH. They need some credit for it.

But this is the clearest demonstration of what happens when you don't have containment isolation, and in this case, you are going to have a whole lot more core damaging events than if you did or you would have in the other kinds of plants, and which don't rely so heavily on containment to provide the back pressures.

MEMBER SIEBER: There is a number of current generation BWRs that need some containment pressure needed to take credit to get MPSH adequate for --

MEMBER ROSEN: Yes, mother nature was telling us that there is some other function for containment other than directly protecting the public's health and safety, because it does show up in some BWRs, and in some PWRs. But here it is much clearer. Just an observation.

MEMBER SIEBER: You could accomplish the same thing without containment and not that you have it, you can use it. Otherwise, the plant just gets taller and taller.

MR. SCHULZ: I am not going to show you the large break cases. I have already really talked about them, but what I would like to do now is talk about the long term cooling case, and the one that is the most interesting there is the one with the failed containment isolation.

And so what we have done is an analysis that looks at the largest single penetration, which is an 18 inch H back line staying open indefinitely. We assumed the BWR LOCA, which is in our opinion the most limiting LOCA because it results in a lower initial water level and containment.

That X is about two feet, and I forgot to write that down, but what that means is that if you had a non-DVI LOCA, including any large LOCA, the initial containment water level would be two feet higher.

So you would have a lot more inventory that you could lose out the break, out the hole in the containment, before you would challenge core cooling and a recirc long term mode. So that waw the events that we looked at.

And what you will see following here is some analysis that shows hat with passive containment cooling operating, with the water cooling going on, that the containment leakage is terminated in about 2-1/2 hours.

For that 2-1/2 hours, you have leakage going out of the containment. After that 3-1/2 hours, there is essentially no more leakage.

MEMBER ROSEN: And no more driving head?

MR. SCHULZ: Right. And what has happened is that a accumulation of decayed heat has dropped and the PCS performance improved, and the reason why it has improved is that during the leakage, the leakage has taken air, as well as steam, out of the containment.

And taking the air out of the containment increases the partial pressure of steam, and increases the temperature of the mixture in containment at these low pressures. And allows for better heat transfer through the containment.

And as a result, you end up with PCS performance going up, and decayed heat coming down, and about 2.8 hours out, you end up terminating the leak out of containment. During that time, you lose about .3 feet of level in the containment, which is not very much.

And then we did a COBRA-TRAC analysis to show that with this reduced level and atmospheric pressure that we are still okay. This shows you what is going on in containment in this event. The IRWST level is dropping as it injects, and in fact spills.

The PXS-B is the room where the PXS valves are located and where the break is located, and so that is a separate volume in containment and it behaves differently from the bulk of the containment. There is a drain line out of the bottom, but it tends to get overwhelmed by the blow down from the break.

So it tends to fill up faster as you see than the containment, which is this solid line, is the main containment. Then eventually the main containment becomes the highest level and it is driving the recirculation flow back through and into the reactor coolant system.

You see down here the containment leakage, and it is higher early, and then in about 10,000 seconds or 2.8 hours, it drops to about zero. Containment pressure goes up to about 10 psig for something, and then it drops to atmospheric pressure in that same time period.

This code here is a little confusing, in that it shows the decayed heat level on the dotted line which seems to be above the PCS, and that is above the PCS heat removal, and so you are saying why is it matching decayed heat.

Well, the PCS heat removal is what is actually going through the shell and it doesn't count other places that heat can go. So if you look at this whole time frame, the water going into the reactor is somewhat subcooled, and it is fairly highly subcooled in this early time frame.

And even out here it is still somewhat subcooled. So the PCS doesn't see that. It just sees how much heat is going out from steam generation basically that is going out through the wall in the containment.

It also doesn't see how much heat is going into concrete or steel inside a containment. Now, you see in the end here that things are coming together as the subcooling goes away and as the passive heat sinks and saturates.

Okay. This is just a summary of the T&H uncertainty analysis. We had calculated the probability of the low margin sequences, and the selected risk important low margin sequences, the important ones.

And the defined seven bounding cases, and five short and two long term. And we analyzed all those cases using DCD codes and methods, and for all of them have shown successful core cooling.

And that by doing that, we have bounded 98 or 99 percent of the risk of the plant with those conservative analysis. Any questions? No?

CHAIRMAN APOSTOLAKIS: Very good. Thank

you very much. You finished early. Okay. We are going to break for 20 minutes. We will be back at 3:22, which is a mean value and Selim will tell us what the high bound will be.

(Whereupon, at 3:03 p.m,, the meeting was recessed and resumed at 3:27 p.m.)

CHAIRMAN APOSTOLAKIS: All right. Now we will hear from the NRC staff, Mr. Saltos.

MR. BURKHARDT: Yes, and before Nick gets started, Dr. Apostolakis, I would like to make a few comments. I am Larry Burkhardt, the NRR AP-1000 project manager.

As Mike stated earlier in his opening comments, we obviously do have an established schedule, and our next milestone is to issue the draft safety evaluation report in June of this year. So as you can imagine, we are in the midst of our review looking at the RAIs and all the other material that Westinghouse submitted.

And consequently what you are going to hear here is not final, but we would like to give you a snapshot of where we are in our review. So with that said, this afternoon you will be hearing from Nick Saltos on the level one PRA, and Walt Jensen on PRA success criteria, and Marie Pohida on the shutdown

PRA.

And one more comment. There are three different groups of slides, copies of slides, going around. So I hope that everybody has a copy. With that said, I will turn it over to Nick Saltos to about the level one PRA review.

MR. SALTOS: Good afternoon. This is Nick Saltos from the NRR, the Probabilistic Safety Assessment Branch, and I am going to talk about major objectives in the process of the PRA review, and also talk about the major issues of the level one PRA review.

The major objectives of the PRA review are to ensure the quality of the PRA, and commensurate with its intended use, such as gaining insights about the design, and support the design certification processes.

MEMBER KRESS: You know, if Dr. Wallis was sitting here, which he isn't, he would ask you two questions I'm sure. The first one would be how do you measure the quality of the PRA, and the second one he would ask is how do you know when the quality is commensurate with its intended use? Have you got some gauges or criteria that --

MR. SALTOS: Yes, we have some generic

means I would say to do that. By evaluating the models and assumptions, and data, used in the PRA and comparing with other PRAs.

MEMBER KRESS: But in terms of the ASME quality standards would you call it a 2, or a 3, or a 1, or what?

MR. SALTOS: Yes. I see that there is compatibility there, but this work is based on the AP-600.

MEMBER KRESS: So that was before we thought about that.

MR. SALTOS: But I don't see that there is a conflict there with those criteria. The emphasis of course is on PRA modeling of novel features, like passive systems and the ITAAC. and (inaudible) for major contributors to risk, and features that contribute to reduce risk with respect to operating the reactors.

And areas of uncertainty that have to be addressed, and defense in depth to mitigate specific initiating events. Support the design and most of the PRA support of the design is done at the pre-application stage, but still we have to ensure that the PRA is valid to do that.

At that stage the PRA was used to define capabilities, and to introduce features to reduce or eliminate vulnerabilities. Quantify the effect in terms of risk of the new design features, and select a manual alternative features operating strategies, and design options.

And the use of the PRA design certification process, and then we go to the second bullet, and this is a major objective of the PRA, and a proper interpretation and use of the results for decision making in the certification process, such as identified design and/or operational changes to address weaknesses, and identify certification requirements, such as ITAACS, which stands for inspections test analysis and acceptance criteria.

And these requirements will be the ones that will be used to ensure that any future planned reference in the AP-1000 design will be operated in a manner that is consistent with important PRA assumptions.

Another area that the PRA is used in the certification process is to determine the appropriate regulatorial oversight for non-safety systems, and what Westinghouse calls defense in depth, and systems that are not safety related, like the normal RHR start up flood water system.

And first of all, determine if oversight is needed, and if it is needed, what system is better to have in terms of risk reduction to have this oversight, and what is the appropriate level of oversight.

And it is used also to determine the significance. PRA results are used to determine the risk significance of raised uses, and the focus of the most important uses, and the use of less important issues.

CHAIRMAN APOSTOLAKIS: Maybe we can skip to the next slide.

MR. SALTOS: Okay. The major issues from the review of the PRA level one power operation is the thermal-hydraulic uncertainties and success criteria, and Westinghouse talked extensively before. Another reason is the fire induced --

CHAIRMAN APOSTOLAKIS: Let me understand this. It is a major issue because you have reviewed what they have done and you don't agree?

MR. SALTOS: Well, we have not reviewed Westinghouse's response extensively yet. We are still reviewing those forms. But we had a request for additional information on this issue when we received their submittal to the PRA.

So this is one of the major issues that has to come to a close, because that impacts success criteria, and it can impact the risk and impact the requirements for the certification requirements, like risk and ITAACS.

CHAIRMAN APOSTOLAKIS: And what was the issue?

MR. SALTOS: I will talk next about that. Another issue is fire-induced spurious actuation of ADS squib valves, and another issue is that the identification of certification requirements, such as ITAACs and RTNSS, that result from major differences and design differences with respect to AP-600, because our list of AP-600 certification requirements that forms the starting point.

However, some certification requirements could change according to the resolution of some of the outstanding issues.

CHAIRMAN APOSTOLAKIS: I think this is what Mr. Schulz just described to us, right?

MR. SALTOS: Yes, more or less, but there might be some additional clarification from our point of view if you are interested in hearing that. When we start with this issue, we are talking about passive systems that rely on small driving forces, such as gravity, to perform primary functions. Such driving forces are small in comparison to those with pump systems that we use in the care and operation of power plants.

The uncertainty now in the valves of such driving forces as compared to a best estimate computer code, thermal-hydraulic analysis, can be of a comparable magnitude to the predicted values themselves.

So when the thermal-hydraulic uncertainties are concerned, some success accident sequences may actually not be a success and lead to core damage. So it would be converted from success to core damage.

CHAIRMAN APOSTOLAKIS: Could you be a little more specific? What kind of uncertainties?

MR. SALTOS: We are talking about decayed heat, for example. That has a mean aloe, and if the decayed heat is higher than what is assumed in the best estimate that could make a big difference in the thermal hydraulic analysis results about reaching the core uncovery and in terms of 2200 degrees.

CHAIRMAN APOSTOLAKIS: And it is not related to what you say there, passive systems rely on small driving forces?

MR. SALTOS: Yes, they are talking about all the thermal hydraulic parameters in the plant, and parameters that go into the thermal hydraulic analysis.

So for some accident sequences with frequency are high enough to impact the results, but which are not predicted by best estimate thermal hydraulic analysis code to result in failure, in core damage, may actually lead to core damage where these thermal hydraulic uncertainties are considered.

MEMBER LEITCH: Nicholas, presumably this is an issue that has been raised in RAIs and responded to, and --

MR. SALTOS: This is a different issue. I am going to have in my next slide and say what exactly it is.

MEMBER LEITCH: The current status of this, okay.

MR. SALTOS: Okay. This issue was addressed in the AP-600 PRA by the risk-based bounding approach, which Westinghouse described also, which uses conservative assumptions for key thermal hydraulic paraments.

It involves the identification of lower thermal-hydraulic margins, risk significant accident scenarios. When we talk about risk significant, we do not mean that they are risk dominant or risk important means.

We do not want them to cause core damage because if we (inaudible), then the results would be impacted, and therefore the inside would be impacted. In that sense, we will call them risk significant.

So this process involved the identification of low thermal hydraulic margins risk significant accident scenarios, and then the use of design basis accident computer codes like NOTRAM for small LOCAs, for example, to bound the thermal hydraulic uncertainty.

Such an approach relates to the impact of the thermal hydraulic uncertainties, to changes in the success criteria. The success criteria become or demand more equipment to be available, and therefore the risk would also change.

And when Westinghouse admitted the PRA, they told us that no sequences beyond -- there were not sequences beyond those that are defined in the AP-600, are classified as low thermal hydraulic margin risk significant on the grounds that the two designs are similar.

And the staff requested the use of a

systematic approach and/or additional analyses, as was done for AP-600, to support this argument. And Westinghouse submitted this approach that was presented before about blowing out the event trees, and basically what they do is what we consider as success sequences.

Every success sequence can be a success having one accumulator, or two accumulators, or one CMT, or two CMTs, or taking credit for a passive RHR, or not taking credit for a massive RHR based on the best estimate of thermal hydraulic codes.

Now what they did is that looking at some minimum availability system sequences. For example, one accumulator or no accumulators, and that is one key to success, and they do those calculations with a more conservative design basis accident analysis code, and this bounds (inaudible) flow rates, and (inaudible) and other initial parameters.

CHAIRMAN APOSTOLAKIS: So when you say the staff requested the use of a systematic approach, is that go beyond what was just presented to us, or is that --

MR. SALTOS: With that system analysis.

CHAIRMAN APOSTOLAKIS: So what you are not asking for is additional analysis.

MR. SALTOS: Well, no, we are asking for the systematic approach, and we review that, and if we agree with that, we are not going to ask for anything else. But we are still reviewing that.

CHAIRMAN APOSTOLAKIS: But when you say additional, it is not additional to what was presented to us.

MR. SALTOS: No. This RAI went to them before.

CHAIRMAN APOSTOLAKIS: Well, that should be clarified. Okay.

MR. SALTOS: The staff believed at the time that the difference in the thermal hydraulic parameters, et cetera, can affect plant response for PRA scenarios involving multiple failures, and potential system interactions.

And in addition, whenever the PRA changes for examining event frequencies and success criteria couldn't have changed the risk significance of the sequence. It would have changed the frequency that they calculated to determine if the sequence was risk significant or not.

And Westinghouse submitted a systemic approach that we requested and it is under staff review. Another issue is that in the AP-600 PRA at-power fire CDF is the dominant contributor to the at-power fire CDF by fire-induced spurious actuation of ADS explosive valves, which lead to a medium LOCA.

And 85 percent of the CDF comes from spurious actuation of ADS explosive valves. In AP-600, the significant uncertainty in hot short probability was addressed by sensitivity studies and design certification requirements.

And what the requirements are that are shown below are use controller circuit requiring multiple shorts of actuation; and routing ADS cables in low voltage cable trays and using redundant series controllers located in separate cabinets.

And provisions for operator action to remove power from the fire zone. This would have the degree of probability of having multiple shorts and therefore have spurious ADS squib valve actuation.

What was not considered then was that one hot short may not always be independent events, and that cable-to-cable interactions cannot be excluded. In the AP-600 certification, it was assumed that this hot shorts in two different cables wold be independent and would not cause the other.

However, the staff since the AP-600 certification, have conducted studies in SANDIA and

EPRI, which indicate that spurious actuations from cable-to-cable interactions, conductors from separate cables could come into close proximity to each other, are credible and likely for some cable types.

So the NRC asked Westinghouse and is working with Westinghouse on that, to see if the ADS cables are routed in the same cable tray, or a common enclosure, and analyze the effect of cable-to-cable interactions, and/or assess the need for additional design features, beyond AP-600, to prevent fire-induced detonation of explosive valves.

And the staff is interacting with Westinghouse to resolve this is.

MEMBER ROSEN: Now why if this is an issue on AP-1000 is it not an issue on AP-600?

MR. SALTOS: Because at the time we did not have those studies from SANDIA.

MEMBER ROSEN: I understand that, but --

MR. SALTOS: Well, I think that is it. More information since then.

MEMBER ROSEN: Well, now that you have the information isn't there some way to reflect it in AP-600?

MR. SALTOS: If we find out that this is important, we should.

MEMBER ROSEN: Yes, it seems like. The staff has to make some sort of special findings, I think.

MR. BURKHARDT: It potentially could be any number of issues that could cause us to revisit the design that is already certified, including the AP-600. One of the things that I am sure that we would do is assess the safety significance of that issue, and the likelihood of someone actually referencing a design.

I mean, the practicality, we have to deal with the human resource issue about these evaluations, and again consistent with this risk significance of the issue, we would deal with that. Another way to do that is just as you referred to.

MR. SALTOS: We might have some additional requirements about routing of cables, for example.,

MEMBER ROSEN: Well, since AP-600 and AP-1000 are not plant sized and built, if it is a backfit, it is a backfit of a design, and not of a facility that is out there operating.

MEMBER LEITCH: This fire induced operation is assumed to occur on one ADS valve?

MR. SALTOS: Well, if one ADS valve opens, you have a medium LOCA. If more than one, you have a large LOCA. But it is less likely to happen in two than one. The concern is for one based on frequency.

MEMBER LEITCH: Is there not a location such that a fire could cause all four valves to open?

MR. SALTOS: For the AP-600, based on (inaudible) cable interaction, or in other words, one short per cable causes a short in the next cable, which would be a multiple hot short, and would spuriously open the valve.

MEMBER LEITCH: But isn't there some point back in the circuit where there is a common signal?

MR. SALTOS: Well, that is why we have these requirements that I talked about here, that they are trying to prevent that. If the cables are routed that way, and the plant is built according to these requirements, that would not be very likely.

CHAIRMAN APOSTOLAKIS: So you can't have a hot short or a series of hot shorts that create a large LOCA. Is that what you are saying, or are you making the condition being in a different phase?

MR. SALTOS: Yes.

CHAIRMAN APOSTOLAKIS: Yes what

MR. SALTOS: Well, in terms of frequency, it will be much more and you would have to have many hot shorts.

CHAIRMAN APOSTOLAKIS: Even if the cable is on the same tray?

MR. SALTOS: Well --

CHAIRMAN APOSTOLAKIS: I mean, you just mentioned common cause failure.

MR. SALTOS: At the time, we didn't consider that if a (inaudible), and has another one next to it, we would consider that the hot shorts in those two cables would be dependent. So the probability that one would fail, the probability of the other failing, they don't have any common cause.

CHAIRMAN APOSTOLAKIS: But now you consider that --

MR. SALTOS: It is now time to figure that out.

CHAIRMAN APOSTOLAKIS: And that can lead to the opening of one valve, and I think that is the question from Mr. Leitch.

MR. SALTOS: Yes.

CHAIRMAN APOSTOLAKIS: And the question is --

MR. SALTOS: That you have more than two hot shorts.

CHAIRMAN APOSTOLAKIS: You have to have 3 or 4?

MR. SALTOS: Yes, 3 or 4.

CHAIRMAN APOSTOLAKIS: And you declare those as very unlikely?

MEMBER LEITCH: I am not concerned about multiple hot shorts. What I am concerned about is there a location where one could postulate a hot short that would open all the valves?

CHAIRMAN APOSTOLAKIS: A single hot short?

MEMBER LEITCH: A single hot short. I am picturing that at some point the circuit must be common to all four valves, and then you have got a cable going out to each and every valve, but at some point I would think that there is a commonality there. Is that not the case?

MR. CUMMINS: Maybe I can help. The ADS valves, each are in two pairs, and one pair that we have four actuation divisions. So one pair is actuated by both A and C actuation divisions; and the other pair is actuated by B and both B and D actuation divisions.

So the two valves are in one steam generator compartment, and the other two valves are in the other steam generator compartment. I don't know absolutely the answer to your question, but I would believe that it might be possible to actuate two of them, but it is not possible to actuate four of them.

MEMBER LEITCH: Okay. Thank you.

MR. SALTOS: The other outstanding issue is certification requirements. As I said before, an important objective of the AP-1000 PRA review is to use PRA results and insights to identify certification requirements.

And this is done by identifying important safety insights, related to design features and assumptions made in the PRA, and use such insights to support certification requirements, such as ITAACs, TS, D-RAP, and COL action items.

And to support the process used to determine appropriate regulatory treatment of non-safety systems. The identification of certification requirements requires integrated input from uncertainty, importance, and sensitivity studies.

And based on that we, we performed sensitivity studies to see how important is the issue, and do an importance analysis also to identify the importance of the issues.

And based on all this integrated results from this important sensitivity analysis, we decided what kind of certification requirements are important that we will to at future plants that we will have to achieve.

CHAIRMAN APOSTOLAKIS: Were you here this morning when we discussed the PRA?

MR. SALTOS: Partly.

CHAIRMAN APOSTOLAKIS: Were you here when we discussed the issue of common cause failures?

MR. SALTOS: Yes, I was.

CHAIRMAN APOSTOLAKIS: So that could be one of those?

MR. SALTOS: Yes. Yes. The common cause failures, you cannot do a PRA basically if you do not use common cause failures. You have to start with some number.

CHAIRMAN APOSTOLAKIS: The issue was can you do a common cause failure analysis on a generic basis.

MR. SALTOS: We do a generic basis, yes.

CHAIRMAN APOSTOLAKIS: And are you saying a requirement is that when you do the plant specific PRA to pay particular attention to it?

MR. SALTOS: Yes, you have to have a starting point. If they build the plant at the beginning, you have no information, plant specific information, and the staff will start with this.

So the safety for the human reliability

analysis that you talked about, we did sensitivity analysis and taking actually all the -- assuming that the operator would not do anything, and the risk increased, but it didn't increase that much like the operator in the plants.

The other sensitivity analysis we did was that we increased the operator and error probabilities, the human error probabilities, by a certain factor, and we saw that it didn't make much different; or if it did make any difference, that was part of our integrated process of defining sites and requirements for the design, like training procedures or whatever would be necessary.

Although I don't think that for AP-600 and also for AP-1000 that human errors are not as important as operating (inaudible).

MEMBER KRESS: As I recall, they assumed that the operator wouldn't do any of its required actions, CDF increased by a factor of 60.

MR. SALTOS: Something like that.

MEMBER KRESS: How do you decide whether that is okay, or that is --

MR. SALTOS: Well, it is not okay. It is an insight, and it tells you that this design does not rely on operator accidents as much as operating accidents.

CHAIRMAN APOSTOLAKIS: But this is based on the operator actions that have already been identified.

MR. SALTOS: Yes.

CHAIRMAN APOSTOLAKIS: Have you looked for possibilities of errors of commission?

MR. SALTOS: Well, I guess that was a long time ago, and we based this review on AP-600, and we didn't look for additional, unless it was due to some differences in the design.

CHAIRMAN APOSTOLAKIS: But now we come back to your earlier point that now we may have new information.

MR. SALTOS: Well, I don't think we have any new information that would change the results.

CHAIRMAN APOSTOLAKIS: There are NEUREGs where your colleagues on the staff compiled errors of commission in operating reactors. Wouldn't it be worthwhile to look at some of those and look at the general conclusions that your colleagues reached and see whether any of that would be applicable here?

Because, you know, I understand and appreciate raising the probabilities to one of identified human errors, but that would also be an additional investigation that would give us this warm feeling that these are better machines.

I mean, the NEUREGs exist and they have executive summaries, too, if you don't want to read the whole thing, and they say this is what has happened the last 15 years for such and such a reason.

And with a focus being on the NRC Commission, and that is part of the ATHENA effort, and the Office of Research.

MR. SALTOS: We considered some errors of commission at the time, but --

CHAIRMAN APOSTOLAKIS: On the AP-600?

MR. SALTOS: Yes, I am talking about the AP-600. But that involves the way of going against the procedures, and doing something that you are not supposed to do. It is not very easy to quantify probability anyway.

CHAIRMAN APOSTOLAKIS: And the rest of it is? Come on. You are talking about passive systems, and you are talking about all sorts of things here. And you can do a qualitative analysis.

MR. SALTOS: Yes.

CHAIRMAN APOSTOLAKIS: Like over there, I think one of the errors is throttling the high pressure injection system, and here can that happen?

Could they be asked to intervene and do that? I think that this kind of qualitative analysis would be useful.

MR. SALTOS: I think we did some of that for --

CHAIRMAN APOSTOLAKIS: You don't have to tell me that you have done it. Do you agree to do it?

MR. SALTOS: We asked for that, and we did not -- we don't find any mechanism that the operators would so something, and it was very likely to do something that would pose --

CHAIRMAN APOSTOLAKIS: But people are very creative and that is what I am saying. If you go back to the actual experience, you might see something where you say, gee, I didn't think of that, but it can't happen here because.

MEMBER KRESS: Is it the fact that they are only considering one operator in the control room change your perception of what the human error probability might be, rather than having a team of 2 or 3 operators? Is one person more likely to have a human error than if you have a team looking at the thing?

MR. SALTOS: Sure. Absolutely. It could make some change, of course, but I think that was included in the methodologies that were used to assess the human error probabilities.

MEMBER SIEBER: When we say one operator, that sort of misleading. There is an operator, but there is also a licensed supervisor.

MR. SALTOS: Yes.

MEMBER SIEBER: And the licensed supervisor is telling the operator what to do, and so the interchange between the two has a tendency to reduce the human error.

MEMBER KRESS: Or increase it. I mean, I am going to do what my supervisor tells me, whether I think it is right or not.

MEMBER ROSEN: No, I don't think so.

MEMBER SIEBER: Well, you are a different guy than me.

MR. SALTOS: But the important thing that we found --

MR. CORLETTI: Nick, excuse me, this is Mike Corletti from Westinghouse. On this subject of human errors of commission, for AP-600, one of the issues that was raised by the ACRS was to address issues of adverse system interactions, and we prepared a topical report on that, where we did the systematic approach of system interactions. Included in that evaluation was a qualitative assessment of the effects of human errors of commission, and as part of one of the RAIs that we received for AP-1000 was to repeat that systematic assessment, which we have included, and we just submitted quite a bit of information, and it probably has not been looked at yet.

But we have gone through that same -- it is a qualitative assessment of human errors of commission for AP-1000.

CHAIRMAN APOSTOLAKIS: Well, that is all that I am asking for.

MR. SALTOS: That is part of the PRA though.

MR. CORLETTI: It is no part of the PRA. It is part of the adverse systems interaction and evaluation. It is part of what we submitted.

CHAIRMAN APOSTOLAKIS: Yes, but you can go to the PRA and if you judge that some of them are credible, look at the LOCAs and ask yourself what happened.

MR. CORLETTI: It was written by Selim, and so it is part of our PRA, but it is not an official part of the PRA as far as it was not submitted with the PRA.

CHAIRMAN APOSTOLAKIS: Well, the staff

could do that.

MR. SALTOS: Well, yes, we concentrated our review to the differences, and this was not a difference between the AP-600 and the AP-1000. We have done some for AP-600, and that was seven years ago. I don't remember the details.

But I don't remember coming up with some scenario that would be very likely.

CHAIRMAN APOSTOLAKIS: And I agree. All I am saying is that just in the fire case, you argued that there is this additional information now that came from EPRI and maybe there exists additional information from the ATHENA project.

All you have to do is pick up the phone and ask for the report, and look at them, and evaluate it.

MR. SALTOS: The only difference is that the spurious situation was a big issue for AP-600. The human error probabilities and human error analysis was not that important.

CHAIRMAN APOSTOLAKIS: And you may conclude again that --

MR. SALTOS: We changed the human error probability by a factor of 10, and it would make a difference in the CDF by 11 to 50 (sic) percent or something.

CHAIRMAN APOSTOLAKIS: Again, it is the errors that they have already identified and what I am talking about is new errors.

MR. SALTOS: Okay. Yes.

CHAIRMAN APOSTOLAKIS: Are you saying that you don't want to do it?

MR. SALTOS: No, no. We will look at that in the future.

CHAIRMAN APOSTOLAKIS: Very good. That is all that I am asking. Why are we arguing here, just because of the national origin? Thank you, Bill. You pay attention, I see.

MEMBER SIEBER: I sure would like to go back to the question of the ADS, because I don't understand it.

CHAIRMAN APOSTOLAKIS: Of course.

MEMBER SIEBER: If I look at Westinghouse slide 16, that is a schematic of sorts, and they chose the ADS, and it seems to me that there is two valves on each train, and two trains on each route; is that correct?

MR. SALTOS: Yes.

MEMBER SIEBER: And then someplace else I heard that it is a DC system that is ungrounded. So if you have a significant hot short, with two valves in a series with different control systems and an ungrounded DC system, I don't know how you can get a single hot short and make that train operate. Maybe somebody can explain that.

MR. CUMMINS: It is not related to the ungrounded DC system. The valves are actuated with the PMS, which is an AC system, which came from DC power.

MEMBER SIEBER: Yes, but this is way back, the PMS>

MR. CUMMINS: The PMS does the arming.

MEMBER SIEBER: That is the logic end of it, right?

MR. CUMMINS: Right.

MEMBER SIEBER: And that is still DC and the output of the PMS.

MR. CUMMINS: There is no DC. The PMS runs on AC.

MEMBER SIEBER: Yes, the input.

MR. CUMMINS: The power to actuate the squib valves comes from the AC power of PMS. In some kind of charge capacitor comes conceptually way, and then also closes a switch conceptually way, both with AC power.

MEMBER SIEBER: But these are all signal strength, as opposed to tower strength?

MR. CUMMINS: Right.

MEMBER SIEBER: I mean, they are high on (inaudible) and global recert.

MR. CUMMINS: Right.

MEMBER SIEBER: And they are physically separated, right?

MR. CUMMINS: I believe that we agree with elements of that, and I think we are still under discussions with the staff as far as what are design really is, and whether this is an issue. I think the issues that have been raised in the industry reports are related to these hot shorts to ground, which don't really apply to this application.

MEMBER SIEBER: Well, maybe as a way to help me out, we are going to talk about this stuff at another meeting sometime, and maybe somebody can come back after they have looked at the wiring, and look at the physical locations, and explain to me how many shorts you actually have to have to make these systems operate. More than one.

MR. CUMMINS: That is what we would like to do. We have experts in this and I think we believe actually that it is essentially impossible to -- we are way lower in probabilities to do this, but let the expert explain it to you, and not me.

MEMBER SIEBER: And I would like to believe whatever the truth is, and I think you have to look at the circuits and the spacial relationships.

MR. CUMMINS: Yes.

MEMBER SIEBER: Okay. You have answered my question.

MR. SALTOS: There are several outstanding issues that have the potential to either individually or collectively to affect PRA results, and change certification requirements. with respect to AP-600, such as written requirements, for example. Examples of such issues are initiating event frequency changes.

For example, for large LOCAs, we talked about this this morning. The initiating event frequency changed by a factor of 50 or so. Maybe it is based on the NRC's contractor report, but I don't think that it is the NRC's position.

And additionally it includes more uncertainty, and uncertainty also has to be considered in the decision making process. And the same thing for the steam generator and tube router, and the PRHR-TR, and while the tubes and the number of hidden areas increased, the frequency decreased.

Another issue is the late containment failure modeling issue, which has to do with the passive containment cooling, and if there is no water cooling available, the success criteria for just air cooling are not -- we are not sure that the containment would survive and it is possible that containment failure would occur, and how that would impact core damage in the long term.

Westinghouse agrees with us with uncertainty as a sensitivity standard, and that the core damage frequency would decrease by 29 percent. Therefore, it is not big.

But on the other hand, for the (inaudible) of non-safety system failure persists when we don't credit the non-safety systems, this might be much larger than 29 percent.

And another issue that we have been discussing about is the common cause failure probability of explosive squib valves, which I related to safety injection line breaks, when one line is gone and you have just one line.

The common cause failure probability was calculated as 2 of 4 valves that are in the line that is not available anymore, instead of 2 of 2. And this makes quite a bit of difference in the results.

And what I am saying here is that if you combine the impact of all of this outstanding issues, some results might change and some of the conclusions could change regarding the certification requirements with respect to AP-600, of course, and also of course RTNSS.

CHAIRMAN APOSTOLAKIS: AP-1000.

MR. SALTOS: Well, we started with AP-600 and basically unless there is some difference because of the design difference, and they impact the PRA more, or the same, and we start with a list of certification requirements that we have for AP-600, and update that to reflect the changes, and the impact on the PRA.

CHAIRMAN APOSTOLAKIS: Is it a true perception of mine that you really are not dealing with any show stoppers? You are dealing with it down to the detail level, imposing additional requirements, and this and that, but you don't have an issue that might say, no, this is unacceptable, and you guys go back to the design boards?

MR. SALTOS: Well, yes, that is my feeling on this. Yes, I don't feel we have any, but we have to do this to make sure that we might help some important issue.

CHAIRMAN APOSTOLAKIS: Absolutely. You are doing your job, yes. Is that it?

MR. SALTOS: Yes, and we received a response from Westinghouse on this issue and it is under review, and we are working on this. This concludes my presentation. Any other questions to me?

CHAIRMAN APOSTOLAKIS: Thank you very much.

MR. BURKHARDT: This is Larry Burkhardt again, and the next staff reviewer or presenter will be Walt Jensen, discussing PRA success criteria.

CHAIRMAN APOSTOLAKIS: Who is Ms. Marie Pohida?

MR. BURKHARDT: She is to my left. She will be discussing shutdown PRA after Walt.

MR. JENSEN: I am Walt Jensen, and I work in the Reactor Systems Branch of the NRR, and I have been looking at the thermal hydraulic basis for the PRA to see if things are to be a success.

CHAIRMAN APOSTOLAKIS: Let me say something here.

MR. JENSEN: Sure.

CHAIRMAN APOSTOLAKIS: Were you here when they made the presentation on the thermal hydraulic --

MR. JENSEN: Yes, I was here.

CHAIRMAN APOSTOLAKIS: We are trying to save some time because we have an extra thing that we have to take are of as a supplement. Would you please not repeat things that we have had already and go directly to what you feel are your important points.

You don't have to tell us again how they did it,and so --

MR. JENSEN: No, I will not go into that. I am going to go very fast if you don't mind.

CHAIRMAN APOSTOLAKIS: Yes.

MR. JENSEN: I will move right along, and as you said, we have had a lot of discussions about the MAAP code, and we haven't -- we viewed the MAAP code, but it has been accepted as a tool to use as a scoping analysis.

Westinghouse benchmarked MAAP against their licensing codes for AP-600, and the results were about the same, but there were some differences in the defined structure of the sequence and the timing of when the systems actuate. But the overall conclusions were about the same.

We requested justification that the AP-600 benchmark using MAAP are valid for AP-1000, and Westinghouse promised to provide that to us. The minimum success paths, and these are the low margin sense of equipment that Terry talked about, and a lot of these were identified using MAAP and we think that they should be benchmarked against the licensing codes.

We asked for a sensitivity study for AP-600, and Westinghouse instead chose to use the bounding approach, and they used the same approach for AP-1000.

MEMBER KRESS: Why did they use MAAP? Was it because it runs so much faster than these licensing codes that they can run a lot more data and less failure?

MR. JENSEN: Yes, sir, I think it runs in just a few minutes, where I know it takes RELAP, and we have to run that all night to get the same sequence. So you are going to run 500 sequences and you would never get through using RELAP.

And we feel that all the limiting success paths that it would identify with MAAPS, and it would be verified with the licensing code. Westinghouse, of course, feels that the ones that are of very low risk are important for the PRA and don't need to be (inaudible) with the licensing codes, and we are reviewing the risk of the low margin. And we agree with Westinghouse that they are indeed of low risk.

CHAIRMAN APOSTOLAKIS: It is interesting that you do this for the thermal hydraulic analysis, but not for other elements of the PRA.

MR. JENSEN: I can only speak for the thermal hydraulics. I really don't know what is done in the rest of the PRAs.

CHAIRMAN APOSTOLAKIS: It is a loaded and unfair question and you handled it very well. You say we have reviewed MAAP4, but they are doing it, and Mr. Saltos just told us that we are using the PRA insight, and so is all of this allowed because PRAs are not formally required by the regulations?

MR. BURKHARDT: It is formally required.

MR. JENSEN: Well, we have done some review and it has been benchmarked against the licensing codes, and we have a pretty good feel about it. But we just would like to see the end states to be verified by the licensing code.

CHAIRMAN APOSTOLAKIS: But there is a slight conflict though, because the licensing codes are currently conservative, and the PRA is supposed to be at least, right?

MR. SALTOS: This is Nick Saltos. Let me see if I can answer that. Because of this (inaudible) and the magnitude of the uncertainties, not addressing and having the conservative success rate criteria is the equivalent of having some addtional failures in the PRA that would increase the CDF.

CHAIRMAN APOSTOLAKIS: You are doing fine, you know.

MR. SALTOS: Because some of them would be much more significant in other areas, and the success criteria in the PRA are a very important part of the PRA, and if the success criteria is best estimate, then basically you don't have a good PRA.

CHAIRMAN APOSTOLAKIS: But on the other hand, here is this agency spending a few millions of dollars developing the ATHENA methodology for human error analysis, and they have convinced this committee that there is such a thing as an error forcing context, and that it could be very important. And how we are about to certify a design, and we don't even mention it that there is such a thing as an error forcing context.

And I don't know. Are there any error forcing contexts here? Was the NRC wasting its time and money when it was sponsoring that major project for years? I don't know. I mean, we seem to live in parallel universes. I am not complaining, even though it sounds like I am complaining.

But I think this committee at some point -- I am planting a seed now, Mr. Jensen. This committee at some point has to face that problem. I mean, the Office of Research is not a separate pipe there that is empowered to add to the others, and the real work doesn't require what they are doing.

I mean, for years now we have been hearing about the error forcing context and I am perplexed. Do we have any error forcing context here? I never even heard the word. So let's go on.

MR. JENSEN: Well, perhaps we are hearing a conservative PRA because of the bounding approach that Westinghouse has taken.

MEMBER SHACK: Let me just say the large break LOCA is treated by a best estimate code, right? And the small break LOCAs are treated by an Appendix K type code; is that correct?

MR. JENSEN: That's true. WCOBRA-TRAC for --

MEMBER SHACK: And you would include your uncertainties in your analysis reports?

MR. CORLETTI: Right.

MR. JENSEN: Okay. The purpose of this slide is to say we have benchmarked some of the NOTRUMP PRA calculations, and PRA bounding calculations with RELAP, and these had numerous failures and which resulted in some (inaudible) in the second case, and for a fairly extended time, but Westinghouse checked or calculated the peak cladding temperature of around 1500 degrees, and we calculated less.

But to me this shows the robustness of the plant design for small break LOCAs, and that all these failures can occur and still (inaudible).

And this is just a sample of a comparison between RELAP and NOTRUMP.

Well, it is amazing, the same results. This is just impressive, but the passive systems are operating on about the same sequence, and the controller is decreasing the pressure. So this is very gratifying.

We did one comparison with MAAP, which is not such a limiting scenario, and it only fails one accumulator, and one of the four ADF4s, and it does consume containment isolation failure, which it just imposes the atmospheric pressure on the steam within the reactor and so the ADF4 is effective in relieving the steam from the reactor system.

Now, we don't get such a good comparison with MAAP, and the MAAP calculation is a lot higher than RELAP, until all of a sudden ADS4 comes on somewhat earlier than RELAP, and the pressure just goes dropping like a stone as you see.

Again, ADS-4 actuates earlier than MAAP, and a lot more flow of course puts the pressure higher when ADF-4 does actuate. And the break flow is about the same idea, but in MAAP undergoes sudden changes between high and low, which I believe is simplifying assumptions used in the code that switch the quality from a two-phased mixture to a separated flow, and that does it very abruptly in there.

So basically the conclusions from the staff audit calculations are NOTRUMP and RELAP, you get about the same answer, and they show predicted for one case, and both codes predicted brief periods of core uncovery, which were within acceptable limits.

MEMBER KRESS: So you are saying then that RELAP results are in your mind a good representation of the codes that they are going to use, so that your comparison of RELAP and MAAP gives you some indication what they might get when they do their comparison?

MR. JENSEN: I think so and when they compare MAAP to NOTRUMP, they are going to get about the same results that I get with RELAP, because RELAP and NOTRUMP seem to be getting equivalent results.

MR. JENSEN: And then we have reviews still going on, and we have unresolved issues. Westinghouse claims a failure with one of the ADS4,and they can withstand containment isolation failure, and still cool the core and long time cooling, and we have asked for that to be verified.

This is one of the scenarios though, and that i believe Westinghouse says is very low risk and the risk is so low that it is inconsequential. So we are working with that.

We are looking at the scenario where the 18 inch vent line opened in the containment, and the containment is not isolated and a LOCA occurs, is there still enough water contained within the containment building to keep the core cool, and Westinghouse analyzed that with MAAP.

Again, we would like that to be verified with one of the licensing codes, like WGOTHIC, and we are wondering about maybe some entrainment might occur from a larger break and it might get carried out of the open vent, and they are going to respond to that.

MEMBER KRESS: Where is the vent? Is it physically in containment, or are you just postulating any kind of event?

MR. JENSEN: I don't know. I don't know

whether Westinghouse postulated that.

MEMBER SIEBER: Usually you can't get entrainment unless you are pretty close to where the surface is.

MR. CUMMINS: That is how we are going to answer the question. It is assumed to be an HVAC vent, the largest existing design penetration on the containment.

MEMBER KRESS: ADS-4 discharges a sonic velocity choke flow, and how does the containment pressure influence this, in terms of whether it is isolated or not?

MR. JENSEN: Well, at first there would be choke flow, but then later the flow would become non-choked.

MEMBER KRESS: But that would be way out at the end of the thing wouldn't it?

MR. JENSEN: It is my understanding that the reason --

MR. CORLETTI: It becomes unchoked below a hundred psi as far as the reactor coolant system pressure.

MEMBER KRESS: Well, that sequence is over.

MR. CORLETTI: For large breaks, during

the PCT for a large break, I think you are right, the pressure is higher. For the key area that we were thinking of, which was for small break, was at the time of IRWST injection, and it isn't choked at that point.

MR. CORLETTI: I don't think it takes very long for pressure to get below a hundred psi once we go to stage 4 ADS.

MEMBER KRESS: Yes, it comes out of there pretty fast.

MR. JENSEN: Then Westinghouse has used the AP-600 analysis to justify some of the success paths, and we have asked that these be verified to be applicable to AP-1000 and they are going to provide us with that.

And then last of all, we are reviewing the risk significance of the unbounded cases and the expanding event trees to see if we agree with the risk, and if it is success to have these low risk paths to be unbounded by analysis with the licensing codes. And that concludes my presentation.

CHAIRMAN APOSTOLAKIS: Good job.

MEMBER KRESS: Looking at the ADS4 results, compared to RELAP for a couple of these cases, it looks like in my mind that the MAAP 4 is conservative from the standpoint of whether or not the core gets uncovered, compared to RELAP, and would that be your assessment?

MR. JENSEN: I don't know. Both of these --

MEMBER KRESS: The pressure stays up higher, for example, in this.

MR. JENSEN: The pressure was higher.

MEMBER KRESS: And to me that means that you are getting less injection coming in and probably less going out the relief valves. I don't know if that means more coming out of the relief valves and less injection coming in. That is what I would assume that higher pressure does to you, which means that the core is uncovering more.

But an auxiliary question to that is have you looked at MAAP to see why it has this difference?

MR. JENSEN: No, sir, we have not reviewed MAAP in detail. We haven't been funded to do the review.

MEMBER KRESS: It would take a pretty big effort wouldn't it?

MR. JENSEN: And I know that there are some user functions in map that the user can tune the results to get the appropriate answer, and I would suspect that Westinghouse is keying the MAAP input to pretty much follow NOTRUMP as close as they can. So this is why we sort of get the same answer with RELAP.

But there was no core uncovery in either MAAP or RELAP, and so I can't really say which is the more conservative, but as you say the pressure is higher, but perhaps if there were more leak flow, and I guess they did get about the same leak flow. It looks like suddenly that maybe the quality switches, and the voids are collapsed, and the liquid is coming out of the break. I am not sure what it is doing.

MEMBER KRESS: Yes, I don't know what causes those things. Does MAAP use the same critical flow model that RELAP does?

MR. JENSEN: I don't know. Westinghouse can pitch in.

MR. SCOBEL: This is Jim Scobel from Westinghouse. MAAP uses Henry Falsky for critical flow. I don't know what RELAP uses.

MR. JENSEN: Thank you, Jim. All right. Well, if there are no more questions, then Maria Pohida will talk about --

MEMBER RANSOM: Mr. Chairman, I don't have a question, but I do have a comment.

CHAIRMAN APOSTOLAKIS: Sure.

MEMBER RANSOM: It seems to me that there is an awful lot of subjectivity in the selection of cases that are used for bounding or checking for whether or not damage would be expected in these calculations between the, say, simplified methods and the more detailed methods.

And there are enough cases and history where subjectivity engineering judgment has been wrong to make me at least a little bit nervous about that. And I don't see why you wouldn't apply a statistical approach to something like this in a sampling, and there are very good methods for telling you how many cases you actually have to check in order to achieve a given confidence level in the result.

And that would it would seem to me to provide a lot more tighter justification for whatever reliability you want to place on such calculations. Whereas, simply choosing a few and sampling may give you a warm feeling, but it doesn't really to me at least tell me where I am at in terms of reliability of those results.

MR. SCHULZ: This is Terry Schulz, Westinghouse. I don't think I understand what you mean by subjectivity in choosing cases. I think that I or at least I tried to show you a very systematic way that we selected the low margin risk important cases, and that was not subject to engineering judgment or sampling.

MEMBER RANSOM: I think a better way would be to statically choose these cases, which gives you a method then for providing a convincing argument on what degree of reliability or confidence level you can place on those.

MR. SCHULZ: We may be able to do that.

MEMBER RANSOM: To give you an example. For example, when NASA fires a rocket, they will fire it a few times and then measure the specific impulse that they obtain, and from just a few samples, you can actually get a randomly chosen -- this would be with a solid (inaudible), and then with a high degree of probability predict what the expected performance from those additional ones would be. And they do use those such approaches.

And I would think that you could do the same thing here, unless you can by some other course, if you never depressurize the system, and you would never expect any 2-phased uncovery of the reactor vessel, and you could rule out cases like that presumably.

But if there are cases where you might

suspect that there could be core uncovery, and yet you want to use the simplified methods to explore a large number of cases, then you should be able to statistically sample that large number and benchmark them I guess against your more detailed code, and then tell a person to what degree of reliability you can rule out a possibility of core damage as a result (inaudible) --

MR. CUMMINS: Can I just clarify how we selected? We selected as low margin every case where MAAP predicted core uncovery. We didn't sample.

Every case where MAAP predicted core uncovery, we put it in the low margin bin, and then we tried to disposition that and either as significant to the PRA or not significant to the PRA. And if it was significant to the PRA, we used our DCD analysis codes.

MS. POHIDA: Okay. As I was introduced earlier, I am Marie Phida of the PRA group at NRR, and I am the current reviewer of the AP-1000 shutdown PRA. My review of the AP-1000 shutdown PRA is based on my review of the AP-600 shutdown PRA.

I issued several RAIs and many of them focused on changes from the AP-600 PRA to the AP-1000 PRA, and that includes common cause failure. the probabilities and the grouping of the high pressure gravity injection squib valves, and the high pressure recirculation squib valves.

They were put together as a single common cause failure group. This failure is risk significant, and appears in many of the dominant sequences of the shutdown PRA.

Shutdown risks for the AP-1000 design as you probably heard this morning is dominated by failures of the normal R&S system or the failure of the support systems during drain maintenance outages.

MEMBER KRESS: What CDF do you get from shutdown?

MS. POHIDA: It was 1,23, 10 to the minus 7.

CHAIRMAN APOSTOLAKIS: About 30 percent then.

MS. POHIDA: And with the bulk of that, 60 percent of that, occurring during drain maintenance operations. So because the path charged system is not available, the first three stages of the ADS valves are open, and what you have is if you were to have a loss or interruption of the residual heat removal system, or the R&S system, what you have left is gravity injection.

If it fails to go automatically, then the operator can try to initiate injection manually through the IRWST injection lines, or initiate injection through the R&S suction valves, the R&S lines.

Also, the RAI also focused on common cause failure of the low pressure recirculation squib valves, and once again since recirculation is required, following a loss of the operating train of (inaudible) during mid-loop operation, you need successful gravity injection and recirculation.

My review also focused on shorter response times for operator recovery actions, and these include containment closure, and containment closure is required to maintain long term cooling water inventory.

And specifically we have reduced times to boiling and it is now 17 minutes, and it was 17 minutes in the AP-600 design, and it is now 10 minutes for AP-1000 design. The containment closure capability is covered by the AP-1000 tech specs, shutdown tech specs.

MEMBER ROSEN: How do they have a containment open? Do they have the equipment hatch open during mid-loop operations? What are you assuming?

MS. POHIDA: I can't remember if I assumed that analysis, but that is also part of my RAIs, is basically how did you arrive at your containment failure closure probabilities, okay? So that is still part of my review.

MR. CORLETTI: If I could, I could address it. Our tech specs are to the opening of the equipment hatch to a time to boiling based on the amount of decayed heat that would be in the core.

So that for periods of time where the time for boiling would be rather short, the containment equipment hatch would have to be in place and would not be allowed to be open.

And that takes into account the decayed heat level and the inventory, and the water if it is a mid-loop operation.

MEMBER ROSEN: But operating practices say that you don't open the containment hatch while you are at reduced inventory.

MR. CORLETTI: That's right, and if you apply that criteria that would be the outcome for AP-1000. But it is based on a criteria with low -- say after a long refueling, and you were coming back up, and you wanted to go to bin loop, and you didn't have a lot of stored energy, it would take a long time for boiling.

And the equipment hatch would be allowed to be opened.

MEMBER ROSEN: Back-end mid-loops.

MR. CORLETTI: Yes.

MEMBER ROSEN: But these days back-end mid-loops occur -- the average durations are getting so short, and I don't want to go to AP-1000, but on current plants, the difference between back-end and front-end is 20 days.

MR. CORLETTI: And really the way that the tech spec is set up is that you have to ensure that you would have adequate time to close containment before you would have steaming. So if the timing is such that you cannot show adequate time, you would not be able to have the equipment hatch open.

MS. POHIDA: Okay. Well, this whole containment closure issue still is under review there, because it also impacts -- what about release, and in the event of a severe accident at shutdown, and you were for some reason unable to close your containment, what is your source term, and what is your release frequency if you will.

So that is still under review, that whole area, okay? The shorter response times also impact gravity injection, manual gravity injection. To me this issue is secondary to the primary issue, which is containment closure, because the low shutdown risk estimates that are reported in the AP-1000 PRA stem from the fact that you have automatic injection, which is much different that we currently have at operating plants.

Once you have low level in the hot leg, your ADS4 valves open up, and you have automatic injection from the IRWST. We also asked some additional questions and one was trash control during shutdown, and once again recirculation required to maintain a long term cooling water inventory, and we wanted to make sure that trash was controlled so that the common cause failure estimates for the sump strainers plugging up made sense.

There wasn't a shutdown fire or flood risk assessment that was provided to the staff and once again our concern is that during shutdown you have a lot of people moving around the plant, and you may have fire barriers that are breached or open while people are performing maintenance or testing.

So that is another area of our focus, and what I would like to say is that we have not seen any show stoppers as of yet, but we are still have not completed our review and that ends my discussion.

CHAIRMAN APOSTOLAKIS: Did you also raise all the human error probabilities to one to see what happens to the core damage frequency?

MS. POHIDA: Okay. I am trying to think. With the AP-1000 design, Westinghouse didn't report any importance analyses. Now, based on the results of the AP-600 importance analyses, there was not a tremendous change in CDF.

There was not a lot of liability associated with the automatic gravity injection.

CHAIRMAN APOSTOLAKIS: How about a larger release frequency? The containment closure issue.

MS. POHIDA: The containment closure issue?

CHAIRMAN APOSTOLAKIS: They never close it. What happens? I wonder whether the same sensitivity analysis that was done for level one power would show that even if all the humans make mistakes all the time, still the core damage frequency is low and the LERF is slow, and that applies to low power and shutdown operations.

Maybe you want to think about it. You don't have to answer now, but that is certainly something that I would be interested in knowing.

MS. POHIDA: Well, that's why I am bringing it up on the slide, because of that tech spec, which is supposed to say that you are not going to open anything up unless you can get it closed before the RCF begins to boil, no release frequencies for shutdown were reported.

And I agree with you that during my review that I need to make sure that that still makes sense, in light of that now the boiling takes 10 minutes. It is almost half of what it was in the AP-600 design.

CHAIRMAN APOSTOLAKIS: Okay.

MS. POHIDA: And that's it.

CHAIRMAN APOSTOLAKIS: Any other comments to Marie?

MR. CUMMINS: I am not sure we quite understand the containment closure. If it took -- let's say it takes an hour to close an equipment hatch, what the tech spec says is that -- and let's say it takes us as she said 10 minutes to get to boiling, you cannot open the equipment hatch until it takes an hour to get to boiling if it takes an hour to close the equipment hatch.

So you have to sort of measure your decayed heat, or calculate your decayed heat, and you can only open the equipment hatch at mid-loop if the time to boiling is longer than the time to close the containment. So in this case the time is protected by the tech spec, and I suppose you could still argue or we could always ask what happens if the operator fails to follow the tech specs.

And that is sort of beyond what we normally do in the PRA. We assume tech specs, I think.

CHAIRMAN APOSTOLAKIS: Well, you have a certain period of time and you are asking what is the probability that they will actually do it in that period of time.

And I am a little concerned about all these sensitivity studies that are so extreme. They work here and so we advertise them as look, we found the problem. We set all the human error probabilities to one and nothing happens. That creates a precedent, and what if something does happen and you do that to low power shutdown.

And then you back away from it, right? And you say, well, that was too much. I will do something else. And that makes me a little uncomfortable with the whole thing.

MS. POHIDA: Well, those importance

analyses that I was referring to for the AP-600 design, that didn't cover containment closure. That only covered the level one portion of the analysis.

CHAIRMAN APOSTOLAKIS: Anyone, you are reviewing AP-1000.

MS. POHIDA: Yes.

CHAIRMAN APOSTOLAKIS: And your final determination will not be I hope that this design is as good or better than AP-600. I mean, it would be an absolute determination won't it?

MS. POHIDA: Yes.

CHAIRMAN APOSTOLAKIS: You are using AP-600 for convenience, but it will be an absolute determination.

MR. BURKHARDT: That's correct. It will be a stand alone evaluation based on the AP-1000 design. We may discuss some differences to the AP-600, but the evaluation will based on the AP-1000 design.

MS. POHIDA: And the insights that we generate will be based on the AP-1000.

CHAIRMAN APOSTOLAKIS: Okay. Any more comments from the members? Any questions for Marie?

MR. CORLETTI: No, I don't have comments for Marie right now.

CHAIRMAN APOSTOLAKIS: From the NRC staff? No. Thank you very much.

MS. POHIDA: Thank you.

CHAIRMAN APOSTOLAKIS: And how it is back to you.

MR. CORLETTI: I think we can wrap up today's meeting. I don't think that they are that crucial, but I have some slides.

CHAIRMAN APOSTOLAKIS: How many do you have?

MR. CORLETTI: Three, but I think I will just wrap this up in five minutes. I think just in the next several slides really characterize the areas that the RAIs covered, and the RAIs related to the PRA.

And just to clarify with our answers, we did make changes to the PRA that we submitted with the RAI responses, and we collected those changes to incorporate them all into the PRA.

We expect to be able to submit the PRA with those revisions by the end of this month, the end of January. I think we have listened to the staff and the issues that were characterized I think all are in progress.

And I think we are working with them to

resolve those. I think what I have heard from this committee in regards to additional information that you might want to hear, or we want to hear, is on the ADS valve, and to me it sounds like we want to hear about the valves, the developed design features, and how it works.

And also the issue of the control and how the power to valve, and how we have attributed spurious actuation hot shorts, and I think we could handle that in the plant meeting later.

MEMBER ROSEN: But also on the valve, and not just how it works, and the design, and the likelihood of stress corrosion cracking of the seam, and other issues of vulnerability of materials, and what the reliability numbers for the valve.

MR. CORLETTI: And the basis for those.

MEMBER ROSEN: And the basis for those.

MEMBER SIEBER: And how to get explosives past the security guard.

MR. CORLETTI: I guess I would then like to open it back up to you. Is there additional items that you have heard today that you think rise to that same level that you need more information? Otherwise, I don't think I have anything else at this time.

CHAIRMAN APOSTOLAKIS: But you are not

ignoring the other minor points that we made. I mean, you just pointed out what you think are the most important.

MR. CORLETTI: Right. No, of course not.

MEMBER KRESS: On the squib valves, you mentioned that there was smaller squib valves like this out there in plants?

MR. CORLETTI: Right.

MEMBER KRESS: Has there been any experience on them being in place for a number of years, like 10 or so and then people taking them and testing them afterwards to see if they work?

MR. CORLETTI: Well, as a matter of fact, that is what the in-service testing requirements for squib valves that are in operating nuclear plants.

MEMBER KRESS: Yes, but that only goes to the point of they never shoot people with a bullet.

MR. CORLETTI: They test the charge.

MEMBER KRESS: Yes. And I worried about the charge deteriorating over time, for example.

MR. CORLETTI: Yes, they test the charge every -- it is in accordance with the ASME. Periodic testing, Terry, just like some percentage.

MEMBER LEITCH: They are in BWRs, and the same bi-liquid control systems, and which are fairly small. I would say they are on the order of one inch valves, ambient temperature, and as I recall the charge has to be replaced once per refueling outage, but what you do is you test and get a batch of charges, and you test a sampling of that batch, and if the sample works okay, then it implies that the charge is okay, and you use that particular charge.

MEMBER KRESS: They have been stored at room temperature though.

MEMBER LEITCH: Yes, in storage at room temperature.

MR. SCHULZ: This is Terry Schulz. ASME has specific requirements for in-service testing of squib valves, and I am not sure I remember the exact frequency, but for our ADS squib valves, we do not have to replace the charge every refueling outage on every valve.

MR. CORLETTI: It is a sampling.

MR. SCHULZ: So what we are doing is on a sequencing basis, like one valve every refueling outage, and then over a period of four refuelings, we replace every one of the charges over 6 to 8 years.

And when we replace that charge, we take the charge that was in the valve under the actual service conditions, and we go put it at a text fixture and actually fire it.

MEMBER KRESS: Okay. That is what I was interested in.

MR. SCHULZ: And that is in addition to other controls that they have put on when they make the charge material initially, and they do basic tests there to make sure that it is okay before you put it in, and then we do these post-service tests also.

MEMBER KRESS: What is the charge?

MR. SCHULZ: What material? I don't know.

MEMBER ROSEN: Well, my concern is more than just that the charge goes off, is that the valve works, and that it severs whatever, and locks over. I mean, just having the charge work and operates doesn't do you any good.

MR. CUMMINS: But we will cover this in our next meeting.

CHAIRMAN APOSTOLAKIS: It would really be refreshing to have a realistic estimate of the uncertainties in all of these things, and I am serious now. A factor of six, I don't think is appropriate here given all the judgments and so on, and this revelation that they are mean values, because as I read the report, it says here and there, and we are very uncertain about this thing and we put a factor of 10.

But given that your point estimate was a mean value, what you are telling me is that you are stretching the distribution on the low side. A factor of 10 doesn't mean the same thing with what it meant with the reactor safety standards, where You would go 10 up and 10 down. Now you are just pushing it all the way down.

And you may say this is a calculation and instead of 2 times 10 to the minus 7, you may find now 4 or 5 times 10 to the minus 7. But even with all these uncertainties and judgments about common cause failures of software and this and that, realistically is it a factor of 10 or 12, up and down, or up, and that is what I am interested in.

I mean, it would still give you below the goals, but it would be nice to have some sort of -- I mean, instead of using formal methods to propagate uncertainties that are not important to begin with, like failure rates, you have this realistic assessment at the end.

MEMBER ROSEN: Could I have one more word?

CHAIRMAN APOSTOLAKIS: Yes.

MEMBER ROSEN: Not on that subject, but

going back to the reliability and squib valves. What I am really trying to do is not to get you to do some sort of academic exercise and come back with some numbers that you can put up on the screen.

What I am really trying to do is get a solid feeling of the reliability of this valve on command that it will actually open, and that this is a valve that has not been built yet.

And at some point it would seem to me that it needs to be built and some component testing done of it before we -- and if it was a valve out in the periphery, sure, no. But it is at the very heard of the safety analysis of this plant, and that is my concern.

MEMBER SIEBER: There have been squib valves used in applications other than this one.

MEMBER ROSEN: Well, at this temperature, you know, and with these kinds of pressures, what I am trying to get before I say I am wiling to say, gee, I think this is great. I didn't sign off on AP-600, but I am going to have to be part of the process on AP-1000.

I want that warm comfortable feeling that I have great confidence in this valve's ability to function as designed.

CHAIRMAN APOSTOLAKIS: Any other comments from the members? Thank you, Mike.

MR. CORLETTI: Thank you.

CHAIRMAN APOSTOLAKIS: And your colleagues as well, and we will see you again tomorrow, right?

MR. CORLETTI: At 8:30.

CHAIRMAN APOSTOLAKIS: At 8:30.

MR. CORLETTI: Thank you.

(Whereupon, at 5:04 p.m., the meeting was adjourned, to reconvene at 8:30 a.m., on Friday, January 23, 2003.)