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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

FUTURE PLANT DESIGNS

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FRIDAY, JUNE 25, 2004

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The Subcommittee meeting commenced at 8:30 a.m., in Room T-2B3 of the Nuclear Regulatory Commission, 11545 Rockville Pike, Rockville, Maryland, Dr. Thomas S. Kress, Subcommittee Chairman, presiding.

SUBCOMMITTEE MEMBERS PRESENT:

THOMAS S. KRESS, Chairman

VICTOR H. RANSOM

STEPHEN L. ROSEN

WILLIAM J. SHACK

JOHN D. SIEBER

GRAHAM B. WALLIS

NRC STAFF PRESENT:

GOUTAM BAGCHI

STEVEN BLOOM

NRC STAFF PRESENT (Continued):

THOMAS CHENG

GANESH CHERU

JOSEPH COLACCINO

DAVID CULLISON

BOB DENNIG

ANDRE DROZO

LAURA DUDES

ROB ELLIOT

BARRY ELLIOTT

MICHELLE HART

MATTHEW A. MITCHELL

LAUREN QUINONES

SELIM SANCAKTAR

JOHN SEGALA

PATRICK SEKERAK

DAVID SOLORIO

DAVID TERAO

JERRY WILSON

ALSO PRESENT:

MIKE BATTAGLIA, Ionics, Inc.

ED CUMMINS, Westinghouse

CESARE FREPOLI, Westinghouse

R.O. GAUNTT, Sandia National Labs

ALSO PRESENT (Continued):

RANDOLPH GOUNDER, Ionics, Inc.

PAIGE NEGRES, GE

JIM SCOBEL, Westinghouse

TERRY SCHULZ, Westinghouse

JOHM TROTLER, Framatome

LEE TUNON-SANJUR, Westinghouse

RON VIJUK, Westinghouse

C O N T E N T S

P R O C E E D I N G S

(8:30 a.m.)

CHAIRMAN KRESS: This is the meeting of the Advisory Committee on Reactor Safeguards, Subcommittee on Future Plant Designs.

I am Thomas Kress, Chairman of the subcommittee. Members in attendance are Jack Sieber, Bill Shack, Steve Rosen, and Graham Wallis.

MR. SIEBER: And Vic is here.

CHAIRMAN KRESS: Vic Ransom is here also. Okay. He just arrived.

MR. SIEBER: There he is.

CHAIRMAN KRESS: Okay. The purpose of this meeting is to discuss with the NRC staff and Westinghouse representatives the AP1000 safety evaluation report, and the resolution of any open items and any ACRS lingering concerns and issues.

The subcommittee will gather information, analyze relevant issues and facts and formulate proposed positions and actions as appropriate for deliberation by the full committee.

Dr. Medhat El-Zeftawy is the designated federal official for this meeting.

The rules for participation in today's meeting have been announced as part of the notice of this meeting previously published in the Federal Register on June 14th, 2004.

A transcript of the meeting is being kept and will be made available as stated in the Federal Register notice. Therefore, it is requested that speakers identify themselves and use a microphone if possible.

We have received no written comments or requests for time to make oral statements from any members of the public regarding today's meeting.

I don't have any particular preliminary comments except to say that this is probably the culmination meeting of a long series of ACRS meetings with Westinghouse and the staff on this subject. So with that, I'll turn the floor over to the Westinghouse people to get started.

MR. VIJUK: And I'm Ron Vijuk. I manage the licensing for AP1000 in Westinghouse, and we wanted to start today with an overview of the design and some of the analysis that backs it up just as a refresher, if you will, and Terry Schulz will make that presentation.

MR. SCHULZ: Good morning. As Ron said, my name is Terry Schulz, and I hope to just throw some information up here for your consideration. You've probably seen it all before, but it will put us all on the same page.

CHAIRMAN KRESS: It never hurts to refresh the memory of the ACRS.

(Laughter.)

MR. SCHULZ: I didn't want to say too much.

DR. WALLIS: Is this an eye test on the bottom right-hand side there?

MR. SCHULZ: No, you don't have to read that. This is sort of a visual thing here, impression.

AP1000 is built on a huge investment that Westinghouse and our partners made in AP600 technology, developing and designing systems, arranging the RCS loop, introducing and developing modular construction.

The eye test down here is a very, very detailed construction schedule which I certainly don't intend to get into, but it is based on actual sort of bottoms-up, you know, piece by piece building.

The design approach results in major simplifications in the design which help construction schedule, help safety in terms of having fewer things to worry about, maintain, inspect and test. Severe accident PRA has been incorporated into the design from the beginning of the development program. AP600 has been licensed before, which is a stepping stone with a big step forward helping us go ahead with AP1000, and of course, behind it is a lot of testing that you've hear about to prove out the passive systems.

Of course, the thing about AP1000 is trying to increase the power sufficiently so that we can be competitive in the deregulated U.S. power market.

We had a lot of constraints that we put on ourselves to maximize the use of AP600 design basis and all the information we did, and in particular, the structures. We basically didn't change any of the plan view of the structures. We did have to raise the containment a bit. I'll show you some more of that later.

In our mind we needed to retain the AP600 proven component, and this, in particular, the power generation, the core, the reactor, the steam generator, the reactor coolant pumps, those things.

And of course, this all then relates to the basis and the credibility of the cost estimate and construction schedule and all of that. And of course, we had been talking about licensing with you, and we're nearing completion of that process, and having piggybacked on AP600 has obviously helped us all.

The design features, the basic design features are the same as AP600. We are talking about an integrated plant design, the proof in components, no prototype, simplified loop and canned pumps, passive systems, increased safety margins, a simplified defense-in-depth systems, the digital I&C pump at control room (phonetic), and optimize plant arrangement incorporating construction maintenance, modularization, and all of that.

CHAIRMAN KRESS: What's your experience base with hand motor pumps of that size? Have you --

MR. SCHULZ: The pumps that we were going to use in AP600 were of very similar size to what's been the latest Navy pumps in the carriers.

CHAIRMAN KRESS: I see.

MR. SCHULZ: So that size pump has got a solid, very direct basis. The pumps for the AP1000 are a little bigger. The experience that the pump designers have had in, for example, creating the Navy pumps which were a step up from pumps they had before was very good. They've developed design techniques and the test development programs that they have seem to be effective in these incremental increases in pump sizes.

So the pump for AP1000 hasn't been built exactly, but things that are near to it have been built, and there has been confidence and good experience in making, you know, such size increases.

DR. RANSOM: As long as we're asking questions, what was the nth in the cost on the first slide?

MR. SCHULZ: What's that? Six? Three, three plants.

DR. RANSOM: Or three, that's a third plant?

MR. SCHULZ: Yes.

AP1000 is going to start out at a higher level of design detail than we did in the paste. So I think we'll be a sharper learning curve.

You've seen the main loop. It is obviously a two-loop plant, four pumps. Having four pumps does minimize the size of the pumps, which helps us in incorporating the canned motor pumps.

The fuel internals, reactor vessel, are very similar to the Doel Tihange 3, which were three-loop plants with a similar power rating. South Texas has similar internals, but it's obviously a four-loop plant and a little bit bigger. There's no bottom on instrumentation. So the traditional Westinghouse movable in-core instrumentation has been eliminated. Again, this is the same as AP600.

Improved materials for 60-year life.

We have a larger steam generator, which is similar to what the Westinghouse CE type design, and in the System 80 and Westinghouse-Pittsburgh has actually built replacement steam generators of a similar size.

We talked a little about the canned motor pumps. they have a lot of benefits for the plant design in terms of new seals that can fail, can leak, and from an accident point of view, they also require maintenance of the utilities like that. So these pumps are very almost maintenance free.

There's a lot of good experience, history mostly in the nuclear Navy, but also in some earlier like shipping support in Yankee Rowe (phonetic) plants.

The main loop piping has been greatly simplified. Each leg has got a weld on either end. So there's fewer welds in between. The supports because the pumps are connected to the steam generator, they're not supported directly; just the steam generator.

The pressurizer is larger, which gives us operating margins relative to operating plants.

Approach to safety, we use our, quote, unquote, passive safety systems which do rely on realignment, a one time realignment of valves, but does not rely on any active pumps, diesels, fans to operate.

So once we realign the systems into their passive safety mode, they continue operating without the need for support systems. The only support system we actually do need, of course, is anything involved with realigning the valves. A lot of the valves are fail safe, which then means if you lose power, lose the I&C system completely, they go to the safe position.

There's a few of them, like the ADS valves which need to be powered. So we do need electrical power in I&C.

Importance of operator reactions has been significantly reduced. You can see that in some of the PRA numbers.

Design basis accidents are met with just the passive systems, without reliance on the non-safety. The PRA safety goals can be met without the non-safety systems.

We do still have active non-safety related systems for normal reactor make-up, start-up feedwater. These things reliably support normal operation. They can also minimize the challenges to the passive safety systems by dealing with anticipated occurrences. They typically have redundant active equipment powered by on-site, non-safety diesels, again, not required to mitigate design basis accidents.

CHAIRMAN KRESS: On the use of the active systems, I presume that they're being used to compensate for some transient or some accident that you don't want the passive systems to come on. Would they completely overwhelm the passive if you needed them because of the driving forces?

They probably wouldn't even know the passive systems were there, except for maybe the tanks that blow down from the nitrogen.

MR. SCHULZ: The potential interaction of active and passive systems was a significant discussion we had on AP600. A lot of the both SPES and OSU testing incorporated active features as well as passive features so that we could not only analyze, which we did do, but the tests, the potential interactions.

And basically we didn't see anything which was adverse. Now, there are some almost designed-in interactions. For example, if you have ADS, one of the things the operators are told to do is to start the shutdown cooling system in an injection mode, and that's a nonsafety feature.

One of the purposes of that is to provide a back-up in case something goes wrong, but it also avoids the need for Stage IV, and the way it does it is it interacts with the core make-up tank draining because it goes into the same line and through the same orifice that limits the same T drain down. It builds up back pressure, and as long as it's pumping, --

CHAIRMAN KRESS: The core make-up tank just --

MR. SCHULZ: -- core make-up tank stops about half full or something, depending exactly on when the operators start that, but it's still active aligned. So if the RNS stops, then the CMT would start going again, and then you'd get Stage IV, and then you'd get gravity injection of RWST injection.

So that's one interaction that was really designed into the plant, but for example, start-up feedwater to passive OHR, now those are a bit more functionally connected differently. So we don't really see an interaction.

We do have automatic signals to cut off the nonsafety features if things degrade, okay, and we really need the passive features. So if you're getting like a steam line break and you're getting excessive cooling, that signals stop start-up feedwater because that could be contributing to excessive cool-down.

Just because we start passive RHR, we don't cut off start-up feedwater, but if there's a plant condition overfilling of the steam generator, over cooling of the RCS will cut off start-up feedwater, and we do similar things with the CDS make-up to make sure we don't overfill the pressurizer because of it.

On overview of the passive core cooling system. You see all of the major components here. The passive RHR, of course, is the transient, non-LOCA decay heat removal feature. Natural circulation. It puts heat into the RWST, which is inside containment. That provides a heat sync for several hours, and then it starts boiling. The steam goes into containment, passive containment cooling system, condenses it, and it drains back into the RWST with a gutter collection system. That's all safety related.

That basically replaces the function of safety related auxiliary feedwater system in the current plan.

The passive safety injection is made up of the core make-up tanks, which are a unique feature to AP600, AP1000. These replace the high head pumps, and they can operate at any RCS pressure. For minor leaks and tube rupture they operate in a water recirculation mode, and they never really drain down in that situation.

For small LOCAs, you would eventually transition into a steam drain down mode when the cold leg is voided. For larger LOCAs that happens pretty quickly without any water recirculation.

Accumulators, of course, work similar to current plants, except they're connected to the reactor vessel directly. So for large LOCAs, you don't spill one.

The RWST injection is a very low pressure, just a gravity hit of the tank, and from a functional point of view, they really replace the low head safety injection pumps. We eventually would get into a containment recirculation, which uses the containment to drive the flow-through screens and into the --

DR. WALLIS: And presumably you have no fibrous insulation.

MR. SCHULZ: We have no fibrous insulation. That's right. We've talked about that.

DR. WALLIS: And you have a very clean containment?

MR. SCHULZ: A very clean containment. We still have screens with a good surface area. So we can tolerate some degree in --

DR. WALLIS: But you don't have much head to drive that closed.

MR. SCHULZ: We don't have much head, right. Now, current plants don't have a lot of head tolerance either because they have to supply NPSH to pumps. So I'm not sure that the head requirements are all that different.

MR. ROSEN: When you say "a good screen," do you know what square footage you're talking about?

MR. SCHULZ: It's bigger than typical plants, although that could be changing and plants vary. It's about -- the trash rack is about 70 square feet each, but the screen is a folded design which has more than twice that surface area. So it's more like 140 square feet each, each of the two screens.

MR. ROSEN: So you have 280 square feet?

MR. SCHULZ: Yes, and the screens are cross-connected such that if one of the passive core cooling system recirc. lines fails to open or is blocked, both screens will function to feed the intact lines.

MR. ROSEN: Would you have a big problem if somebody said you needed four times as much square footage? I mean, is there a space for more?

I mean, this is a current issue and really you don't know where it's going.

MR. SCHULZ: It is a current issue. These screens are located along walls. We have some vertical height to play with. We don't have necessarily a lot of width to play with. We probably could do something. I mean, you always can do things with the areas.

CHAIRMAN KRESS: But whatever the resolution of this issue is, you guys have made it what, a COL action item?

MR. SCHULZ: Yes. Yeah, we've done some preliminary work on resident debris and DPs across the screens, but the staff and we recognize we couldn't really resolve it now given the state of knowledge. So we ended up putting a COL that will be recalculated based on more definitive information from testing and plant feedback, although we have a very robust design. With the last of fiberglass insulation, with larger screens than operating plants, with folded screen designs which tend to be good from a debris trapping point of view, we've got these horizontal plates that protect the screens from heavier debris settling in front of them.

It doesn't protect them against fibrous type debris which tends to move with the flow. We have done a lot of things to improve the design and make it robust, but until we get a final resolution of the data, the information, we can't confirm that everything is okay.

DR. RANSOM: What is the mesh size f the screens?

MR. SCHULZ: It's pretty much a standard. I think it's one-eighth of an inch. I'm not 100 percent sure about that. It's controlled by a fuel page openings like current plants.

We don't have --

DR. RANSOM: It is about an eighth of an inch, you say?

MR. SCHULZ: I think. I think that's right. I'll confirm that.

DR. RANSOM: And the other question is: is there any paint in the containment.

MR. SCHULZ: Yes, there is paint in the containment. There's sort of two things to think about there. One of them is on the inside of the containment shell, which, of course, is involved in our passive heat, transfer heat cooling system, is an inorganic zinc which is safety related. Okay? And it's safety related because we want to make sure that the heat conduction is properly accounted for, and also the wetting and the film formation on the inside of the containment.

It's not as critical as outside where we want the thin water cooling film to form a nice, spread out surface, and we don't want rivulets running down. Inside of the containment we tested it with the inorganic zinc on it. So we've kind of ended up with that being a safety requirement.

So we expect that to stay put. If it doesn't, it's not an issue because it's 85 percent zinc. So it's very heavy. So, you know, it will sink, especially with our screens. There's, you know, two foot below the bottom of the screen. The screens are ten to 13 feet high, and then there's this horizontal plate on top of them. So the zinc can't enter the water right in front of the screen. It has got to enter ten feet in front of the screen, and it will sink before it gets to the screen.

Now, there are other coatings inside containment on concrete walls or steel walls that are part of our modules. These will typically be epoxies. they will re purchased as safety related, qualified coatings with a high density, specified density, where we've shown that that kind of a density will result in the paint chips if they were to come loose to sink before it gets to the screens.

Now, the actual application and maintenance of the coatings is not required to be safety in this plant.

DR. RANSOM: There's some concern about chemical reaction. This is borated water, I assume.

MR. SCHULZ: Yes.

DR. RANSOM: And how it would react with the coatings.

MR. SCHULZ: Again, these are qualified coatings. Okay? So to the extent we know about the coatings, as in operating plants, the coatings are supposed to stand up to that environment. Okay?

The issues of chemical debris, chemical corrosion, debris related to screens is part of the

COL item that will have to be revisited for the COL.

DR. RANSOM: One other quick. What is the diameter of the CMT balance lines?

MR. SCHULZ: Those are eight inch Schedule 160. The inside diameter is 6.8-something. That's the same size as the injection line, by the way. Those are the same size lines for AP600 and AP1000. We get more flow in AP1000 by changing the orifice, which we had a fairly strong orifice, small orifice for AP600. We've opened it up a bit for AP1000 to get a little more flow.

MR. SIEBER: Is there any aluminum in containment?

MR. SCHULZ: I think there's allowed to be some limited amount, but it's typically not used. We use some galvanized steel for ratings in stairs and things like that, cable trays. I don't --

MR. SIEBER: No insulation jacketing or anything like that?

MR. SCHULZ: No, would not be aluminum, no.

DR. RANSOM: What kind of insulation is used?

MR. SCHULZ: For the thermal insulation, it's the metal reflective foil type.

DR. RANSOM: Multiple layers?

MR. SCHULZ: Yes, yes. It has been shown that especially in the flow fields that we all have, that kind of insulation even if damaged will sink. It's stainless steel.

DR. RANSOM: Aren't the layers separated by fibers?

MR. SIEBER: No.

MR. SCHULZ: No, no.

DR. RANSOM: And particles?

MR. SIEBER: No.

MR. SCHULZ: No.

DR. RANSOM: No?

MR. SIEBER: Air.

MR. SCHULZ: Just air, and it's not leak-tight.

MR. SIEBER: Pure air.

CHAIRMAN KRESS: Is the ADS four-line aimed in a direction? Is it away from any of this fibrous area or this insulation?

MR. SCHULZ: Yes. I t's basically aimed at a compartment wall.

CHAIRMAN KRESS: It's at a wall?

MR. SCHULZ: Yes. So it will probably remove some paint from that wall.

CHAIRMAN KRESS: How far is that wall from the --

MR. SCHULZ: Not terribly far. A few feet.

MR. CUMMINS: This is Ed Cummins.

I think it's between two and three feet. We actually take the thrust loads on it by hooking back into the wall.

MR. ROSEN: Two and three feet, and how big a line is it?

MR. CUMMINS: It's a 14 inch line. The ID of the valve is like nine inches.

DR. WALLIS: It's impinging on a piece of steel though, isn't it?

MR. SCHULZ: Yes, it's a steel module, modular.

DR. WALLIS: It would eat the concrete if it was --

MR. SCHULZ: Yes.

DR. WALLIS: -- part of the concrete.

MR. SCHULZ: But there's not concrete. Well, there's concrete behind steel. It's protected by the steel. It's part of the steel modules that make up the compartment walls.

CHAIRMAN KRESS: How thick are those

walls? The steel?

MR. SCHULZ: The steel?

CHAIRMAN KRESS: Yeah.

MR. CUMMINS: Ed Cummins again.

That's a structural requirement because it is the reinforcement, and I'm not sure I remember. I think it's quarter inch.

DR. WALLIS: So that steel is going to swell up.

MR. SCHULZ: Yes, it's going to.

DR. SHACK: Which of the piping is designed to be leaked before a break?

MR. SCHULZ: Basically everything -- well, in these lines here, all of these lines are at least eight inches, except for Stage 1 ADS up here, which is four inch. All of the eight inch lines in all of these things you see here are leak before break. The four inch is not.

DR. SHACK: Okay. So it stops at the four inch.

MR. SCHULZ: Right.

MR. CUMMINS: We weren't allowed to have four inch.

MR. SCHULZ: So six inch and up is leak before break, and that includes everything here except for Stage I.

Here's a little bit more detail on the passive RHR system. Normally isolated by --

DR. WALLIS: What do you do with something like the diaphragm in the ADS-4 value? Is that leak before break or what do you do with something like that?

MR. SCHULZ: The diaphragm?

DR. WALLIS: Well, the Squib valve.

MR. SIEBER: The gate.

DR. WALLIS: What do you do with that in terms of leak before break? That could fail presumably.

MR. CUMMINS: I believe it has the same acceptance criteria as the pipe. So it is qualified for leak before break.

MR. SCHULZ: This configuration is identical to AP600. The elevations are identical. The pipe sizes were increased from I think ten to 14 inch to support more flow. The tube surface area was increased by adding a few tubes and making the horizontal sections longer to get about the same amount of power increase as the power in the core went up.

CHAIRMAN KRESS: Do you have a drain line in the bottom of the reactor vessel?

MR. SCHULZ: No. No penetration.

CHAIRMAN KRESS: How do you get the water out when you want to?

MR. SIEBER: Put a pipe down there.

MR. SCHULZ: Yes.

CHAIRMAN KRESS: Suck it out.

PARTICIPANT: Suck hard.

MR. SCHULZ: If you need to. You don't normally have to do that.

CHAIRMAN KRESS: Well, I was thinking about when you go to mid-loop operation or whatever.

MR. SCHULZ: Well, you don't. You leave the water down there. Your mid-loop, you go to a mid -- it's actually not quite mid-loop. It's about three-quarters full hot leg, and you drain water out. It actually comes out of the RNS piping, which comes off the bottom of the hot leg, and off of the RNS piping is the connection to the CDS, and that gets automatically isolated, that drain line, if the water level starts getting low in the hot leg to protect RNS pump.

The passive safety injection, we've talked about the major components here. Again, the types of valves that we're using are identical with AP600. The same configuration. The only real change in configuration is this MOV is normally closed, shown normally closed in AP600. We've opened it to improve the PRA reliability because the MOV is a lot less reliable than the Squib valve.

So in terms of -- this line has a dual purpose. It's both a recirc. line during a LOCA. It's also the line we use in a severe accident to dump the IRWC. Obviously this line can't be used because of the check valve, and of course, there's two of these, two screens and two sets of these valves, and so this line has a dual purpose to dump, and by opening that valve, we've reduced the probability of failure of not being able --

DR. WALLIS: Now, the ADS-4 line goes to the PRHR. We noticed that.

MR. SCHULZ: On one of them, right.

DR. WALLIS: Right, and we had a question about that. I'm not sure if that was resolved or not. What happens during the ADS-4 operation? Does flow go up that line as well?

We had a question about that, I remember, and I thought you were going to get that resolved. It presumably was resolved at some time. Maybe we should ask the staff.

MR. CUMMINS: This is Ed Cummins.

You have the ADS-4. You have sufficient cooling just from a feed-and-bleed sort of thing. I believe our analysis model shows a very little bit of flow goes into the PRHR, but it doesn't really contribute to the --

DR. WALLIS: It seemed to be going the wrong way is the thing. Maybe we could ask the staff about that. It's in the minutes of our meeting.

MR. SCHULZ: I remember it being discussed.

The core makeup tanks are about 25 percent larger, and the flow is about 25 percent greater. The RWST surface area is the same, but we've raised the water level, normal water level. So we've got a little bit more head and a little bit more water.

The injection lines from the RWST, the recirc. lines, and the ADS-4 lines were made larger. ADS-1, 2, and 3 are the same size as AP600.

DR. RANSOM: Well, you said there were no bottom penetrations in that IRWST.

MR. SCHULZ: No, I said off the reactor vessel.

DR. RANSOM: Oh, the reactor vessel. Okay.

MR. SCHULZ: No, the RWST you need --

DR. RANSOM: How do you get the water out of the IRWST?

MR. SCHULZ: Yeah. Yes, there's little pits, two pits that serve as bottom drains as well as injection lines out of the RWST.

We have a little bit more detailed information here about ADS-4 qualification, which we understood there was maybe a question about that. So the next three slides show you what commitments there are in the DCD, what ITAACs there are, and the final one is anticipated testing that Westinghouse would do to qualify the valve.

In terms of the DCD in the section shown here, it basically says there's a need for valve qualification, pre-operational testing, and in-service testing. I'm not going to talk any more about these things. They are also discussed in the DCD, but in terms of valve qualification, there's a specific requirement to verify the flow capability. It doesn't say exactly how to do that, but it does address that, and --

DR. WALLIS: That's an interesting test because you get varying qualities going into this thing. It tends to be a fairly interesting test to supply the steam and the water and everything with this big valve.

MR. SCHULZ: I'll show you what we're planning on doing. Okay? It maybe is not quite as interesting as you think it could be.

(Laughter.)

DR. WALLIS: Oh, okay. Are you going to impinge on a steel plate when you come out of it?

MR. SIEBER: Once you test it, it's no longer any good for anything.

MR. SCHULZ: Oh, no, that's not true. You need to replace some internal parts, but the valve is the one --

MR. SIEBER: Yeah, the ones that function.

MR. SCHULZ: Yeah, yes.

MR. SIEBER: That's what you're testing.

MR. SCHULZ: Well, actually you're testing the geometry once you've opened it. Okay? That's the flow test.

Now, there's also will the valve open.

MR. SIEBER: Right.

MR. SCHULZ: Is a separate question, and that's what this second one here is, to verify the opening capability, and this says you can do type testing, ASME QME-1, as well as EEE type, as it applies to the different components.

And this would be done considering some minimum-maximum DPs, limiting plant condition in terms of environmental aging, steam heat, as well as structural loads on the valve.

So this would be very --

MR. ROSEN: What can you do to assure us that the valve you actually test will be identical or so nearly identical that you can't tell the difference between it and the valve that's actually being used?

There's a concern that some of this testing is done on prototypical stuff that doesn't really represent the actual --

MR. SCHULZ: ASME QME-1 has a lot of criteria on that. One of the things that you have to deal with in a typical operating plant, although it's a little bit less -- it doesn't really apply so much to the ADS Stage IVs because they're going to be unique valves, bug if you have, say, a whole range of gate valves, motor operated gate valves in a plant design, how many of them do you have to test?

And that's where you get into the type testing and what are the restrictions in terms of how many tests you have to do so that you can show that all of the valves get qualified even though you don't test every single size.

And there are issues, I think, that it addresses in terms of, you know, providing a -- and I think there's something in the ITAAC, which I didn't include in the next page, which talks about there will be a report that shows that the valve installed in the plant is covered by the testing an analysis done so that it's applicable.

And it is stated like that, and the staff would have to be satisfied that the report, in fact, justifies that.

MR. ROSEN: Well, you gave an example of a low range with different size gate valves, which is inapplicable to this case, but just talking about the ADS-4 valves, we know exactly or you know exactly what that's going to be. So it's just a question of how close you get. The valve you use for testing, how close is it going to be to the one that you actually use in the plants?

And that's my question.

MR. SCHULZ: Yeah, The only answer that I have in terms of what commitments have been made is what I said. Okay? Is that there will be a report that justifies that the valves tested are analyzed, is consistent with what's put into the plant.

Now, this valve is from a flow geometry point of view, is very simple. It's like an orifice.

MR. SIEBER: A straight pipe.

DR. WALLIS: It's a straight pipe almost.

MR. SCHULZ: Yes. There's a little step-down. There's a picture, two pages, ahead that we'll show you.

DR. WALLIS: That's fine. The interesting part is the up stream conditions. You've got bends and things. So the up stream two-phased pattern is going to be more important than just the geometry. The geometry is simple. It's a straight pipe.

CHAIRMAN KRESS: Well, I'm not sure what happens to the diaphragm when they blow it off.

MR. SCHULZ: Okay.

MR. ROSEN: Why can't you just say a simple thing, which is what I expected you to say, which is we'll test the valve we use in the plant?

MR. SCHULZ: That's what we intend to do. That's not a licensing commitment written down in the VCD or the --

MR. ROSEN: Why don't you make it? What's the hardship?

MR. SCHULZ: Because when you say that,

that means if one rounded corner is a millimeter different, then it's not identical. So when you start about saying "the same," it's very hard to pass that test sometimes.

MR. CUMMINS: This is Ed Cummins. I think the way most of the industry works is that you try to build the valve that you think that you want. That's the objective, and the testing process, you may find that there's ways that you can improve the performance of the valve that you test, and you want to incorporate those improvements in the valve in the plant, and whether you find that or not is not something that you know before you try this whole thing.

So as you enter the qualification program, you start with an objective of producing the valve that you are going to have in the plant. In the end you might decide that there's something that you can improve, and then it's slightly different.

But then you go to QME-1 to see. If you deviate too much, you fail in QME-1.

MR. SCHULZ: You have to retest if it's too big of a change.

These are the specific ITAACs, and these are kind of listed separately sort of by function. So there's a seismic capability function, and it says a type test would be required and/or analysis.

Harsh environment. So this is the igniter in the case of the Stage IV primarily, and again, type tests or analysis.

The change position function specifically says tests or type tests. That doesn't give you any option.

DR. WALLIS: But these kind of igniters have been in radiation environments before. They're used in other nuclear systems.

MR. SCHULZ: Yes. They have been used in high temperature containments. The BWR is used in radiation fields, but not inside containment.

DR. WALLIS: And not at the same temperatures. Okay.

MR. SCHULZ: However, there was a qualification program that the GE actually did for their SBWR on a valve that looks very much like this for service conditions inside containment. So they developed and actually went through the qualification of the propellant.

Then in terms of flow capability, these are the commitments in terms of the ADS lines for noncritical flow would be inspected and an analysis would be done to show that the resistance is less than some limiting value. It wasn't practical to actually put flow through those lines. They're very big lines. They discharge into the containment. So you'd need more flow than we can produce from the RNS system, and we don't really have a place to put it.

And given that the lines are simple from a single phase or noncritical flow -- I shouldn't say single phase -- we have this --

DR. WALLIS: I wonder if any university uses units of feet per gallons per minute squared.

(Laughter.)

DR. WALLIS: Most extraordinary units I've seen in a long time.

MR. SCHULZ: We have had some communication issues with us and our nuclear safety buddies, but we sorted that out. So we have got conversions that you can do. There are some advantages to doing that, but it's not important.

For critical flow, we have an inspection of the Stage IV valve which is to inspect the minimum flow area. Again, this is very simple geometry.

DR. WALLIS: That's just a measurement, isn't it? I mean, it can't be way off. It was made with a certain diameter; it has got that diameter.

MR. SCHULZ: Yes, yes, and that's the real important thing.

There's also one on the elevation of the Stage IV to make sure it's proper.

So that's the DCD and the ITAAC. And this is more what we intend to do, and the intention would be to take the as designed valve and run it through these tests. So if things work out well, we would end up testing what we install.

MR. ROSEN: Now, this valve is bolted in.

MR. SCHULZ: The valve? Here you see the pipe, and the pipe ends in a flange.

MR. ROSEN: So do you typically take this valve out during each outage and do anything to it or --

MR. SCHULZ: No, not typically. What will be happening on a sequential basis is that I think every outage one of the four valves will have its booster removed and test fired in a --

MR. ROSEN: Let me tell you about my concern. My concern is right there are the orifice, right there at the --

MR. SCHULZ: Here?

MR. ROSEN: No, the seal, what forms the pressure boundary.

CHAIRMAN KRESS: Right there.

MR. ROSEN: Right there. What I'm worried about is cracking that proceeds along that line.

MR. SCHULZ: Yeah, we've discussed that.

MR. ROSEN: Over time and ultimately weakens the joint, and is there any way to detect that?

MR. SCHULZ: We've discussed that in the past with the ACRS. I don't know if you were here when we did that, and we talked about we would do inspections in accordance with ASME code requirements to look at, in particular, that joint.

DR. WALLIS: Did you see any boron stalactites hanging off the end of this valve?

MR. SCHULZ: Yeah.

DR. WALLIS: How do you do it? If you don't take it off, how do you inspect that?

MR. SIEBER: The discharge is open.

MR. SCHULZ: This is open. There's nothing connected on this site. So you can get very close on this site. So if there's any leakage at all --

MR. ROSEN: Oh, well, yeah, you can see leakage, but that's too late. I'm worried about cracking that's not through wall.

MR. SCHULZ: Yes, yes. And the intention is on, I guess, a plan basis. We would take the valve off and actually inspect that.

MR. ROSEN: Yeah, I'd think you'd have to look at it this way, with ultrasonics or dye penetrant or something on that surface, and the only way to get at it is to take the valve off.

MR. SCHULZ: Yes, yes.

MR. ROSEN: And then, you know, if you did that fairly routinely for a while and there was no cracking, why, you know, you could extend the frequency dramatically, but I think at the beginning you need to assure me, assure someone, yourselves, the owner, that you're not going to have a LOCA right there.

That's the nasty thing about relief valves. They're designed to open, and sure enough, they do.

Now, this is a special valve, granted, but still, the cracking along that line would create exactly the LOCA you're trying to prevent.

CHAIRMAN KRESS: What's the material? Is it 609?

MR. SCHULZ: We are, I think, 316.

CHAIRMAN KRESS: Three, sixteen?

MR. SCHULZ: That's what we're thinking right now, but I don't know that we've really made a final determination. So obviously it's not a very big part, and --

DR. SHACK: It won't be Alloy 600 if that's what you're thinking.

CHAIRMAN KRESS: That's what I was worried about, yeah.

(Laughter.)

MR. SCHULZ: And so this will be something that will be both the material selection, the engineering of it will be done very, very carefully.

MR. ROSEN: See, I don't get any confidence from you telling me that it's going to be tested and inspected in accordance with the ASME code. I mean, the code is great for a lot of things, but for this particular circumstance, I don't know what the code says about it.

Does it say you need to take it out and inspect it every outage? That's kind of what I would want to do for a while.

MR. SIEBER: No.

MR. ROSEN: Until I got real confidence that there wasn't something special going on in there. It's a highly stressed location. It's in oxygenated steam.

MR. SCHULZ: No, no steam. It's not oxygenated.

MR. ROSEN: Why is there no steam against the valve?

MR. SIEBER: It's water.

MR. SCHULZ: It's water from the hot leg.

MR. ROSEN: So you don't get steam until it opens.

MR. SCHULZ: Right.

DR. WALLIS: You hope.

MR. ROSEN: You hope.

DR. WALLIS: If you get steam, there's a crack.

MR. ROSEN: A crack wouldn't produce steam here.

DR. WALLIS: No, but it would come out in the --

MR. ROSEN: Well, obviously as it goes through the -- yes.

So what are the ASME test requirements? You say it's going to be tested in accordance with the ASME code. What are the ASME -- does that mean everything, every ten years and once a ten-year cycle or --

MR. SCHULZ: That's my understanding. The only thing that we've done differently than that is say that it would be done on a sequential basis so that you wouldn't wait ten years to do them all. You do one of them and --

MR. ROSEN: So you have four of them in the plant, right?

MR. SCHULZ: Yes.

MR. ROSEN: And you do one at two and a half years, another at five, another at seven and a half, and the other at ten.

MR. SCHULZ: Yes.

MR. ROSEN: Presumably. So we'll have to wait two and a half years before you see an inspection of this, of the first one.

CHAIRMAN KRESS: That seems reasonable.

MR. SEGALA: This is John Segala from the NRC staff. Back in the last future plant meeting, we have a copy of Westinghouse's slides at that time, and they said in accordance with ASME every ten years perform the following: measure sheer cap dimensions to assure no thinning. Perform dye penetrant tests to insure no cracking. Use staggered testing.

That's what they said back at the last meeting.

MR. ROSEN: That's pretty consistent with what was just said. So that means staggered testing every ten years, four valves, two and a half years.

Well, how long is the operating cycle? How long is your operating cycle going to be?

MR. SCHULZ: Oh, the fuel cycle is more like a year, 18 months.

MR. ROSEN: So this would probably be in the second operating cycle you would have to do the first valve 36 months into it roughly.

DR. WALLIS: The figure we had shows something attached to the outlet. There's obviously some holes for bolts at the outlet.

MR. SCHULZ: Yes.

DR. WALLIS: What is on there?

MR. SCHULZ: In our design there will be nothing.

DR. WALLIS: Ah, there will be nothing.

MR. SCHULZ: The drawing was taken from another application that actually was going to have a pipe.

DR. WALLIS: Okay. I thought there was nothing there. I thought ours has something there.

MR. SCHULZ: Yes, yes. These bolt holes here won't exist in our final design, and there won't be any flange or any pipe connected to the outlet of the valve.

DR. WALLIS: So the massive pieces of pipe are hardly necessary.

MR. SCHULZ: Massive?

DR. WALLIS: The massive housing there is hardly necessary. It doesn't attach to anything.

MR. CUMMINS: This is Ed Cummins.

I mentioned before that we have four struts that come from the wall that hook to that end thing so that when it blows even at full pressure, that it doesn't cause damage to the rest of the reactor coolant system.

So while there's no pipe at the end of that, there are some pretty big lugs that go back to the wall to take the force of the --

DR. WALLIS: Thank you.

MR. SCHULZ: So we may still have those old --

MR. ROSEN: That's a very good idea actually.

MR. SCHULZ: Okay. I was trying to go through this here. From a valve operability point of view, we will test the valve using both maximum and minimum inlet pressures. Minimum pressures actually can be potentially limiting in this valve because if you have a high pressure in here, it has got this connection stress, and it may be a little bit easier to break it off.

With very, very low inlet pressures, then all of the force necessary to shear that point needs to come from the booster assembly. So we will test both conditions to make sure that the valve will function in both cases, and we will use a degraded booster by an arbitrary amount. I think what has bene used in the past has like a 80 percent booster to, again, provide some margin and robustness to the design.

From a flow capability, our intentions are to use a water flow, pulled water flow test to establish an L/D of the valve and then to do a saturated steam flow test to basically give us an effective flow area, which is what the nuclear safety people use as an input to their safety analysis.

DR. WALLIS: So there is no two-phased testing.

MR. SCHULZ: That's right.

DR. WALLIS: And everything is done theoretical in terms of a fee squared (phonetic) or some --

MR. SCHULZ: Well, it's not theoretical. It's based on the testing we've done at OSU and --

DR. WALLIS: Scaled up from OSU.

MR. SCHULZ: So we use OSU to establish the system kid of interaction performance. This test is really making sure the valve is consistent with the systems test and the system analysis.

DR. WALLIS: Typically if you know the water flow capability, you can convert it to steam flow. So it shouldn't be very interesting.

MR. SCHULZ: We hope not.

And then, of course, there's the environmental considerations with irradiation, steam, and heat aging, which would cover the whole life cycle of the boosters from storage normal standby condition and then post accident conditions, and then the aged boosters, it would be actuated to show that they would work.

And then there would also be seismic and other dynamic load testing, which is envisioned to be a shaker table kind of thing.

DR. WALLIS: Now, this is a dead end pipe with hot water in it.

MR. SCHULZ: Normally hot water. There is, say, a partial loop seal.

DR. WALLIS: Right. No, what I'm thinking is --

MR. SCHULZ: Which means that this going to be --

DR. WALLIS: -- these things where you get weird circulation patterns and you get thermal fatigue.

MR. SCHULZ: This system is all well insulated right up to this flange. So --

DR. WALLIS: But it is cool at the end, isn't it?

MR. SCHULZ: The end is --

MR. SIEBER: Cooler.

MR. SCHULZ: -- cooler.

DR. WALLIS: Right.

MR. SCHULZ: Yeah, but because of the size of the pipe and the fact that it doesn't dip very much, it's going to be--

DR. WALLIS: It's probably all right. It's just that there are these events where you get weird circulation patterns which get intermittent. So there's a temperature cycling at the end of the pipe.

DR. SHACK: Well, the good news is this valve won't leak.

DR. WALLIS: Yes. It's probably okay.

MR. SIEBER: Theoretically.

DR. WALLIS: I guess it's something to bear in mind always when you get this sort of situation.

MR. ROSEN: You mentioned the degraded booster with the 80 percent. How did you pick that number? Why wouldn't you use 30 percent or some other number?

MR. SCHULZ: That's something that the vendor has suggested and used from his experience base with these type of valves. What he's told us is that if applying at 20 percent margin will cover, more than cover the kind of changes that they might have seen in making the boosters, they put a lot of quality control on the boosters when they make the propellant initially, test it in samples, and then when they make a batch of boosters, they test, you know, some boosters right away to make sure they're okay.

And the tolerance and variation that they get in that is significantly less than that 20 percent, though that seems to be adequate to cover reasonable variations in the boosters in terms of manufacturing and environmental effects.

DR. SHACK: When you replace a booster, do you then go off and blow it up?

MR. SCHULZ: Yes.

DR. SHACK: So you'll have a check on that.

MR. SCHULZ: That's a standard ASME in-service testing for a Squib valve. They've actually got it codified. That's what we've committed to do in the CD, is that when we replace the booster and there's a schedule for that, we would then take the one that was in the valve and then go test it to make sure it would have been okay, and if there's any problem shown up, then you use your tracing of finding similar boosters and maybe replacing them or go root cause and try to figure out what went wrong and that kind of stuff.

But that does give you a reasonable check on if it would work.

MR. SIEBER: The effect of using a very degraded booster, actually what you're doing, it takes a certain amount of energy to get the valve to operate. So if you want to test it in a degraded mode, the only way you can do that is make a larger booster, which makes a larger actuator housing and a larger valve for no real purpose.

MR. SCHULZ: Other than the margin, right.

MR. SIEBER: Other than that test.

MR. SCHULZ: So if you kind of overdo that, then the valve is getting huge.

MR. SIEBER: Yeah, and perhaps less likely to work because all of the parts are heavier.

DR. WALLIS: The propellant does deteriorate with time at these temperatures. Isn't that --

MR. SIEBER: Yes.

MR. SCHULZ: Yes. In fact, one of the things about this, since this pipe is hot, you'll notice there's fins here.

DR. WALLIS: I was assuming that most of this whole thing is pretty well at primary temperature.

MR. SCHULZ: Well, the booster is supposed to be less than 280 degrees or something.

DR. WALLIS: It's as cold as that?

MR. SCHULZ: And in order to make it that cold, the valve body is not insulated, and there's fins located here. There's also vertical fins around the top of this housing, and a test will be done with this at maximum design inlet temperature.

DR. WALLIS: So there is quite a lot of heat transfer going on in that area then. So that's okay.

MR. SIEBER: Which causes some internal food.

DR. WALLIS: So you have water coming in at primary temperature going through some natural circulation in there and some of it leaving that may be two or 300 degrees colder?

MR. SCHULZ: No, I don't --

DR. WALLIS: No? Well, you said that temperature is --

MR. SCHULZ: Yes, the temperature up here. The temperatures here will be much closer to --

DR. WALLIS: To uniform, the primary temperature. Okay.

MR. SCHULZ: That's an awful big pipe connected here.

DR. WALLIS: Yeah.

MR. SCHULZ: Okay. Moving on to passive containment cooling, we've talked a little bit about this. Again, the same configuration as AP600, except we added a third valve path, which was due to PRA considerations, and it is a different normally closed valve. It's a motor operated gate valve instead of air operated butterfly valves, and that was done to add diversity as well as redundancy to help the PRA.

And the reason we did that is because

there's a slight chance that if you were running on air only cooling in AP1000 that the containment could fail after a day, whereas in AP600, you could go basically indefinitely with design basis and ambient conditions and not fail the containment at emergency stress limits.

But with AP1000 we have a little less margin. So to compensate for that, we added a more reliable water drain system.

We did increase the volume of the tank in order to account for the fact that we have higher decay heat. The standpipes control the flow of water. With all standpipes running, we have a relatively high flow rate that lasts for about three or four hours. That quickly establishes the water film initially and also it is greater than decay heat so that the containment pressure has tended to be dropped down in that time frame.

After that, the stand pipes are arranged to more or less follow decay heat out through the 72 hours.

MR. SIEBER: There is a -- if those valves fail, there is an operator action in the SAM-Gs (phonetic) to go up on the side of the containment and open the valves manually. Do you have a ladder built into the containment?

MR. SCHULZ: There's stairs and ladders, depending on --

MR. SIEBER: That gets to those valves?

MR. SCHULZ: Yes, yes.

MR. CUMMINS: There's actually an elevator, kind of a crawler elevator and stairs, and then the plant vent is up there, too. So you need to go inspect the air inlet. So there's a reason that you want to be up there periodically anyway, and so we needed to be able to get there easily.

MR. SIEBER: Are the stairs between the concrete and the steel liner?

MR. SCHULZ: No. They're on the outside.

MR. SIEBER: Okay.

MR. SCHULZ: Obviously the valves are actually inside the concrete area. They have to be protected from --

MR. SIEBER: Right.

MR. SCHULZ: -- in the environment, but eventually you have to go inside.

MR. SIEBER: So you've got to get in there.

MR. SCHULZ: Yes. There are obviously then conditions where you might not want to go up there. If you had a--

MR. SIEBER: I could think of hundreds --

MR. SCHULZ: Yes.

MR. SIEBER: -- of reasons not to.

MR. SCHULZ: Now, there are other ways of getting water up there. We have a pipe that goes up to the same drain point where we can put the water from the fire protection system. We can also put water from the Demion (phonetic) water system. We can also put water from fire trucks or something.

So there are a multitude of other ways of getting water up there if you cannot get up there and open those valves up.

DR. SHACK: How robust is that concrete shield building around the containment?

MR. SIEBER: How thick is it?

MR. CUMMINS: It's three feet thick.

MR. SCHULZ: With lots of rebar.

MR. CUMMINS: By the structure. Rebar is because of the structural requirements.

MR. SCHULZ: Yes. Yeah, because it's supporting the concrete tank and --

MR. SIEBER: So it's sort of like the current ice containment.

MR. CUMMINS: Yes.

MR. SCHULZ: Yes. I had mentioned safety margins, and here's a listing of some key accidents and criteria and comparing a typical Westinghouse PWR against AP600 and AP1000. Loss of flow limits is significantly better than operating plants and AP1000 is a little better than AP600.

The feed line break analysis, again, AP600 and AP1000 are much better than operating plants. AP1000 is not quite as good as AP600, but again, still much bigger than operating.

Computer tube rupture, although it's not very interesting from a thermal hydraulic analysis point of view, it can be challenging in a sense of the operators have to do a lot of things in operating plants. They have to do things.

AP600 and AP1000, the operators don't have to do anything. I mean there are procedures to do things to minimize operation of passive systems and things like that, but if they do nothing, the plant is still okay, and that's the way the plant is actually analyzed in Chapter 15 in the CDC.

Small LOCA, again --

MR. ROSEN: Have you looked at errors of commission, operators doing the wrong things? Are there any set of those that you've looked at?

MR. SCHULZ: The way you have to really look at that is in how you design the man-machine interface and emergency procedures to avoid doing that. Ultimately you get to the point where the operators could turn things off like TMI.

That can still happen, and the main defense that you have against that is to, first of all, try to avoid putting the operator in a situation where you could have got conflicting goals. He doesn't want to overfill the pressurizer, but he needs to keep the high hid (phonetic) pump on. Okay?

We have pretty much designed those kind of things out of AP600/AP1000. So we don't think he'll be in that situation where he's damned if he does, damned if he doesn't kind of thing.

But still ultimately you have to rely on training because you can postulate if the operator turns off the SI or cooling or something to the core, he could eventually get into trouble.

Now, things will actuate, tend to actuate, but eventually in order to allow recovery of the plant, you have to be able to block the safety injection signals and start feedwater cooling or not startup, but passive RHR signals to be able to recover the plant from an accident.

So how do you know that's recovery versus, you know, errors of commission? So you do the best job you can from the design point of view and try to minimize putting the operator in a situation where he has got conflicting goals, and then you do a good job on managing interface in terms of telling him is the core being cooled; what are the temperatures and then good emergency procedures on what he should be doing and checking and rechecking to making sure that he has not gone off and done something stupid.

MR. ROSEN: And you'll have a full scope simulator.

MR. SCHULZ: Yes.

MR. ROSEN: So that they can practice doing the right thing and not doing the wrong thing.

MR. SCHULZ: We actually did a little bit of prototyping of that in the AP600 days, but it was not a full scope simulator at that point. We were just starting to develop wall panels and the soft touch controls because it's a new design. So we were actually bringing some operators in to get some preliminary experience, but the ultimate one will be a full-scale simulator, yes.

DR. WALLIS: That's an Appendix K figure or was there a 95th percentile, that large LOCA?

MR. SCHULZ: Yes.

DR. WALLIS: It's Appendix K?

MR. SCHULZ: Yes. No, excuse me, not Appendix K. This is --

DR. WALLIS: This is a realistic person.

MR. SCHULZ: With uncertainty.

DR. WALLIS: With uncertainty. This is a 95th percentile thing or something?

MR. SCHULZ: Yes.

DR. WALLIS: I see.

MR. SCHULZ: So it's a very conservative number. The best estimate or more realistic numbers are 200 degrees plus cooler than that, lower temperature.

And then ATWS is with the low boron core. We have no exceedance of time during the core cycles, and the pressures are lower.

MR. SIEBER: At the risk of causing confusion, I'd like to ask one more question about passive containment cooling.

MR. SCHULZ: Okay.

MR. SIEBER: And manually operating the valves. You say the valves are inside the concrete shield wall?

MR. SCHULZ: Yes.

MR. SIEBER: And as I recall it, the operator has 24 hours to go up and open those valves before the probability of containment failure becomes --

MR. SCHULZ: Non-zero.

MR. SIEBER: Well, it's .02.

MR. SCHULZ: Yes.

MR. SIEBER: Okay. After 24 hours after a LOCA, what's the radiation dose where those valves are?

MR. SCHULZ: Well, it depends on what happened. Okay? If it's a small LOCA, it's very, very low. If the core is melted, he can't get up there.

MR. SIEBER: Okay.

MR. SCHULZ: And he wouldn't even try. He would use his other --

MR. SIEBER: And so you go to the increased probability of containment.

MR. SCHULZ: No, you go to putting water up there from other sources.

MR. SIEBER: All right.

MR. SCHULZ: The other multitude of ways of getting water up there.

DR. WALLIS: Well, you can be a hero and

go up there.

PARTICIPANT: Once.

MR. SIEBER: Well, you probably have time to open the valve.

MR. SCHULZ: We weren't putting that into the emergency procedures.

Moving on toward the risk part of the plant design, one of the things that's good to keep in mind is the multiple levels of defense that have been designed into AP1000, many more than the current operating plant. This is showing a tube rupture as an example, and operating plants have basically sort of two levels of defense. One is the safety one, which is using I-head safety injection pumps, auxiliary feedwater, and operator actions to reduce and stop the leak.

And then they have some other means to back that up which typically are in the PRA in the feed-and-bleed type cooling thing where they would reduce the RCS pressure, minimize the leakage. The leakage is not really isolated, and the RCS is vented to the containment. And that is considered a success path. And if that doesn't work you get into core damage.

For AP1000, the first level of defense

shown here which is probably -- the way these are shown is from the most likely to be used to the least likely to be used.

In this case, the most likely to be used is the operators would do the same things they would do in the operating plant, but instead using startup feedwater, CVS makeup, and operator controls to isolate the leak.

If he doesn't do that, then the passive systems come into play automatically, and this is what we show in the DCD, and that would also isolate the leak through CMT, passive RHR, actuation, automatic isolation of DVS and startup feedwater, and steam generator isolation.

And then if that doesn't work you get into several different kinds of, again, feed and bleed, the pressurization schemes similar to this, but with some variations. This kind of thinking ends up getting built into the PRA event trees, and is the main reason why the probability of core melt from, say, tube ruptures of other kind of things is much lower.

It's not just that we have a passive system that's incredibly reliable. It's mainly that we have many different ways of --

MR. SIEBER: Alternatives.

MR. SCHULZ: Alternatives.

DR. SHACK: And there's nothing he could do in that first stage that would negate the action of the passive safety system

MR. SCHULZ: Nothing? "Nothing" is a pretty strong word.

DR. SHACK: "Nothing" is a big word, or that's included in the PRA.

MR. SCHULZ: Typically what happens here, in order to avoid getting into this, he's got to shut the plant down without getting a safety injection signal. So if you actually have a tube rupture that captures the operators sort of off guard, they're not aware of leaking and they're not following the event and they're not shutting the plant down, then you tend to get into this second mode here.

If the operators are tracking leakage and they're anticipating what's going on and they --

DR. WALLIS: They anticipate a ST tube rupture?

MR. SCHULZ: Well --

MR. SIEBER: Yes, you can.

DR. WALLIS: Can you?

MR. CUMMINS: There's steam radiation detectors.

DR. WALLIS: So it is leaking first. It hasn't ruptured yet.

MR. ROSEN: Yeah. You track this very small leakage over long periods of time.

MR. SIEBER: Detectability is pretty good in current plants.

MR. SCHULZ: So if they get into this mode here, they can completely avoid, potentially completely avoid the start-up of the passive RHRs. Now, if they're in that mode and the steam generator water level is going up because they're not doing something, they're not being effective at terminating a leakage, that will stop, automatically isolates startup feedwater and CVS, which is one of his main tools.

DR. WALLIS: So they could block the ADS line presumably if they were really foolish and prevent it opening?

MR. SCHULZ: Well, yeah. The ADS is not going to come into play.

DR. WALLIS: No, but I think the question was is there anything they could do to prevent success by the later paths.

MR. SCHULZ: Okay. I was addressing this guy versus this guy.

DR. WALLIS: Right, but the later ones, it all depends on ADS working.

MR. SCHULZ: Some level of ADS working. Now, you basically have to block the CMT actuation, which is a precursor or necessary to get ADS, which you can do, but again, from a procedures point of view they shouldn't need to do that when they're just doing this.

So it would be only if this thing starts screwing up and the plant starts getting out of -- the water levels in the generator get too high. They lose startup feedwater. Eventually they get an S signal because the pressure goes low because they're not getting makeup anymore from the CVS, and then they get an S signal.

Now, they should get into emergency procedures then. They shouldn't just go run off and isolate it. Again, operators can make errors of commission. If they make enough of them, you can get into trouble initially. This event in that situation would take a while because it doesn't evolve rapidly.

DR. WALLIS: is the weakest part of this whole thing the reliability of this S signal, depending on the level? That's something a little bit less than 100 percent reliable?

MR. CUMMINS: No, the S signal is part of the protection system, and it has got four divisions independently sensed and then a vote, two out of four. So it's as reliable as you can get in current plants.

DR. WALLIS: That's why it has got four division.

MR. CUMMINS: Right.

MR. SCHULZ: Yeah, and it's actually the main input. There is a pressurizer low level that will start it. There's also a pressurizer pressure which will start it.

Diverse actuation system also comes into play to start core makeup tanks, passive RHR. It won't automatically kick in ADS, but it does provide some level of backup.

DR. WALLIS: I think you're going to take twice your allotted time here.

MR. SCHULZ: The PRA, you see the summary, the numbers here for core damage frequency, large release frequency, at power, shutdowns, based on internal events, floods and fires compared to the safety goals.

And we think that not only just from the numbers, but from the sensitivity studies that we've done that we have a very robust design. It ha lots of margin and relatively little uncertainty, and a lot of that goes back to the passive systems are simply. There's not a lot to model. There's not a lot that can go wrong.

You don't have the complex network of systems that start from AC power, cooling water systems, HVAC systems that go all the way up through your front line pumps and fans and whatever that you have in the current plants.

MR. ROSEN: These are very interesting results. They first show something that we've suspected for some time in operating plants, that risk during shutdown is comparable to the risk during operation, and we show that again here, two or E to the minus seven in both cases.

MR. SCHULZ: Yeah.

MR. ROSEN: And the other thing it shows is something else we've suspected all along, is that fires are important both during operation and shutdown, and that you show again here, and in fact, you show it more important than shutdown and operation. I mean it's a higher risk.

I'd be interested if you could off the top of your head tell me why, but it's really just perverse curiosity.

MR. SCHULZ: I'd say first that the shutdown internal events is --

MR. ROSEN: The fire number.

MR. SCHULZ: I understand. I just wanted to say something about -- because you had commented on both.

This number is calculated in a very similar way than the at power, which is kind of unique to this plant design, which doesn't rely on shutdown systems to provide the safety. We still have -- a shutdown cooling system is still a non-safety system. Okay? So we always have passive features that provide the bulk of the core melt protection, and so we don't have to rely on trying to anticipate maintenance outages and having taken part of your protection out of service during a shutdown.

So it's a lot simpler and probably less uncertainty in the shutdown number here. When you do that with an operating plant, it's a lot more difficult, and it's probably more uncertainty in terms of, you know, in-service testing, inspection, maintenance.

Now, internal fires, these numbers are not calculated with the same level of detail as the internal events. In order to simplify the analysis, we ended up making it more conservative, and so I think these numbers are not as comparable in terms of their accuracy. It's more of a conservative number, but they're a little bit higher than we would think they would really be.

So I think your statement may be misled or we may be misleading you a little bit by showing these numbers that are more comparable and you saying that fire is important. And what we're saying is that these are conservative numbers, more conservative than these numbers just because of the simplifications we did in doing the fire PRA.

MR. ROSEN: Well, I was specifically commenting on the fact that the shutdown fire core damage frequency is higher than your at power.

MR. SCHULZ: No, it's not.

MR. ROSEN: Eight E to the minus --

MR. SCHULZ: Eight, minus eight though.

MR. ROSEN: Yeah, versus five E to the minus eight.

MR. SCHULZ: Oh, okay. You're comparing this. Yes, yes.

MR. ROSEN: And that was the -- I believe that because I think at least in current operating plants there's a lot more going on in shutdown. There are a lot more people there. Fires, you know, are more likely.

MR. SCHULZ: What tends to happen to AP1000 is that when you start looking at those levels of defense, when you look at shutdown, you have fewer levels of defense involved, and that's what tends to -- even though you're there less often so the initiating event challenges are lower, you also have less protection.

MR. ROSEN: You're there less often for a shorter duration of time than you are at power.

MR. SCHULZ: Yes.

MR. SIEBER: Do you have a seismic CDF in WHARF (phonetic)?

MR. SCHULZ: No. The seismic was done on a seismic margins basis.

MR. SIEBER: Okay.

MR. SCHULZ: We looked at, I think, .5 G.

MR. SIEBER: And so that's not included in your final number?

MR. SCHULZ: That's not. Seismic is not in there, right.

And at risk of showing the in-vessel retention picture, I wanted to at least go through the different things that are in the design that relate to severe accidents and capability. Obviously core competent interaction, the in-vessel retention is a feature that minimizes, reduces that importance. We've done testing analysis for both AP600 and AP1000.

For AP1000, we improved the shape of the insulation. In AP600 there was more of a cone shape down here, which was less effective at promoting the actual circulation and cooling of the lower head than the hemispherical head that we now have. And this was one of the things that we tested for AP1000.

High pressure core melt is dealt with by the highly reliable ADS which has --

DR. WALLIS: You do have instrument penetrations in the bottom of this vessel?

MR. SCHULZ: No.

DR. WALLIS: Nothing at all?

MR. SCHULZ: No.

MR. SIEBER: No.

MR. SCHULZ: High temperature core melt is reduced greatly in probability because of the highly redundant, diverse ADS system. You know, ADS-1, 2, 3 or 4, all or any of those are sufficient to get you down low enough in pressure to prevent a high pressure core melt.

Hydrogen burn detonation is dealt with by arrangement of the containment, where we put vents on the IWST to keep potential hydrogen flames from damaging the containment shell, as well as by the fact that we have redundant, diverse igniters/pourers (phonetic) in there.

Ex vessel steam explosions. Again, heat being the core in the vessel would prevent that, and we've also, as you heard, I think, the last time we talked about containment integrity even if IDR fails.

DR. RANSOM: The vessel insulation, is that on multiple shields, too?

MR. SCHULZ: Yes.

DR. RANSOM: What material is that made out of?

MR. SCHULZ: Stainless steel.

DR. RANSOM: And how many layers or how thick is each layer?

MR. SCHULZ: They're like foil. so they're very thin.

DR. RANSOM: Very thin.

MR. SCHULZ: The interior layers. Now, there's an inside layer which is heavier and an outside layer which is heavier for handling purposes.

DR. RANSOM: So they're a jacket that's made and installed.

MR. SCHULZ: Yes, yes. It has to be, you know, fit to the --

DR. RANSOM: Are they evacuated also?

MR. SCHULZ: No.

DR. RANSOM: No. Are they filled with argon?

MR. SCHULZ: No, just air. They're not sealed.

DR. WALLIS: No, they're filled with Oak Ridge actually.

(Laughter.)

MR. ROSEN: I assume they're probably dimpled or something so there is a means of creating an air gap between the layers.

CHAIRMAN KRESS: Yeah, they're spaced.

MR. SIEBER: I don't recall that.

MR. ROSEN: Pardon?

MR. SCHULZ: The samples --

MS. CUMMINS: You can't see the -- on the outside you see a box which looks like a stainless steel box, and on the inside are all of these foils.

CHAIRMAN KRESS: They generally have spacers, shims.

MR. SIEBER: They are not a precision kind of a thing.

CHAIRMAN KRESS: No.

DR. RANSOM: Well, I assume that they're at least made so that, you know, the gap provides some resistance to conduction.

CHAIRMAN KRESS: That's true.

MR. SIEBER: Well, the joints, you have conduction all the way through. So they get --

MR. SCHULZ: And leakage. You take a little bit of a hit here from insulation effectiveness point of view. So you have to account for that and the normal heat loads in containment are a little bit greater with this kind of insulation.

DR. RANSOM: Have you ever brought a sample of that here?

MR. SCHULZ: No. I have one sitting on my desk back in Pittsburgh.

MR. SIEBER: It's the same as what they use in plants today.

MR. SCHULZ: Yeah.

DR. RANSOM: Today?

MR. SIEBER: Yeah.

MR. SCHULZ: It's not new.

MR. SIEBER: It takes a bunch of sections and you strap them all together.

MR. CUMMINS: You buckle them together,

and you have to take them off if you want to inspect the pipe, and it's kind of a pain actually. That's why people start using the other stuff.

DR. RANSOM: So if these are ripped off by the discharge from an ADS valve, why, they're just big chunks.

MR. SIEBER: Then you've got a bunch of boxes on the floor.

MR. CUMMINS: Yeah, it's stainless steel pieces.

MR. SIEBER: A bunch of boxes on the floor.

MR. SCHULZ: The next couple of slides deal with some structural considerations. This is pretty much a list of the main structural changes to the AP1000. As I mentioned the containment shell, as well as the containment vessel, were raised about 25 and a half feet.

DR. WALLIS: Only on the top, right?

MR. SCHULZ: Yeah, the top part. Down here was not changed, but basically inserted a ring in both the steel shell and the concrete that was 25 and a half feet.

The PCS capacity was increased about 50 percent, and that's this water storage up here. Now, that's less than the containment or the core increase, and we did a couple of things there to minimize the increase. One of them is that we didn't have to increase the flow rate in the first several hours because that was based more on establishing a water film quickly and the flow rate was high enough to still reduce the containment pressure. So that didn't have to be increased. So that didn't contribute to water flow or water volume increase.

The other thing was that AP600 originally was designed to try to go seven days with water instead of three days, but we basically didn't have enough water left over after three days to provide sufficient cooling. So we tried to do something and we ended up not really pulling it off.

So we ended up deciding with this AP1000 we're just going to use that extra water in the first three days. So that also reduced the amount of increase that we needed in the tank volume, and at the end of three days this tank would be empty.

Now, of course, there is still the ancillary water storage tank that we have provided and ancillary pumps that can refill that, plus the fire connections and all of that.

MR. ROSEN: Now, these valves that Jack

Sieber was worried about earlier, you can show us where they are?

MR. SIEBER: There's the spares right there.

MR. SCHULZ: There's a little room that's depicted here. Here' stairs that are inside the concrete, and then outside. I think this is actually part of the covered access up to this side of the containment. It's on the outside of the concrete.

So from here down you're outside the concrete, and then you have to transition in to get to that room.

MR. ROSEN: And where are those valves right there in that?

MR. SCHULZ: They're right there in this room so that the lines come down from the tank into this room and then go over to the top of the containment.

MR. SIEBER: And the containment there is about an inch and a half thick, the steel part.

MR. CUMMINS: Inch and three-quarters.

MR. SCHULZ: And three-quarters. It's slightly thicker than AP600, and then I think the next slide actually shows it.

DR. SHACK: And it's a higher strength

steel, too.

MR. SCHULZ: Right.

MR. SIEBER: But from a radiation shielding point of view, it's almost transparent.

MR. SCHULZ: The air inlets up at the top here were reconfigured in shape, this same area, and the reconfiguration was to allow for a stronger connection between the dome and the side wall.

The polar pane was raised and facet increased because of the larger steam generators. Obviously the reactor vessel gets a little bit longer. Steam generators are bigger. The concrete walls around the steam generators were raised because the U tubes were raised, and the pressurizer height was raised because of volume changes.

And the only thing out in the auxiliary building that changed was the lowering of the spent fuel pit floor because we have longer fuel.

CHAIRMAN KRESS: You had to change out those steam generators. Did you have to cut a hole through the containment?

MR. SCHULZ: Yeah. It would go up through the center here. It would move this concrete shield and the screens that are in here, and if you cut a hole in the steel and then --

CHAIRMAN KRESS: Pulled it right up there.

MR. SCHULZ: -- pull it right up there, right.

MR. SIEBER: That's one way. You don't have room enough to turn it inside.

MR. CUMMINS: I think we do, but we haven't finished that study.

MR. SIEBER: You have to cut the moisture separator off to do that.

MR. SCHULZ: This shows you the steel containment vessel. The same diameter as AP600. Again, it's 25 or so feet longer. Here's the different material we're using. Design pressure went up from 45 to 59 psi, the same design pressure, and we have some external pressure capability to deal with.

DR. WALLIS: But you never pull a vacuum in there, do you?

MR. SCHULZ: We've tried hard to see if we could, and basically the limiting case is if you have very, very cold weather and you lose your heating. Then the cold weather will tend to pull the containment down, and if you're starting at atmospheric pressure, you will drift into a mild vacuum.

There is no spray system. Turning water

on with cold weather actually helps because the water is warmer than the air.

The seismic design basis, the main point here is that both AP600 and AP1000 have a response spectrum that's amplified at high frequencies to cover -- to bound off the reg. guide.

CHAIRMAN KRESS: Is this a limitation on the site you can use?

MR. CUMMINS: The hard rock is the limitation on the sites you can use. I think the current sites, maybe 30 percent are hard rocks, and this was a decision to expedite the process because the soft soil analysis is long and expensive, and we ultimately will expand to soft soil sites and do that analysis, but it's not in design cert.

CHAIRMAN KRESS: I was wondering if you could sell one to Japan with that limitation.

MR. CUMMINS: Well, the .2 G is probably not sufficient for Japan.

MR. ROSEN: So you're limited to .3 G with a hard rock foundation for now.

MR. SIEBER: But there's still room for additional analysis.

MR. CUMMINS: Yes, you can expand that. There's no question. It just takes lots of engineering hours. What we're going to expand it to is to the utility requirements document set of soil conditions which bounded I think it was 80 percent of U.S. sites.

MR. SIEBER: And for non-hard rock sites, it doesn't really pay you to do a generic analysis because soil liquefaction and all of that differs from site to site.

MR. SCHULZ: The last couple of slides are basically summarizing some of the other features of the design. I had mentioned great simplifications of the design. Here you see some numbers in terms of your reduction in safety related valves. This is just total numbers of pumps, safety related piping, 83 percent less, again, with a great simplification in not having pumps outside containment, multiple headers inside containment.

The cable reductions are mainly with multiplexing and digital I&C, as well as having fewer valves and pumps and thing. This all ends up translating into smaller buildings, especially the seismic buildings.

This gives you sort of a graphical picture of how much smaller the footprint is, and the colored parts are the safety related stuff that's train oriented and whatever. This is actually Seiswell, which is sort of advanced evolutionary type design with four trains. So with four diesels, and it's probably a little bigger than most operating plants, but not too different from where you'd end up with an evolutionary advanced design.

MR. SIEBER: When you did the civil layout, did you take into account providing sufficient space to maintain the equipment?

MR. SCHULZ: We had a lot of help back in AP600 from U.S. utilities. We had a handful of guys sitting in our building helping us to make sure we had laid on space. There were reviews done, and the EPRI requirements are pretty strong in that area.

So we didn't make the plant smaller because we chinced on maintenance and lay-down space.

MR. SIEBER: Well, that was the practice in the middle to late '60s and early '70s. You know, let's make it smaller, smaller, smaller until you couldn't work on the heat exchanger, couldn't retube anything. You know, it was always a big adventure.

So I hope that that mistake wasn't made here.

MR. SCHULZ: Well, we think not. We've done a lot of things in terms of --

MR. SIEBER: Well, you've thought about it at least.

MR. SCHULZ: Installed platforms, where things are located so that you don't have to put scaffolding up.

MR. SIEBER: Right.

MR. SCHULZ: All that kind of stuff.

MR. SIEBER: Okay. Good.

MR. SCHULZ: We've done a lot of work in the general arrangement. AP1000 is the same as AP600. Separation of radioactive/nonradioactive areas out in the AUX building; fire separation even in containment. We obviously can't put wall barriers up per se, but we try to do some innovative things.

We're having two trains above the operating deck and two trains below the operating deck as the primary routing to get some separation. Safety/non-safety, again, especially outside in containment.

Here's your maintenance inspection. We've also added access areas and staging areas right outside of the main operating deck out into an annex building out here. So right before refuelings, you can get everything all ready here to go in a nice, big space.

You also have some storage space out here so that you don't have to keep -- you're not tempted to keep tools and fixtures and things inside containment which can end up being debris in an accident.

The access to the containment, we have basically two equipment batch kind of things, one at the operating deck and one at the main level below the operating deck so that we can get stuff in and out easier and quicker during fuelings.

MR. SIEBER: But those are both inside the aux. building?

MR. SCHULZ: That's right. They're both covered by you can see here safety related structures. Now, there is another building out here, which is a non-safety related structure. It's still a radiation controlled environment.

MR. SIEBER: Having one equipment hatch outside was a convenience for moving material in and out.

MR. CUMMINS: This is Ed Cummins.

The utility requirements document prevented that.

MR. SIEBER: Oh, okay.

MR. SCHULZ: Yeah, that was their --

MR. SIEBER: They didn't want it.

MR. SCHULZ: Now, the lower one you can get a truck up from grade to that door. So we have some pretty easy access to that one, but they wanted to get through the building.

MR. SIEBER: Yeah. Well, okay. It's still easier to rig and lift on the outside rather than inside some building someplace, but whatever the customer wants, I guess.

(Laughter.)

MR. SCHULZ: That's what we were working on.

Improved construction methods. The first thing, of course, is simplifying, reducing what you have to build. Another main thing was use of modularization, extensive use. You see here sort of an outline.

The main module inside containment with the steam, two-loop compartments, the refueling canal, reactor cavity underneath, the pressurizer compartment.

That thing will be put together by steel panels. You see these lines here are panels that would be factory fabricated, shipped to the site and then welded together in this large module outside of containment, and then the whole thing lifted inside containment. That kind of construction we think will add to the quality as well as to the speed of construction.

We've done a lot of work on construction schedule including what we call 4D modeling using our 3D computer model of the plant coupled with time in a construction kind of mode to see how the plant goes together.

You know this story probably better than we do. We've been successful with maintaining our schedule, and we just have a few steps to go, important steps though.

This is just a summary. We think that AP1000 meets with some comfort the NRC and industry standard, both deterministic and probabilistic, and that the final design approval is an important step in our journey.

DR. WALLIS: Tell us the status for future plants. There are not any future standards though. You don't know what they're going to be.

MR. SCHULZ: No.

DR. WALLIS: So these are really existing standards.

MR. SCHULZ: Existing standards, yes. To

the extent that they do exist for --

DR. WALLIS: For light water reactors.

MR. SCHULZ: -- light water reactors and for new plants.

MR. ROSEN: This picture raises a question in my mind, which may be better addressed on Slide 18. Could you go back to that one?

Yeah. Where is the grade in this? Oh, that's it. Okay.

Could it be deeper? Could you sink this whole thing deeper?

MR. SIEBER: Sure.

MR. ROSEN: I mean, is there any reason that the grade needs to be at that point?

MR. SIEBER: You just have a little stack coming out of the ground.

MR. ROSEN: Well, that's where the access is, right?

MR. CUMMINS: Yeah. Maybe if you started all over again you could have it, but at this stage you have a lot invested in the access and all the other arrangements on how you got any piece of equipment out for repair. You couldn't have the whole thing underground because you have to have air cooling, but you could have had a design philosophy of more underground, but the studies done by the industry in probably the '80s assessed that underground construction was much more expensive and difficult than above ground, and all of the recommendations from these DOE sponsored constructability things said that it would be good to minimize underground.

Of course, we have a little bit different environment now, but --

DR. WALLIS: But what the underground is the core is essentially underground and the spent fuel pool is --

MR. CUMMINS: Yeah, there's two floors of the auxiliary building underground, but I don't think that that gives you much because the steam generators aren't. So we don't claim any security benefit from that.

MR. ROSEN: Where is the fuel pool on this one now?

MR. SIEBER: It's out there.

MR. ROSEN: But where? But relative to grade?

MR. SCHULZ: See, this is operating deck here.

MR. CUMMINS: I believe that the top of the fuel pool is 135 and grade is 100. So maybe the fuel is -- I don't exactly know -- maybe the fuel is below, but there's a lot of water above.

MR. SCHULZ: Another thing to consider in our design, we did wind tunnel testing to make sure that the air inlets and the air exhaust were not perturbed by air flow over the turbine building or nearby hills. If you started lowering the containment I don't know what would happen to such interactions.

MR. SIEBER: It would lower everything.

MR. SCHULZ: The hills?

MR. SIEBER: Office buildings, turbine.

MR. SCHULZ: Yeah, I see. If you lower the --

MR. SIEBER: All you'll have is that little stack at the top that's coming out of the ground.

CHAIRMAN KRESS: Okay. I guess at this time would be a good time to take a break. So I'll declare a break until 10:30, and then we'll come back.

(Whereupon, the foregoing matter went off the record at 10:12 a.m. and went back on the record at 10:30 a.m.)

CHAIRMAN KRESS: Okay. I guess on the agenda we're at the place where the staff is going into take over. Are you ready, John?

MR. SEGALA: I'm just recovering from a cold. So you'll have to bear with my voice here.

CHAIRMAN KRESS: Just don't breathe on us.

MR. SEGALA: That's all right. I think I'm better. I just have the residual at this point.

MR. SIEBER: What's important is are you contagious.

MR. SEGALA: I have no idea.

MR. SIEBER: I may move over.

(Laughter.)

MR. SEGALA: There are some open seats over there.

MR. SIEBER: In the middle.

MR. SEGALA: Well, I'm John Segala. I'm the lead project manager for the AP1000 design certification review.

The other project managers are Joe Colaccino. He's stepped out for a minute. Steve Bloom and Lauren Quinones over there.

What we did here was we went back to the previous Future Plant Design Subcommittee meeting in Pittsburgh and worked off of what we presented at that meeting and developed an update package for you for this meeting.

So the purpose is to provide a summary of our review and the current status of the project; discuss major milestones and successes that you understand what we reviewed and how we resolved it; and current status of future milestones.

CHAIRMAN KRESS: Success of your presentation is if we have these attributes; is that --

MR. SEGALA: Yes, yes. And you'll see some more attributes as we go down.

So because of time constrained I put both my earlier presentation and later presentation together. So this will actually be two mini presentations.

Just really quick, March 2002 we completed a pre-application review. Westinghouse submitted their design certification application March 28th. On June 25th, NRC accepted the application. June 16th we issued a DSER with 174 open items.

On May 18th, we responded to your interim letter that we received, and on May 25th, we sent you an advanced copy of the FSER.

This slide just points out how many ACRS meetings we've had. A total of 18, including today's meeting. We'll have one more meeting in July for the full committee, and so that will be 19.

Although we did a complete review for AP1000, if you go back to AP600, there were 44 ACRS meetings, which that all sort of builds together.

The remaining milestones, July 7th, full committee meeting which I mentioned before. This July 17th sort of forward looking at we're requesting that that's when you could get us a letter by in order for us to meet the future milestones.

The division director --

CHAIRMAN KRESS: How come it isn't that the slash on that approval, say, slash, discipline?

MR. SEGALA: Well, we're being optimistic.

CHAIRMAN KRESS: Oh, okay.

MR. SEGALA: August 6th, where you have to get --

CHAIRMAN KRESS: Excuse me for that.

PARTICIPANT: You had our heart beating.

DR. WALLIS: From the point of view of punctuation, is there one or two or ten directors involved and is there an apostrophe somewhere in there?

MR. SEGALA: There's four division directors.

DR. WALLIS: So there's an apostrophe after the S.

MR. SEGALA: Yeah.

DR. WALLIS: Okay. Thank you.

MR. SEGALA: August 13th, OGC, no legal objection.

August 30th, EDO memo to the Commission, and then on September 13th, we issue the FSER and FDA.

And December 2005 is our current schedule for the final design certification rulemaking, although we've committed to reassess the schedule and discuss that when we issue the FSER.

CHAIRMAN KRESS: Are you trying to move it up?

MR. SEGALA: Yeah. We're looking at whether we can do that or not.

This is just to give you an idea of the resources that we've put towards this review. This is a total of 88 technical reviewers as well as project managers that have worked on both the draft SER and FSER.

It also shows you that I couldn't have all of these people here today to answer your questions. So if things come up that I don't know the answer to we'll try and get back to you.

As well as the reviewers, these are the contractors we've had supporting our review.

Just really quick, we had 742 RAIs as compared to 7,000 RAIs for AP600. This just gives you a general idea of what areas the RAIs fell into. The significant number of RAIs doesn't necessarily mean anything. The individual items may be significant even though you may only have a few of them.

We issued the DSER on June 16th, 174 open items in it, and in ten months we got that down to resolving all of the open items, and then when Westinghouse issued their Rev. 11 of the DCD, that allowed us to confirm all of the open items.

DR. WALLIS: It's interesting not items appeared between 6/16/03 and --

MR. SEGALA: Well, I'm about to get to that.

DR. WALLIS: Oh, there are some new items which aren't shown here.

MR. SEGALA: There are some new items.

DR. WALLIS: Oh, okay.

MR. SEGALA: This doesn't show that.

DR. WALLIS: Thank you.

MR. SEGALA: Seven hundred -- I went backwards. Am I still going backwards?

MR. SIEBER: There you go.

MR. SEGALA: Okay. One hundred seventyfour open items as compared to 1,300 for AP600. We issued five new open items after the DSER was issued. Four of those were related to materials that were brought up at the Future Plant Subcommittee meeting in Pittsburgh, and one was brought up on sumps.

And we have a slide in a little while that you'll see that will discuss those.

Design acceptance criteria, these are typically limited to those areas that are affected by rapidly changing technologies or design areas which as builts or as procured information is not available, and for AP1000 we've I&C, human factors, control rooms design, and piping.

CHAIRMAN KRESS: There was some debate about the piping early on.

MR. SEGALA: Yeah, piping was not originally approved. For AP600, they did the full piping, but for AP1000 they proposed a DAK approach.

Exemptions. We had three exemptions for AP1000, 5,034 for the safety parameter display. Westinghouse asked for an exemption to have an integrated safety parameter display system, rather than having a separate, stand alone system how current plants have.

And this is something that the staff found acceptable, and I believe it's in our SRP that allows them to do that.

For the ATWS requirements, Terry alluded to this before. They asked for an exemption regarding the requirement to have an aux. feedwater system, and they have a passive RHR system.

And then GDC 17 requires two independent off-site sources, and because Westinghouse doesn't rely on that, that we gave them an exemption on that.

Okay. So this was my first conclusion remarks, was all open items resolved. We believe all ACRS issues are addressed, but that remains to be seen, and we're on schedule to issue the FSER on September 13th.

And I'll just seque into the next presentation.

The purpose of this presentation is to give you a summary of the staff's review and resolution of the open items, and to have you gain understanding of what we reviewed and how we resolved it and get your agreement that the items are resolved.

This other slide you have seen before.

Back in the Future Plant Design Subcommittee in Pittsburgh in July of '03, we had discussed with you the possibility of having some supplemental DSER sections. We ended up completing the review. For Chapter 21 we included the AP600 evaluation in in the AP1000 FSER, and for Chapter 14.2, we issued 28 additional open items. They're sub-open items on the initial test program which we didn't review for the DSER. they're all resolved.

And for Section 13.6, 3.6, 3.4, and 3.3, we resolved all of the open items with that. So in general because there were no remaining open items, we just included that in the final SER rather than issue supplementals.

In Chapter 1 of the DSER, there were three open items that were sort of generic in nature. One was we had a check. The DSER was reviewed up to Rev. 3 of the DCD. We're now up to Rev. 12. So this open item was to make sure that we reviewed the latest revision of the DCD, and we don't expect any future technical changes at this point.

TRT Star information, that's information that's locked down. They have to get staff approval before they can make changes to that. We have reviewed all of that and are happy with what's in the DCD for that.

Combined license action items, the staff has reviewed them and found them acceptable.

For the post SER open items, the four were on materials, and one was on the sump screens. The first materials one is poor shroud susceptibility to stress corrosion cracking. Westinghouse provided a response to that item and stated that based on operational experience no inspections were required beyond ASME, and the staff agreed with that.

This item was no discussed in the FSER.

The next materials question was Alloy 52/152 weldment QA criteria. In Westinghouse's response, they proposed to use 100 percent volumetric examination of all partial penetration J groove welds in the vessel, and the staff found that acceptable, and that is discussed in the FSER.

High chromium nickel-based alloy susceptibility, a low temperature crack propagation was a third materials question, the new item that we asked. Westinghouse's response concluded that there were four conditions that were necessary for the occurrence of low temperature propagation: relative high concentrations of hydrogen in the environment and in the metal relatively low temperatures; the presence of a sharp cracked tip; the presence of loads which rise at a moderate rate to levels great enough to fail a flawed material.

Westinghouse looked at their conditions and concluded that the occurrence of low temperature crack propagation cannot take place in the AP1000 design, and the staff found that acceptable. That is also discussed in the FSER.

MR. SIEBER: A quick question on the course rep. In current PWRs, I don't recall there being any shroud cracking in PWRs; is that correct?

It's BWRs that had the shroud cracking problem as I recall it. Does anybody know?

MR. MITCHELL: Yes, this is Matthew Mitchell, Acting Section Chief, Materials and Chemical Engineering Branch.

I'm not aware of any occurrences of shroud cracking in pressurized water reactor designs. Certainly we have been very familiar with the phenomena in boiling water reactor designs.

MR. SIEBER: Yeah, it seems to me there's no stress. The shroud just sort of sits there, and so it's not a structural member. It's just a flow device.

MR. MITCHELL: Well, the stresses which are attributable to causing the cracking of BWR design generally tend to be welded to residual stresses.

MR. SIEBER: Right.

MR. MITCHELL: Which would also be true of a welded shroud design in a PWR, but the chemical environmental conditions are obviously much less aggressive in a pressurized water reactor design.

MR. SIEBER: Okay. Thank you.

And so it's no surprise that the staff would agree tha these plants are not susceptible to that?

MR. MITCHELL: Correct.

MR. SIEBER: Okay.

MR. SEGALA: The fourth materials new open item was ADS Squib valve notch susceptibility to stress corrosion cracking. Westinghouse' response stated that this sheer section designed to ASME code and environment is not susceptible to stress corrosion cracking, and the staff agreed with that.

The next item on the sump screens, after the DSER was issued, we, the staff, issued Rev. 3 to Reg. Guide 1.82, and in there was a discussion on the chemical effects precipitation that might form and cloud up the screens.

The staff sent this concern to Westinghouse and had them address it, and Westinghouse added a COL action item to consider the generation of chemical debris in an evaluation.

We'll talk a little bit more about the sump screens.

MR. ROSEN: Before you get off there, would you talk a little bit more about the first bullet? What's the rationale? Is there some capsule rationale you can give me why they feel it's not susceptible? Is it materials, stress, environment rationale? What is it?

I believe that it was the conditions for that to happen.

MR. MITCHELL: Yeah, this is Matthew Mitchell again.

I was not directly involved in that particular issue, but I believe what I have heard is that it's a relatively shallow notched design, not likely to lead to a severe stress intensification for the Squib valve design. Plus the material that's being used has been not shown to be prevalent to stress corrosion cracking in a PWR environment.

If the gentleman from Westinghouse could refresh my memory as to what the material is on that, I believe it's a low carbon stainless; is that correct?

MR. CUMMINS: A 316 stainless steel.

MR. MITCHELL: Three, sixteen.

MR. SEGALA: The ITAAC for the plan are to assure that the as-built plant conforms with the certified design. We had 35 ITAAC related open items. Some of them proposed new ITAACs are changes to existing ITAACs, and some of them are related to resolutions of other open items that we had in other chapters.

And to date all of those have been resolved.

Quality assurance. There were five open items in the DSER. The staff went out and did inspections at OSU, as well as at Westinghouse. For OSU they identified a notice of violation and two nonconformances, and OSU corrected that and provided a response and the staff found that acceptable.

And at Westinghouse we had a notice of nonconformance, and Westinghouse went out and performed some audits of their vendors, and they provided a response and the staff found that that was acceptable.

Leak before break, we had two leak before break open items. The issues included Alloy 690, 52, 152, susceptibility to pressurized water, stress corrosion cracking. The results from the sensitivity studies using stress corrosion cracking, crack morphologies indicate that that if margin exist in LBB application.

Acceptability of Westinghouse's LBB approach was another item. Westinghouse used a combination of qualitative assessment and quantitative evaluation to evaluate all AP1000 candidate, AP1000 LBB piping subsystems. That --

DR. WALLIS: Getting back to the 690, 690 is the magic material, isn't it, which is much better than the previous material? There's not much experience with it yet in nuclear plants, or is there?

MR. SIEBER: There is.

DR. WALLIS: How much experience? There is a lot of experience.

MR. SIEBER: Steam generator tubes.

DR. WALLIS: So there is a lot of experience. So we have a really good basis for making this evaluation.

MR. ROSEN: Well, we don't have a long experience, but we have a lot recently. I think the jury is still out on 690.

DR. WALLIS: Right. So if something comes up, you'd just be alert if something comes up with this material

MR. SEGALA: Yeah. Westinghouse did one

LBB analysis for the DVI-A subsystem, and then they did an assessment of the AP1000 LBB subsystems using the AP600 analyses and scaling factors for pipe diameters and response spectra against bounding analysis curves.

And Westinghouse considered in their LBB assessments statistically based material properties, more sensitive leakage detection capability, and inclusion of pipe whip restraints, and the staff concluded that this approach was acceptable, and all LBB issues are resolved.

Regarding the sump screen performance, there were six sump screen open items. They were related to debris loading of the IRWS screens and their recirculation screens, as well as debris through the reactor coolant system break.

All open items are resolved. The staff concludes that the screen design is acceptable based on what Terry discussed, how they increased the screen surface areas. They also put a cross-connect between the two sumps. So that was their containment recirc. screen redesign.

The screen designer is robust to prevent screen blockage. They have low flows and the plate over top of the screens help keep material away, and the lack of fibrous insulation.

they have ITAAC which verify the location of the plates above the containment research sump screens. There are screen surface areas. The bottom of the containment research sump screens, how far they're located off the bottom of the containment, and the type of insulation and the dry film density of the coatings.

They also have two COL action items. They have one regarding their cleanliness program, and one performing an evaluation consistent with Revision 3 of Reg. Guide 1.82.

MR. ROSEN: Which means they'll use the NEC guidance or at some point they'll actually show as all other existing PWRs are going to be showing that they can properly and adequately enter and maintain recirc.?

MR. SEGALA: Well, the staff has approved this based on the current design, and we believe that anything that might come out of this evaluation would just require programmatic changes.

MR. ROSEN: Oh, so we don't have to do all of the work we're doing unclogging research and all of that. We can just ask you how to solve it. You seem to have a state of knowledge that far exceeds the industry's.

MR. SEGALA: Well, if it turns out down the road -- well, let me turn it over.

MR. CULLISON: This is Dave Cullison from the staff.

When we put in the Reg. Guide 182 evaluation, at the time that was basically what we had, but the expectation is that the NEI methodology expands on the information in Reg. Guide 182, and we would expect that anybody doing an analysis would be using an NRC approved methodology, which right now is going to be the NEI methodology.

MR. ROSEN: So you feel you have enough of a hook into the licensing of AP1000 that we can be sure that there will be a full and thorough review of the sump design that is analogous or equally complete as is being done for operating PWRs?

MR. CULLISON: Yes, we do.

MR. ROSEN: What is that hook? I know Westinghouse will do the right thing, but what is the regulatory hammer? Where does it arise? I don't get it.

MR. CULLISON: Well, we referenced the Reg. Guide 1.82, which as I explained is the NEI methodology is an expansion on that, but also, we're going to continue to evaluate what comes out of GSI 191, and if more information comes out that makes us decide we need to revisit this, we can evaluate what that we've done for AP1000 and, if necessary, backfit them.

MR. ROSEN: Oh, that's what I was afraid of. So you would have to backfit this design rather than front fit, rather than put a condition in the license now that says you'll --

MR. SIEBER: Once you make it a COL item, doesn't that -- that's the hook, the regulatory hook that makes them comply with whatever requirements develop between now and when they --

MR. ROSEN: I hope so because I don't think that the answer is satisfactory. I would have to condition the ARS approval because I don't think that's adequate. I mean, to say that if this turns out that there's some substantial problem here that we will go to Westinghouse and argue backfit, I simply don't think that's appropriate. Certainly it's not appropriate for the operating plants. I mean, we're not doing that with the operating plants. It's not a backfit to say that they have to successfully say that they have to successfully execute recirc. That's their design basis.

MR. SEGALA: It's a compliance backfit.

MR. ROSEN: Compliance backfit.

MR. SEGALA: Compliance backfit, and that would be the same, I mean that would be the same approach that we would take for Westinghouse, but --

DR. WALLIS: Your Appendix A requires the sump screens to work, and so if you ask a licensee, "Show me that your sump screens work," they have to take into account all of this information and do an analysis.

MR. ROSEN: I'm trying to make sure we have the regulatory authority to not get into a discussion of whether it's required for AP1000 or not. I mean it is. It should be; it must be, and so I am still a little bit confused with the terminology that's being used here. I mean, it's a regulatory point.

MR. WILSON: Jerry Wilson, NRR.

As I understand it, the staff is saying at this point in time that the design that Westinghouse has provided is acceptable and meets the regulations.

So this issue here in the COL action item deals with operational and procedural matters that we would do later on.

MR. CUMMINS: This is Ed Cummins. I think that we have a COL item that says perform an analysis in accordance with this Reg. Guide 1.82 and satisfy the staff that that analysis is acceptable, and we see that and I think maybe the staff should describe what the regulatory process is, but we see that as an open item that we have yet to satisfy and that we must satisfy as we got to the COL stage.

MR. ROSEN: Well, I appreciate that, Ed. I think that's the right point, position to be on, but I'm still trying to figure out why the staff doesn't see it that way, why the staff is saying, "Well, no, we're just going to look at procedures, when in fact we're looking at designs for the operating plants and presumably we ought to be looking at it here, too, on the same basis. It's not a different issue.

Now, clearly AP1000 has a lot of advantages over the amounts to the operating plants because you come so late in the design, in the cycle of knowledge, core acquisition that you know what a lot of the issues are, and you've done things that clearly make the situation better, not less.

I still think we need some sort of -- I don't know -- maybe it's a condition on the license or something other than the staff saying we're going to require Westinghouse to show us the procedures.

Westinghouse is willing to go a lot beyond that. They're saying that they're going to resolve the issue just like the operating plants are.

I hope they will because that's the best knowledge we will have based on all of the research that's going on that will be built in.

CHAIRMAN KRESS: The operation plants will have an option of using their risk informed approach, which Westinghouse may very well take advantage of.

MR. ROSEN: Westinghouse will what?

CHAIRMAN KRESS: Could take advantage of.

MR. ROSEN: I would see no difference between the way the Westinghouse -- Westinghouse should have all of the flexibility that the operating plants have, but in the same breath, one has to say they have to do just as rigorous an analysis based on the current research as the operating points, not some -- there's no pass here. I'm not issuing any free passes on this issue.

MR. CUMMINS: I think maybe we could take an open item and bring the words of the COL item, and I believe that the words of the COL item will satisfy you,b ut I'm not positive.

MR. ROSEN: Maybe you could do that for the full committee meeting because I could make a point that what is Westinghouse's commitment, and maybe the staff could take another look at that.

MR. SEGALA: With regard to structure seismic design, the review methodology was based on review of critical sections selected by the staff, and they were similar sections that were reviewed for AP600. The design constraints which Terry discussed were a hard rock site and a fixed base model for seismic analyses.

There were 38 structural seismic related open items. The major items included basemat uplift and completion of the containment design.

CHAIRMAN KRESS: But could you refresh my memory on what the basemat uplift issue is?

MR. SEGALA: Goutam, do you want to?

DR. WALLIS: It's a rather strange failure mechanism of something. It seems to be that something lifted up into the containment, the bottom of containment.

MR. SIEBER: And then falls over.

MR. BAGCHI: This is Goutam Bagchi from NRR.

The structural properties of the nuclear island, particularly the height, extended height of the shield building and so on increased the susceptibility to overturning, and at safe shutdown earthquake level, it is not a problem.

But at the margins level we reviewed the potential for lifting of the corners of the basement up, and that slapping down of that at another cycle of seismic motion could potentially produce high impact and, therefore, difficulty in analyzing that condition, and as a result they made some changes. They provided sheer connectors to the bottom of the steel containment, and there is still slight uplift, but we have reviewed the calculations in detail, and determined that it is acceptable.1

There was a detailed audit of actual calculations.

MR. SIEBER: When you do the calculation for uplift, does that include an analysis of piping that penetrates containment and goes to the auxiliary building to look for bending and stress and strain effects?

MR. BAGCHI: Well, the whole building is rather complex. It is a finite element model that was used for the analysis, and everything is represented there.

MR. SIEBER: Okay.

MR. BAGCHI: The masses are there. The

stiffness is. Interconnections, all of those things are there.

MR. SIEBER: Okay.

MR. BAGCHI: The staff, along with all of the consultants, reviewed over several days all of the calculations that were done. I think this is as thorough a review as I have done in my more than 30 years with the NRC.

MR. SEGALA: Okay. Thanks, Goutam.

I think that completes that slide.

Thermal hydraulics was an area that we spent considerable effort on. There were five thermal hydraulic ACRS meetings where we talked about all of the thermal hydraulic codes and analysis that were performed.

There were four thermal hydraulic related DSER open items which spanned on --

DR. WALLIS: Well, really they include their result now. They did include.

MR. SEGALA: Did include, yes.

Liquid entrainment which included the hot leg and upper plenum, course weld, long-term cooling and blond precipitation. All of the open items are resolved related to thermal hydraulic, and the staff concludes that they meet 50.46.

For PRA, we had a PRA subcommittee meeting in January of 2003. There were 24 PRA related pen items, and thais lists some of the notable topics, PRA input to design certification process, PRA input to witness process, impact of uncertainties on PRA results and conclusions, success criteria and thermal hydraulic uncertainty, SAMDA evaluation, reactor vessel insulation design and shutdown risk, and all of those open items are resolved.

I now am going to turn over the presentation to Michelle Hart to give her evaluation of aerosol removal.

MS. HART: Okay. I'm Michelle Hart. I'm from the NRR staff. I did the dosage estimate for the AP1000. I also had help from Sandia labs and from other members of the staff.

Westinghouse initially intended to use the AP1000 removal rates for the AP1000 sign. We questioned that concept, and they eventually performed a best estimate analysis with the AP1000 thermal hydraulics calculated by MAAP, and they used aerosol mechanistic code STARNAUA.

And in that code credit was given for gravitational settling, diffuser phoresis, and thermal phoresis, and we accepted these mechanisms as removal, but we questioned the actual calculational values that they came up with.

CHAIRMAN KRESS: The MAAP thermal hydraulic calculations, was that one sequence or a lot of sequences.

MS. HART: It is one particular sequence, and in fact, it's the 3BE-1, the double ended line break of the DVI line, with the failure to activate the intact train.

CHAIRMAN KRESS: Was that risk dominance sequence?

MS. HART: It is risk dominance sequence. It's the one that -- in fact, it's the one that is the dominant contributor to CDF for the AP1000 design.

Also, those thermal hydraulic conditions are typical for the majority of the sever accident sequences, the 3DE class, fully depressurized and reflooded, and as they used the alternative source term reg. guide that we had written for the current operating plants which implements NUREG 1465, the revised source term, and that's supposed to representative of low melt core melt accidents, which is similar to the 3BE sequence.

CHAIRMAN KRESS: How did they synchronize the-- there was a timing in the source term.

MS. HART: Right.

CHAIRMAN KRESS: The timing in the thermal hydraulics, how did they synchronize that?

MS. HART: Right. During the course of -- we had several discussions with Westinghouse over these issues, and the way we had modeled it when we did our independent analyses and we asked if they had done it this way as well, and eventually they did do it this way, is in the full integrated thermal hydraulic analysis when it shows that you have the release from the core, then because 1465 has that timing aspect, that GAP release happens for 30 minutes, and then the core release happens for the one and a half hours. You backed up 30 minutes from that time that it shows in the thermal hydraulics, and that's your start time for the overlaid, deterministic source term.

We contracted with Sandia and did an independent analysis that was a Monte Carlo sampling using the melt core thermal hydraulics. We used our own thermal hydraulics for the same scenario, and used the aerosol deposition mode that is within MELCOR, which is the MAEROS model.

WE sampled on 13 parameters that would affect the aerosol parameters, and ran so many runs that we would have a ninth-fifth confidence level, 95 percent confidence level.

Engineering judgment was used for the choice of parameters and the distribution of those parameters.

DR. WALLIS: What does "engineering judgment" mean?

MS. HART: If we were not sure as to what the actual distribution would look like, we did use something that was skewed toward a more reasonable, conservative value.

DR. WALLIS: That's better. That's a better statement.

MS. HART: Right.

CHAIRMAN KRESS: And in general, these parameters that you sample, you really do know something about the limits on a lot of those.

MS. HART: Right. We understood the limits. If we didn't understand the behavior between those limits, a lot of times we went with the uniformed distribution. Some of them are a normal distribution type.

And these are the sample parameters. I won't mention each one by name. You can look over them later. Some of the more important ones are the shape factors, the aerosol size, and the nonradioactive aerosol mass.

DR. WALLIS: By sample, do you mean these varied randomly?

CHAIRMAN KRESS: Monte Carlo.

MS. HART: Yes. This is the total runs. These are the results from each run varied over time. The large spike at around three and a half hours or so is dues to a hydrogen burn. We don't know why it's such an enormous, obnoxious looking spike, but there it is.

DR. WALLIS: Because if you average all of the curves, you make the spike go away.

MS. HART: Exactly, and that is exactly --

DR. WALLIS: But that's not the way to do it though.

MS. HART: Well, there is some differences in timing. We don't know if a hydrogen spike would actually occur at that time. So you don't want to take account of that in your removal.

DR. WALLIS: Yeah, but the last thing that you want to do is average the curves to make the spikes go away..

CHAIRMAN KRESS: But I suspect the spikes are good things here. You want them to go away. What you're doing is increasing the thermal phoresis problem.

MS. HART: Yes. And it just blows its stuff over to the side, and so really it's a removal mechanism that I mean you don't care if it goes away.

DR. WALLIS: It doesn't do much. For this purpose, you don't care about the peaks.

CHAIRMAN KRESS: That's right.

DR. WALLIS: For other purposes you do.

MS. HART: For use in a dose calculation, that is true. It would be conservative to not account for that removal from that spike.

The late time values converge to around .3 per hour, and this is the uncertainty calculation, the bounds that were given. We have the 80 through -- the fifth percentile through the 80th percentile, and you can see the median as well with the green line in the center.

CHAIRMAN KRESS: For the elucidation of my brethren, a lambda in this case is analogous to a decay constant, related to the mass outborn in the containment so that you know what we're talking about.

MS. HART: Right.

CHAIRMAN KRESS: In case you're not an aerosol expert.

DR. WALLIS: Now, what you really care about is the amount of decontamination interval over the period of time presumably.

MS. HART: Over a particular period of time. That is correct.

DR. WALLIS: So if you integrate the individual curves and get the amount of decontamination, does that give you the same result as if you take the mean of these things and then integrate? That is not clear to me it does.

CHAIRMAN KRESS: What you really do is have a race between airborne material being taken out and what's leaking out the containment.

DR. WALLIS: No, I'm arguing about the treatment of statistical data.

CHAIRMAN KRESS: Oh, oh.

DR. WALLIS: Sometimes if you take the average and then use that as your mechanism you get a very different answer than if you take each curve and integrate for each curve and then take the average of that.

CHAIRMAN KRESS: Oh, yeah. I see what you -- yeah, you're right.

DR. WALLIS: Sometimes you can really, really mislead by taking an average and then using that.

MS. HART: These curves were determined by taking each time step and finding the competence level for each of the --

DR. WALLIS: But do you see what I mean? I don't know if you appreciate what I mean. It is a nonlinear process. If you do this, you may be completely confusing the integrated effect of decontamination.

CHAIRMAN KRESS: I think what he's talking about is when Westinghouse goes to apply, they don't use the full curve. They use a value of lambda.

MS. HART: They are using a value of lambda that they had calculated for a specific scenario.

DR. WALLIS: It's an average value?

MS. HART: I think it's an average for a time period, but I'm not --

MR. CUMMINS: This is a statistical sampling overall of these parameters. They varied. In our analysis we picked the set of parameters.

DR. WALLIS: What number did they pick then? How do you compare what they do with what you do?

MS. HART: We compared by performing a

dose analysis. We used our median lambdas that we came up with from this curve.

DR. WALLIS: Is that the right thing to do?

CHAIRMAN KRESS: No,w to be conservative with these lambdas, you want to bias things towards the lower end. If you want to be conservative, you want a smaller lambda.

MS. HART: That is true.

We did not base our acceptance of their dose calculations on their values for aerosol removal coefficient. We wanted to do our own evaluation using the previous lambdas I had shown you, and we performed an independent dose analysis. We used all other parameters from the Westinghouse DCD except for we did use the medial aerosol removal coefficients.

There was some further averaging I did have to do because of our calculational code. You can only input an average lambda over a time step, and there's only ten time steps that you can use.

DR. WALLIS: Did you try using one of your -- well, I guess you can't -- or some of the actual Monte Carlo runs in calculating the decontamination from them. It's a nonlinear process.

MS. HART: Right.

DR. WALLIS: And this averaging may not be really averaging your integral effect.

MS. HART: I did do some sensitivity calculations where I used one value for lambda of around .4, and of course, with the atmospheric dispersion factors that Westinghouse had given us at that time, that was not enough removal during the early phase to allow them to still be below the dose acceptance criteria.

However, they have changed their chi/Qs in the meantime, and I have not recalculated with the new chi/Q is.

DR. WALLIS: Well, again, it seems to me quite conceivable that although you get all of these statistical variations in your Slide 38, if you actually took the original curves on Slide 37 and used those to predict the amount of contamination, it might turn out they all predict the same amount because the peaks are shifted and so on. And yet on the average, it all comes to the same answer.

So there's no statistical variation in the answer, and yet your 38 shows there's a bit statistical variation.

CHAIRMAN KRESS: I think we're in design basis space here.

MS. HART: That's correct.

CHAIRMAN KRESS: And what you have to think of is this is accompanied by a rule on a pressure and leak rate after containment , and that's a bit artificial. They take a maximum pressure and hold it for 24 hours and then drop it to one-half.

DR. WALLIS: You're on another --

CHAIRMAN KRESS: And what the idea is is to take what's in the containment during that period and see what goes outside and see if you meet 10 CFR --

DR. WALLIS: I understand that. I'm just talking about the proper treatment of statistical data.

CHAIRMAN KRESS: I understand.

DR. WALLIS: Bill Shack is nodding away. He understands what I'm talking about.

CHAIRMAN KRESS: I understand. But you're worried about decontamination, and what they're worried about is how one gets out to the atmosphere.

DR. WALLIS: I'm just asking whether the treatment is appropriate for these statistical variations.

DR. SHACK: And since all of these time histories aren't similar, you know, then when you average at a given time value, you know, you're averaging many -- it's just not clear, as Grant says, what you've got when you're done.

MS. HART: Well, the thermal hydraulics for each of those runs is exactly the same.

DR. WALLIS: Is that supposed to reassure me?

MS. HART: Well, that has not varied for all of those runs.

CHAIRMAN KRESS: Once again, what you're interested in is not the decontamination, but what's left airborne in the containment because that's what leaks out, with a given constant leak rate and a given constant pressure, so that this averaging --

DR. WALLIS: Well, you see what I mean. I mean, if you look at the figure 37, if it were true that the curves which are high early are low later and the curves which are low early are high later, it could well be that the integrated decontamination for all of these curves is about the same, and the way that you average on 38 doesn't show that at all

MR. GOUNDER: Can I maybe offer some clarification? My name is Randy Gounder, and I did those calculations.

That family of curves that you see with

the decontamination coefficient, they all really vary in the same pattern. They're not --

DR. WALLIS: That helps a lot. Are they not displaced in time?

MR. GOUNDER: They are not canceling each other out if that's, I think, what you're --

DR. WALLIS: Well, then if that's true, if they all have the same sort of shape and they all have the same sort of shape as the average curves on the next figure, then we've got some reassurance that there isn't a great distortion of what's going on.

MR. GOUNDER: That's in fact how they behave.

DR. WALLIS: That helps.

MR. GOUNDER: And the big spike that you see shows up in all of the analyses because they're using the same governing thermal hydraulics.

DR. WALLIS: It's a very nonlinear thing so that the spike contributes a huge amount to the answer.

MR. GOUNDER: It's a very transient --

DR. WALLIS: But it has disappeared when you do the statistical averaging.

MR. GOUNDER: Right.

DR. WALLIS: Okay. So I think you

understand what I'm getting at. Thank you.

CHAIRMAN KRESS: But you're interested in the worst two hours of this thing, and what you actually need to be looking at is the airborne concentrations, not the decontamination factors, over the worst two hours, because you basically have a constant leak rate during this time.

And I'll tell you for that worst two hours, the shape of these curves are not going to affect it at all.

DR. WALLIS: it doesn't make any difference?

CHAIRMAN KRESS: It doesn't make any difference at all. It's somewhere during the front end of this thing, is the worst two hours.

MS. HART: And you're still injecting source term at that time.

CHAIRMAN KRESS: Yeah. So really it doesn't make that much difference because we're in design basis space. Where this kind of argument you're talking about can make a big difference, if you're transferring this type of thing and trying to do severe accident, real severe accident analysis in the PRA.

But when you do that, you're actually

using the full curve. You're using what the mean curve is that comes out of the MAAP type code or the MELCOR type code. So you don't average it. You just use it as you go along.

So you're talking about two different spaces.

MS. HART: Now, the only information we use from this whole study is a removal lambda that would be applied to an airborne concentration that is determined in another way.

DR. WALLIS: So what do you use for lambda?

MS. HART: I used varying lambdas. I used the median lambdas, which would be the --

DR. WALLIS: So it does vary.

MS. HART: It does vary, and I have to time average it.

DR. WALLIS: And I guess my Chairman is telling me it doesn't make any difference so I don't need to worry.

CHAIRMAN KRESS: That's right.

DR. WALLIS: All right. Thank you.

(Laughter.)

CHAIRMAN KRESS: Its value makes some difference.

MS. HART: Right.

DR. SHACK: Well, I take more comfort in the fact that all of these things are so similar.

DR. WALLIS: And they're not displaced in time because were they displaced in time the you could, again -- Bill Shack knows what I'm talking about.

MS. HART: Okay. So having done that, even though we used different removal coefficients than Westinghouse did, we also show that the doses are below the dose criteria of 50.34 for off site and GDC-19 for on site, the control room.

DR. WALLIS: Are they far below or just below?

MS. HART: Westinghouse had back calculated and used the chi/Qs that give them the maximum dose for LOCA. So they are right at the limits. My doses are somewhat below that because my removal coefficients are different over the period of time than theirs are.

DR. WALLIS: So they are right at the limit?

MS. HART: They are right at the limit.

DR. WALLIS: So a slightly different tweaking of the data might make them above the limit?

MR. CUMMINS: This is Ed Cummins.

This is really an issue of a site interface issue,a nd the chi/Q, which is the dispersion factor for the site, if you were us, you would calculate the dose limit, the chi/Q that gave you exactly the limit because that would permit the most sites to be. So any site with chi/Q less than what we needed in order to pass is acceptable, and if you're over that, then you have to do all of this assessment.

So, again, it's a rational thing for us to do.

DR. WALLIS: Well, you're always rational.

(Laughter.)

MR. SIEBER: You're trying to find the limiting condition.

MS. HART: Right, right. Exactly.

This slide describes why we think the use of the medium values is acceptable. The traditional approach is the accepted bounding value, which in this case would be at the lower end of those uncertainty analysis like the fifth percentile.

We do believe it's acceptable for our purposes. The median value is the least affected by the user's subjective judgment for the bounds and the shape of those sample parameters.

We introduced that conservative bias I discussed earlier in the choice of those initial conditions for those parameters and the shape of the distribution.

There's a precedence in the Perry AST case where they used a median value for the steam line deposition, and that was based on other conservatisms in the analysis, and our code requires yet another averaging of those lambdas because of the constraints of how the code is operating.

And the fully integrated MELCOR calculated removal rates are mostly well above the fifth percentile. That can be seen on this graph.

DR. WALLIS: The four different code predictions? It looks like thermal hydraulics.

MS. HART: It does, doesn't it? And in fact, it follows thermal hydraulics to some degree. The smooth blue and orange curves are the thermal hydraulics with -- I mean use the thermal hydraulics either from MAAP or MELCOR, and it's the uncertainty calculations that we're running with MELCOR, the Monte Carlo calculations.

The dark blue line is an ERI MELCOR run that they had run with just the 3BE scenario, 3BE-1 scenario, and it's the full integrated, and those are the removal that was calculated within MELCOR, and the red line is our Westinghouse's numbers.

DR. WALLIS: This is what you call reasonable agreement?

MR. SIEBER: Yeah.

MS. HART: I would say for our purposes, yes, this is reasonable.

DR. WALLIS: For your purposes because you only care about getting the decontamination coefficient within 50 percent or something. Is that the idea?

MS. HART: Right.

DR. WALLIS: Because the test of whether the codes are doing a good job really doesn't look very good.

MS. HART: No.

(Laughter.)

MR. SIEBER: It is like thermal hydraulics.

DR. SHACK: They do go up and down.

(Laughter.)

MR. SIEBER: Sensitive to something

DR. WALLIS: Well, there's some strange looking cliffs and things, but anyway, let's pass on.

MS. HART: And that would be the end of my presentation. Are there any further questions?

MR. SIEBER: Thank you.

MS. HART: Thank you.

MR. SEGALA: This is John Segala.

My last slide, all the open items were resolved, and we're still on schedule.

After lunch today I have a presentation to go over the interim letter issues. So we'll have another shot at discussing some of these issues.

DR. WALLIS: So we have to wait until --

CHAIRMAN KRESS: Well, we're ahead of schedule.

DR. WALLIS: Can we move on with the next slide? Are we not allowed to do that?

MR. SIEBER: It's a title slide.

CHAIRMAN KRESS: Well, that's generally a no-no. We could do things like come back at 12:15 -- no, that wouldn't work either.

MR. SIEBER: Why would we do that?

MR. ROSEN: We could take a longer lunch hour.

CHAIRMAN KRESS: Yeah, we could come back at 12:30

MR. SIEBER: That would be good.

CHAIRMAN KRESS: And start at 12:30 and get ahead. That's not enough of a perturbation to schedule that it hurts anything.

So why don't we do that? Break for lunch and come back at 12:30 and start again at 12:30 instead of one.

DR. WALLIS: And what the NRC is going to present is the rest of these transparencies?

CHAIRMAN KRESS: Yes, sir, starting with Item 5 there, and it's the rest of these transparencies.

DR. WALLIS: Okay. Thank you.

CHAIRMAN KRESS: Okay. I'll recess until 12:30.

(Whereupon, at 11:30 a.m., the meeting was recessed for lunch, to reconvene at 12:30 p.m., the same day.)

AFTERNOON SESSION

(12:31 p.m.)

CHAIRMAN KRESS: Let's get started again, please.

MR. SIEBER: Still feeling okay?

MR. SEGALA: Well, my voice is a little bit more scratchy.

MR. SIEBER: You can sit down.

MR. SEGALA: I feel fine. I just can't talk.

I'm John Segala again for the AP1000 design certification.

The purpose of this slide presentation is to go over the interim letter issues that we received from you.

This presentation is pretty similar to what we gave you in the beginning of the month. We do have some additional information regarding the organic iodine.

Issue one was the ADS Squib valve function. We had a slide on this this morning, and Westinghouse talked about this, but I think in the letter you agreed that an ITAAC assures the values meet the design basis, and it has a simple design, Section 3, Class I valve. It has redundant and diverse actuation.

The staff did a PRA sensitivity study and it increased the failure probability to not change the PRA conclusions, and the ITAAC requires a type test, and it says that a test for type test of Squib valves will be performed to demonstrate the capability of the valve to operate under its design conditions, and a test report concludes that the Squib valves change their position under design condition, and that the as installed Squib values are bounded by the testes or type tests.

For the screen blockage issue, the staff would like to propose -- I guess we had discussions earlier on this, and I think we'd like to have some internal meetings and give you a presentation at the full committee meeting in July if that would work for you.

CHAIRMAN KRESS: Okay.

MR. SEGALA: Code deficiencies was an issue. This was during the thermal hydraulic review. The item was when deficiencies are found should the weaknesses be corrected, and I think both looking at the APEX AP1000 data we discovered deficiencies in both NRC's and Westinghouse's codes.

RELAP, which is the staff's code, we're

not planning to go back and fix. However, the face code the staff is assessing against APEX AP1000, as well as ATLAS and UP --

DR. WALLIS: How does fixing up the staff's code accommodate deficiencies in Westinghouse's code?

MR. SEGALA: We're looking in the future for future uses of TRACE. In terms of Westinghouse's code, they performed other analyses that showed that they were okay during those time periods where no --

DR. WALLIS: Yes, I know that. That's part of the discussion in our letter, but it made quite an impression on the full committee. The NOTRUMP and its' one APEX series which didn't look quite the same as the code predictions, and if this is the case, then it would seem that either now or down the road there should be some awareness of this so that when the code is used again, there's some effort to figure out why it didn't work that last time and to fix it because presumably it's a tool that's going to be used again.

So it's not just up to you to fix your code, but there ought to be some way in which the vendor codes, which are sometimes very old, are actually fixed up when deficiencies are found like this.

CHAIRMAN KRESS: Yeah, we didn't consider this an issue with respect to AP1000 certification because they bounded these things and worked around them, but we just thought it wasn't a good idea to have a code there that may have some things wrong with it and needs fixing, and we recognize that NRC blesses these codes for particular uses, and you can put conditions on the use, but we just thought it would be a good idea somehow to get those deficiencies fixed. We're glad you're going to do it for TRACE. That would help.

MR. SIEBER: But that really doesn't solve the problem.

CHAIRMAN KRESS: Well, the problem is in case the code gets used for some other purpose, and the staff has some constraints on these kind of things.

MR. SEGALA: Yeah, when we write our safety evaluations we make it very clear what it can be used for.

MR. SIEBER: Well, as each individual plant is licensed, at the operating license stage they have to run that code for that plant, right? In order to meet Appendix K?

And so if a code is deficient, then that means you've got to have these little bounding fix-up segments in order to come up with a result. I guess that's legitimate, but, on the other hand, it seems to me to be a clumsy way to do it

MR. COLACCINO: This is Joe Colaccino with the staff.

One of the things we asked Westinghouse to do and what they did do was to identify what their evaluation model was in their design control document. So when these plants go into the future, they will have to follow that evaluation model. The constraints do not just exist in our FSER, but it's actually in the design control document.

So I guess with respect to AP1000 we feel like we're on solid ground in the evaluation of the evaluation model.

MR. SIEBER: Yeah, but you will still end up using the bounding calculations for certain segments of the transient, which to me is perhaps okay, but not very sophisticated.

MR. SEGALA: Yeah, and I think the 50.46, when you look at it, it does not require that you have one evaluation model or one code that fulfills that. So in terms of meeting the regulations, those were the criteria that we were faced with.

MR. SIEBER: Okay.

MR. SEGALA: The next issue was the range of pi group values. In the interim letter you stated that the staff should verify a pi group range of .5 to two, as appropriate.

This range has been used as a de facto standard in scaling analysis, and we believe this issue is generic, not san issue specific only to AP1000.

CHAIRMAN KRESS: We heard from Steve Bejoric (phonetic) that there were plans to actually look at this.

MR. SEGALA: Yeah.

CHAIRMAN KRESS: Is there a schedule for that?

MR. SEGALA: Not that I'm aware of. We don't have Steve here today, but we could -- I think everything he told you the last time is pretty much the same as it is today

CHAIRMAN KRESS: Once again, we view that as kind of confirmatory type research. The assumption is that the pi group range is okay, and based on, well, thinking and intuition and looking at code results and things that we'd like to see this as a confirmatory thing for the staff to do.

DR. WALLIS: I think both this item and the previous one point up some what you could call them as generic issues that we have with these things.

CHAIRMAN KRESS: These are generic issues.

DR. WALLIS: Yeah, they don't invalidate the approval of AP1000, but they are some generic issues that have been raised as a result of what some people call lessons learned from this review.

CHAIRMAN KRESS: Well, this will call come up in certification of the other type of design, and we'd like to have a better technical basis for it.

The issue is whether or not over those ranges of pi groups, do you somehow change flow regimes that some how causes a marked change in what you should have expected your code to predict or your scaling to be.

Well, I understand Steve has plans to look at it or somebody has plans.

DR. WALLIS: It's more reassuring when you have a pi group which may be .5 in one facility and it's .2 in another facility, and you can say one is somewhere in between. If it's bracketed in some way, that perhaps is more reassurance than just if the pi group is always under or over in all facilities.

CHAIRMAN KRESS: Pardon? I didn't catch that.

DR. WALLIS: I was saying that if you had -- supposed you have two experimental facilities and the pi group is .5 in one and two in the other, you might tend to believe that one is somewhere in between, but if you have two facilities and the pi group is .5 and one is .55 in the other, that's not so good. I'm just thinking how one might require this to be handled in the future if one had doubts.

CHAIRMAN KRESS: Yeah, if you had two separate facilities.

DR. WALLIS: Right.

CHAIRMAN KRESS: And were using those for carrying it, and if you bracketed those --

DR. WALLIS: Right. That might be more reassuring.

CHAIRMAN KRESS: Yeah, that would be. You're right. Okay.

DR. WALLIS: And I think that may be the case for some of these.

CHAIRMAN KRESS: It could very well be.

DR. WALLIS: Right, right.

MR. SEGALA: Issue five, in-vessel retention, fuel coolant interactions. Westinghouse had a brief slide of that this morning. The interim letter said that the IVR assessment needs to consider the effects of exothermic intermetallic reactions.

We'd like to review the FCI models. The staff provides you a copy of contractor reports. I don't know if you have any comments on that.

CHAIRMAN KRESS: Well, I haven't had a chance to digest those two reports, but I do have them, and it's -- the vessel flooding for AP1000 is almost a defense in depth thing. They don't need it to meet the goals, and it doesn't enter into the design basis space at all. It's just that it's like another generic type issue. We're going to be faced with the same thing for other reactor types, and I'd just like to know how the staff deals with those things.

It may be more important for some other reactors. I don't know, and so the idea of this thing was, number one, did we properly do a review and a defense in depth concept for the AP1000, and I think what I've looked at so far is the sensitivity studies that were done, and it looks like those properly ranged what I would say would be the possible variations in the melt mass to the super heat and a pretty good calculation of the resulting intergetics, and even those things when you go to the extremes didn't fail the containment.

So as far as I'm concerned it's a resolved issue for AP1000, but I still want to know. It's another one of these maybe lessons learned, generic issues, other certification designs.

And so I will review these two other reports and see, but as far as I'm concerned, it's not a problem now for AP1000.

MR. SEGALA: Okay. Issue six, organic iodine production. The issue involved the inside of containment. During an accident you have steaming and the water condenses on the wall, and the concern was what is the pH of the film on the inside of the wall, and you know, a simple statement: water film pH determines iodine behavior. pH less than seven leads to production of elemental iodine, some of which is converted into an organic iodine, and that's what would get released outside of containment.

And sort of the opposite of that is to prevent organic iodine production. The film pH should be maintained above seven.

MR. SIEBER: How do you do that?

MR. SEGALA: Well, Westinghouse did some calculations. The first calculation, they assumed the amount of cesium hydroxide present for the DBA source term, and they determined that the pH is maintained above seven. To sort of look at the effects of limited cesium hydroxide, they did a minimum calculation where 270 grams of cesium hydroxide, about .1 percent of what's available is sufficient to keep the pH above seven.

And then they did a third evaluation where what they called their sensitivity study. They assumed no cesium hydroxide present and then looked at what were the effects of that, and the organic iodine in containment increased from .15 percent to .33 percent, and they were able to show that with the conservatisms in the dose calcs. that they still met the DBA dose criteria.

DR. WALLIS: What is your definition of organic iodine?

CHAIRMAN KRESS: Methyl iodine.

DR. WALLIS: Methyl, it's methyl iodine.

CHAIRMAN KRESS: Yeah.

MR. SEGALA: After we met with you in June, on June 3rd, I believe, the staff audited Westinghouse's calculations in Westinghouse's Rockville office, and the staff found these calculations to be acceptable, and we agree with their conclusions.

CHAIRMAN KRESS: Dana's problem was the nitrogen in the atmosphere would tend to take the film acid, and apparently the calculation for that is the absorption of nitrogen into the liquid and then conversion to the nitric acid, whereas he says, no, that's not the way to do it, that it gets converted in the gas phase and then gets absorbed.

Was anything to address that done?

MR. SEGALA: Yeah, I believe our contractor -- Andre, do you have any?

MR. DROZO: This is Andre Drozo, and I'm representing Kris Parczewski who was doing the actual calculations.

He concluded and we all concluded that indeed the acid is produced in the liquid film.

CHAIRMAN KRESS: In the liquid?

MD. DROZO: In the liquid, yes.

That he went through available literature in at least one Oregon (phonetic) and Oak Ridge test, and that they had a liquid and a gas flowing simultaneously, and they determined that 99.99 percent of acid is being produced in the liquid film.

CHAIRMAN KRESS: So Westinghouse's calculation as opposed --

MR. ROSEN: Are you saying Dana is wrong?

CHAIRMAN KRESS: I don't know.

MR. ROSEN: It will be the first known instance of it.

CHAIRMAN KRESS: The first time.

DR. WALLIS: That's a very slow reaction to dissolution of nitrogen to form --

MR. DROZO: Methyl comes from --

DR. WALLIS: Well, I'm sorry. You're answering a different question.

CHAIRMAN KRESS: Well, the idea is the nitrogen makes it acidic.

DR. WALLIS: Yeah, but it's a very slow reaction, absorption of nitrogen to make an acid.

CHAIRMAN KRESS: Yeah, if you're absorbing it, if you're absorbing it. That's not what Dana says happened.

MR. ROSEN: Yeah, Dana said --

DR. WALLIS: Yeah, but he's saying Dana is wrong, I think.

MR. ROSEN: Yeah, and Dana was saying that the formation is of nitrous oxide in the air.

DR. WALLIS: Well, if that's there, then I can see it being absorbed.

CHAIRMAN KRESS: Yeah, it absorbs rapidly.

DR. WALLIS: But I can't see nitrogen itself being absorbed rapidly.

CHAIRMAN KRESS: And that's the point. Which is it? Is it nitrous oxide in the air going in or is it --

DR. WALLIS: And what makes that?

CHAIRMAN KRESS: Radiation fuel.

DR. WALLIS: Radiation fuel.

MR. DROZO: And I would never say Dr. Powers is wrong. I would never say that.

(Laughter.)

MR. SIEBER: He's not here.

CHAIRMAN KRESS: He'll be here for the full meeting in July. We may have this on the agenda because I think it is probably the one lingering ACRS item that -- you know, once again it's almost a "no never mind" because it doesn't enter design basis space hardly and because you've got a specified source term in there, and severe accidents are such low frequency that who cares almost.

So in my mind it doesn't raise itself to an issue, but it's a kind of a lingering thing that's on Dana's mind, and so it's something we want to get off the table. So keep in mind that this might be one of the things that you want to look at again.

And, in particular, this calculation that Andre is talking about would be well worth bringing forward for the meeting.

MR. SCHULZ: This is Terry Schulz.

Let me just say one little thing here. The sensitivity study that we redid there doesn't depend on what's going on with the nitrogen and nitric acid at all. That only comes in --

CHAIRMAN KRESS: Do you want to let that be acid anyway?

MR. SCHULZ: Yes.

CHAIRMAN KRESS: Okay. Well, that's another. That's well worth bringing out. That doesn't matter.

MR. SCHULZ: Right. This issue of how much nitric acid there is and how quickly it's formed comes into play in the first tube.

CHAIRMAN KRESS: Because you want to add Lead B acid.

MR. SCHULZ: Yes.

CHAIRMAN KRESS: Then Dana is going to ask what were your sources of the organic/inorganic.

MR. SCHULZ: There are still questions, yes.

CHAIRMAN KRESS: Yeah. But anyway, that

is a good point.

MR. ROSEN: Remind me if you will of where this half a pound of cesium hydroxide comes from.

CHAIRMAN KRESS: Right out of the fuel.

MR. ROSEN: That much

CHAIRMAN KRESS: Oh, there's more than that.

MR. DROZO: Potentially in the core.

CHAIRMAN KRESS: Fission products. It might release ten, 30 percent of it.

MR. DROZO: That's correct.

MR. ROSEN: Well, where does the methyl group come from?

MR. DROZO: Well, that's already there.

MR. SIEBER: You need to use the microphone.

MR. ROSEN: In the fuel?

MR. DROZO: Methyl comes from reaction of elemental iodine and the insulation materials in the containment.

CHAIRMAN KRESS: Yeah, it's insulation materials that gives you the --

DR. RANSOM: With stainless steel?

MR. DROZO: No, no. With not rubber but this plastic electrical insulation.

MR. SIEBER: Cabling.

MR. DROZO: Cabling, yes.

MR. SIEBER: Yes, wire insulation.

MR. DROZO: Wires.

DR. RANSOM: It's hydrocarbon material.

MR. DROZO: Right.

CHAIRMAN KRESS: And you can make some methane in the core if you've got the right chemistry. You've got the hydrogen there, and you've got the carbon. You've got the materials. You could make some, and there has been some chemical equilibrium calculations that says there's a certain level of it.

You know, it's not a lot, but you can make it.

But, anyway, this is one that Dana will be interested in hearing in July

MR. SEGALA: Issue seven, which is the last issue, catastrophic failure of steel containment, the concern was a free standing steel containment can fail in a catastrophic manner. When its failure pressure is exceeded, this could lead to a rapid depressurization and resuspension of the deposited fission products.

The staff determination of the frequency of the catastrophic containment failures were small and resuspension would not have a noticeable impact on the commission's safety goals.

DR. WALLIS: You mean on meeting the safety goals.

MR. SEGALA: Yes.

DR. WALLIS: It's not going to change the goals.

MR. SEGALA: yeah.

CHAIRMAN KRESS: Although sometimes I wish they would.

(Laughter.)

MR. SEGALA: So this is in summary open items are resolved from our perspective, although we need to talk to you about one of them. All ACRS issues are addressed, and it looks like you still want to talk about the organic iodine.

CHAIRMAN KRESS: I don't see that as a show stopper, but --

MR. SEGALA: Okay.

DR. WALLIS: You might get questions from Dana.

CHAIRMAN KRESS: You certainly will.

MR. SEGALA: He'll be there at the next fully committee?

CHAIRMAN KRESS: Yeah.

PARTICIPANT: July 7th.

MR. SEGALA: NRC staff is still on schedule to issue the FSER.

CHAIRMAN KRESS: Okay. Thank you very much.

I think we're nearing the end here. This is the time for item number six, and I think we don't need a break yet.

Item number six is a summary statement from either Westinghouse, the staff or both. Does Westinghouse wish to make some summary remarks?

MR. VIJUK: Not really. I think we believe we've satisfied what the staff has asked for, and we hope we're getting close to satisfying you.

CHAIRMAN KRESS: I presume the staff will make any summary remarks or do they?

MR. SEGALA: No, not at this time.

CHAIRMAN KRESS: Okay. I think what we need to do now before we -- well, there is an item on here for public feedback, and I don't see anybody there. So we'll forget that one.

We need to decide on what to do at the full committee meeting in July. Does Westinghouse come to that, I presume?

PARTICIPANT: Yes.

CHAIRMAN KRESS: We have two hours. My proposal is to give Westinghouse 45 minutes and the staff 45 minutes.

DR. WALLIS: Well, I suggest that Westinghouse concentrate on why they meet the regulations and no so much a description of what a wonderful machine it is.

CHAIRMAN KRESS: Yeah, I would suppose you skip the design review. I think we're up on that, and you know, stick on your approach to safety. I think you can skip the Squib valve stuff, too, now and maybe include the PCC and the safety margin slides and maybe the summary of the severe accidents and the CDF and LRF, and that way you can condense this to maybe 45 minutes.

MR. VIJUK: That's fine.

CHAIRMAN KRESS: And the staff, I think you almost have a 45 minute talk with what you have, and I would just sort of repeat that, but remember you may have to spend more time on the organic and add that in.

And I think we also would look forward to hearing about the exact wording of the COL action item on the screen blockage. What does it actually say? You might want to bring that with you.

And I think that that would wrap it up for us.

DR. WALLIS: I think it's miraculous, Mr. Chairman, how the staff has managed to summarize this one foot high stack of paper over here in a short time.

CHAIRMAN KRESS: Yeah. I wonder if I could bill the staff for my eye doctor's appointment, trying to read that off of my PC.

(Laughter.)

CHAIRMAN KRESS: Would that be billable to Westinghouse?

(Laughter.)

MR. CUMMINS: Everything seems to be billable to Westinghouse.

(Laughter.)

CHAIRMAN KRESS: Well, with that, are there any further comments from the subcommittee members?

MR. ROSEN: Yeah. I don't think you've characterized or I don't understand the characterization of the sump issue as to summarize the COL action item. I think the issue is that we've come upon a current item, current regulatory issue item, and the question is do we -- and we're about to certify this design or recommend certification of this design, and the question is how does in regulatory space one handle that subject.

Do you include it as a post certification item, a COL action item, or do you say, no, we need to have a resolution or a commitment to resolution in the current licensing basis for this plant?

My feeling is it's the latter, that this is not a backfit for this plant. This plant is now being licensed.

So you know, to say it's going to be a compliance backfit later like it is for the operating plants, that's because those plants are already licensed. That's why we're treating it that way.

This plant is not licensed.

CHAIRMAN KRESS: Yeah, but it's being licensed to just about the same rules.

MR. ROSEN: Well, the rules are Reg. Guide 1.82. That's with that 50 percent blockage assumption, which we know is incorrect.

CHAIRMAN KRESS: But the rule has associated with it guidance, and that guidance has been followed by the plants and will be followed by Westinghouse, and the idea is that that guidance is going to change, but it hasn't yet.

And so you're stuck in a time warp there, but maybe the staff could be prepared to elaborate a little bit on how that issue is being treated.

MR. COLACCINO: Yeah, this is Joe Colaccino.

And as we said, just after the morning session the staff will give you in the July 7 meeting a complete discussion of it and not just a little discussion of the COL item.

CHAIRMAN KRESS: Yeah, that would be a good thing to put on there, too.

MR. COLACCINO: And we plan to make it a significant part of our presentation to the full committee.

CHAIRMAN KRESS: Good. Thank you.

I think that might be well worthwhile.

Anybody else?

(No response.)

CHAIRMAN KRESS: Well, seeing none, I want to thank all of the speakers, the staff and Westinghouse, and I must say I think our interactions on this have been, over the period of time, it has been very good, and so, you know, I thank you for that.

MR. VIJUK: We feel the same. Thank you.

CHAIRMAN KRESS: And we look forward to seeing you in July.

With that I'm going to declare this meeting adjourned.

(Whereupon, at 1:01 p.m., the meeting was adjourned.)

CERTIFICATE

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

Name of Proceeding: Advisory Committee on Reactor Safeguards Future Plant Designs Subcommittee

Docket Number: n/a

Location: Rockville, MD

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

Rebecca Silberman

Rebecca Silberman
Official Reporter
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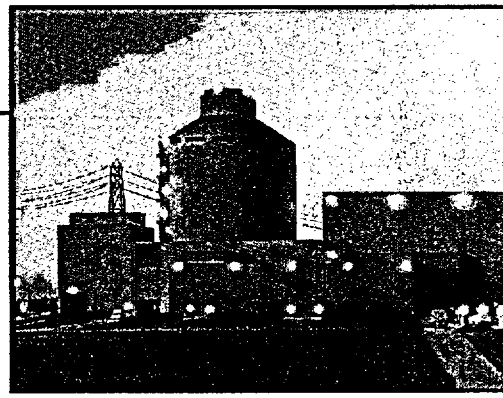
AP1000



AP1000 Overview

Westinghouse Electric Company

Presentation to

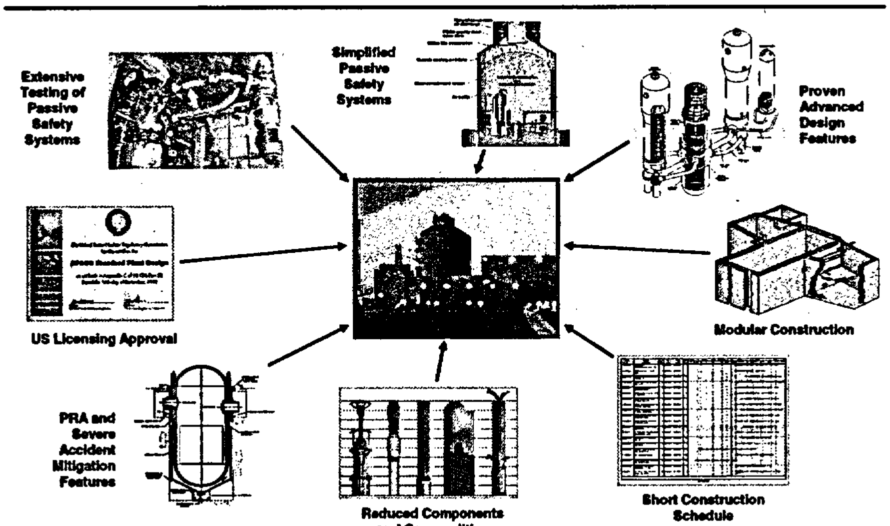
Advisory Committee on Reactor Safeguards

June 25, 2004

BNFL Westinghouse

AP1000

AP600/AP1000 Investment in Technology



BNFL Slide 2 Westinghouse

AP1000 Design Approach

AP1000

- **Reduce Cost by Increasing Plant Power Rating**
  - Obtain a capital cost that can compete in U.S. market $1000/KWe for n^{th} twin plant
- **Retain AP600 Objectives and Design Detail**
  - Increase capability/capacity within "space constraints" of AP600
  - Retain credibility of "proven components"
  - Retain the basis for the cost estimate, construction schedule and modularization scheme
- **Retain AP600 Licensing Basis**
  - Meet regulatory requirements for Advanced Passive Plants
  - Accept AP600 policy issues

AP1000 Design Features .... Same as AP600

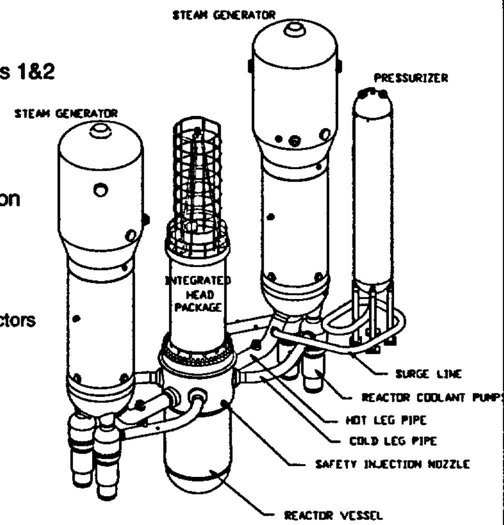
AP1000

- **Integrated, Standard Power Plant Design**
- **Proven Power Producing Components (Reactor, Fuel, ...)**
  - No plant prototype required
- **Simplified RCS Loops with Canned Motor Pumps**
- **Simplified Passive Safety Systems**
  - Increase safety margins and address severe accidents
- **Simplified Nonsafety Defense-In-Depth Systems**
- **Microprocessor, Digital Technology Based I&C**
- **Compact Control Room, Electronic Operator Interface**
- **Optimized Plant Arrangement**
  - Construction, Operation, Maintenance, Safety, Cost
- **Extensive Use of Modular Construction**

AP1000

Proven AP1000 Major Components

- **Fuel, Internals, Reactor Vessel**
  - Similar to Doel 4, Tihange 3, S. Texas 1&2
  - No bottom-mounted instrumentation
  - Improved materials - 60 yr life
- **Steam Generators, Δ125**
  - Similar to large W/CE SGs in operation
    - System 80, ANO RSG
- **Reactor Coolant Pumps**
  - Canned motor pumps, no shaft seals
    - Naval reactors, early commercial reactors (Shippingport, Yankee Rowe)
- **Simplified Main Loop**
  - Reduces welds 50%, supports 80%
- **Pressurizer**
  - Typical West. design
  - 50% larger than operating plants



BNFL Slide 5 Westinghouse

AP1000

AP1000 Approach to Safety

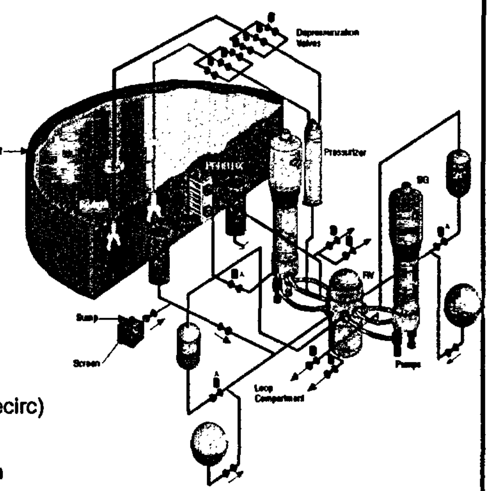
- **Passive Safety-Related Systems**
  - Use "passive" process only, no active pumps, diesels, ...
    - One time alignment of valves
    - No support systems required after actuation
      - No AC power, cooling water, HVAC, I&C
  - Greatly reduced dependency on operator actions
  - Mitigate design basis accidents without nonsafety systems
  - Meet NRC PRA safety goals without use of nonsafety systems
- **Active Nonsafety-Related Systems**
  - Reliably support normal operation
    - Redundant equipment powered by onsite diesels
  - Minimize challenges to passive safety systems
  - Not required to mitigate design basis accidents

BNFL Westinghouse

AP1000

AP1000 Passive Core Cooling System

- **PRHR HX**
  - Natural circ. heat removal
- **Passive Safety Injection**
  - Core Makeup Tanks
    - Full RCS pres, natural circ. inject
    - Replaces HHSI pumps
  - Accumulators
    - Similar to current plants
  - IRWST Injection
    - Low pres (replaces LHSI pumps)
  - Containment Recirculation
    - Gravity recirc. (replaces pumped recirc)
  - Automatic RCS Depressurization
    - Staged, controlled depressurization
    - Stages 1-3 to IRWST, stage 4 to containment

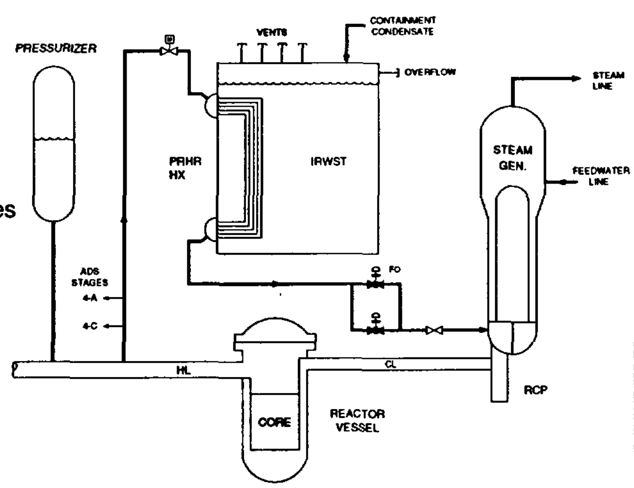


BNFL Slide 7 Westinghouse

AP1000

Passive Decay Heat Removal

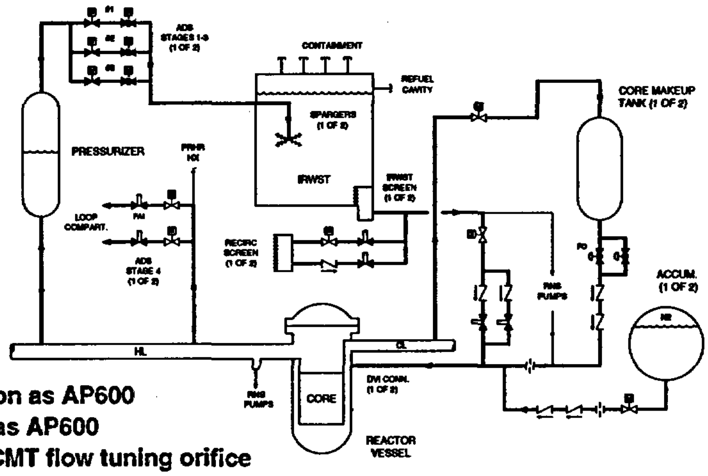
- Same configuration as AP600
- Same elevations as AP600
- Larger pipe / valve sizes
- Increased HX surface
  - More tubes
  - Longer horizontal section



BNFL Slide 8 Westinghouse

AP1000

Passive Safety Injection



- Same configuration as AP600
- Same elevations as AP600
- Larger CMT and CMT flow tuning orifice
- Larger IRWST, Recirc, ADS 4 lines

AP1000

ADS 4 DCD Valve Qualification

- **Design Verification (5.4.6.3)**
  - Includes valve qualification and pre-operational, in-service tests
  - Valve qualification includes
    - Testing to verify flow capability (5.4.6.3)
    - Type testing(1) and/or analysis to verify opening capability (5.4.8.1.3)
      - Min/max DP, limiting plant conditions, ...
      - Structural loads from seismic, flow actuation, ...
      - Environmental aging from radiation, heat, steam, ...

Note 1. Testing, type testing based on ASME QME-1 and IEEE 627.

AP1000

ADS 4 ITAAC Requirements

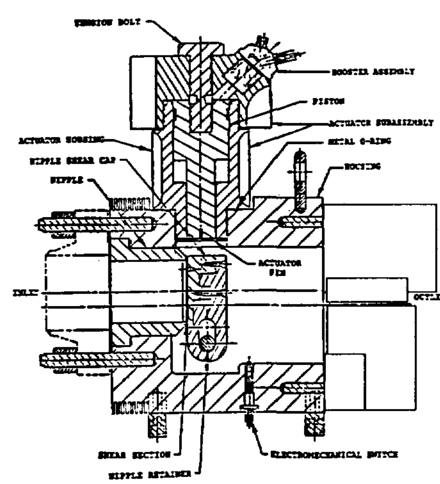
- **Seismic Capability (5.a.ii)**
  - Type test(1) and/or analysis
- **Harsh Environment Qualification (7.a)**
  - Type test(1) and/or analysis
- **Change Position (12.a.iv)**
  - Tests or type tests(1)
- **RCS Depressurization**
  - Stage 4 lines, HL to cont (8.d.ii)
    - Inspection of as-installed lines and analysis (R ≤ xxx ft/gpm^2)
  - Stage 4 valve minimum flow area (8.d.iii)
    - Inspection of as-installed valves (min area ≥ xx in^2)
  - Stage 4 valve discharge elevation (8.d.vi)
    - Inspection of as-installed valves

Note 1. Testing, type testing based on ASME QME-1and IEEE 627.

AP1000

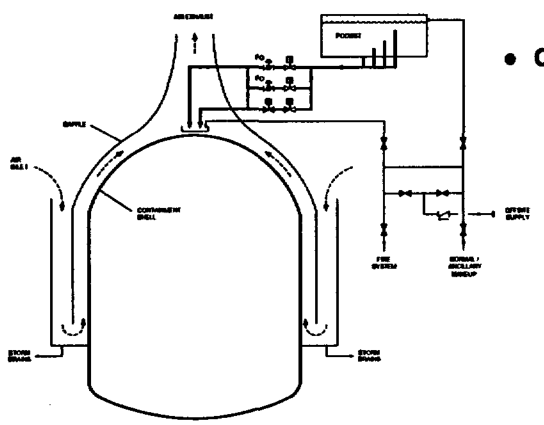
Anticipated ADS 4 Valve Qualification

- **Hydro, Leakage, Thermal (hot inlet)**
- **Valve Operability**
  - Design max / min inlet pressure
  - Degraded booster
- **Flow Capability**
  - Water flow capability (L/D)
  - Saturated steam flow capacity
    - Also provides opening loads
- **Environmental Conditions**
  - Accelerated radiation, heat, steam aging
    - Storage, normal, post accident conditions
    - Aged boosters actuated
  - Seismic and other dynamic loads
    - Vibration testing to cover seismic and valve actuation loads



Passive Containment Cooling

AP1000



- **Same Configuration as AP600**
  - Except added 3rd diverse valve
    - Adds PRA margin
- **Capacities Increased**
  - Containment volume & design pres
  - PCS Water Storage Tank
    - Provides 72 hr drain
      - Afterwards use on/offsite water
      - Air only cooling prevents/delays failure in PRA sequences
    - Flow decreases with time
      - Uses 4 standpipes
  - PCS Flow Rates
    - Same high initial flow
      - Rapidly forms water film
      - Effectively reduces cont pressure
    - Later flows increased
      - Match decay heat

BNFL　Slide 13　Westinghouse

AP1000 Safety Margins

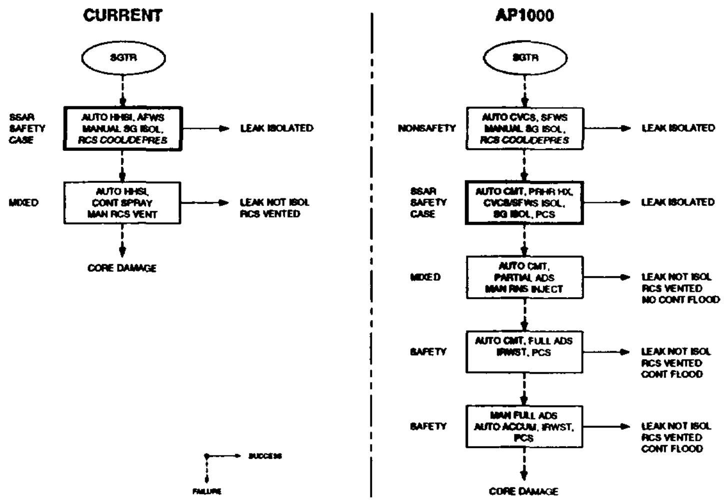
AP1000

	Typical Plant	AP600	AP1000
• Loss Flow Margin to DNBR Limit	~ 1 - 5%	~16%	~19%
• Feedline Break (°F) Subcooling Margin	>0	~170	~140
• SG Tube Rupture	Operator actions required in 10 min	Operator actions NOT required	Operator actions NOT required
• Small LOCA	3" LOCA core uncovers PCT ~1500°F	< 8" LOCA NO core uncovery	< 8" LOCA NO core uncovery
• Large LOCA (°F)	2000 - 2200	1676	2124
• ATWS, Pres (psig)	3200	3200	2800
UET (% core life)	5-10%	10%	0%

BNFL　Slide 14　Westinghouse

AP1000 Has More Levels of Defense (SG Tube Rupture Example)

AP1000



BNFL Westinghouse

AP1000 CDF and LRF Summary

AP1000

- **Meets US NRC Safety Goals with High Margin & Low Uncertainty**
  - *Demonstrates effectiveness of passive safety features*
    - Reduced dependency on operator actions and nonsafety features
    - Low safety risk from floods and fires
  - Severe accidents addressed by design

	Core Damage Frequency		Large Release Frequency	
	At-Power	**Shutdown**	**At-Power**	**Shutdown**
Internal Events	2.41E-07 /yr	1.23E-07 /yr	1.95E-08 /yr	2.05E-08 /yr
Internal Floods	8.80E-10 /yr	3.22E-09 /yr	7.10E-11 /yr	5.40E-10 /yr
Internal Fires	5.61E-08 /yr	8.52E-08 /yr	4.54E-09 /yr	1.40E-08 /yr
Sub-Totals	2.98E-07 /yr	2.11E-07 /yr	2.41E-08 /yr	3.50E-08 /yr
Grand-Totals	5.09E-07		5.92E-08	
NRC Safety Goals	1 E-4		1 E-6	

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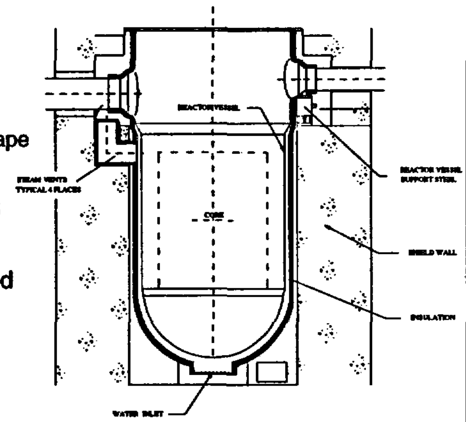
Westinghouse

AP1000 Addresses Severe Accidents

AP1000

- **Core-Concrete Interaction**
  - Invessel Retention / ex-vessel cooling
  - Means of cooling damaged core
  - Tests and analysis of IVR
    - Performed for AP600 and AP1000
    - AP1000 uses improved insulation shape
- **High Pressure Core Melt**
  - Eliminated by redundant, diverse ADS
- **Hydrogen Burn, Detonation**
  - Hydrogen vent paths from RCS located away from containment shell
  - Redundant, diverse igniters / PARs
- **Ex-Vessel Steam Explosions**
  - Prevented by IVR
  - Containment integrity even if IVR fails

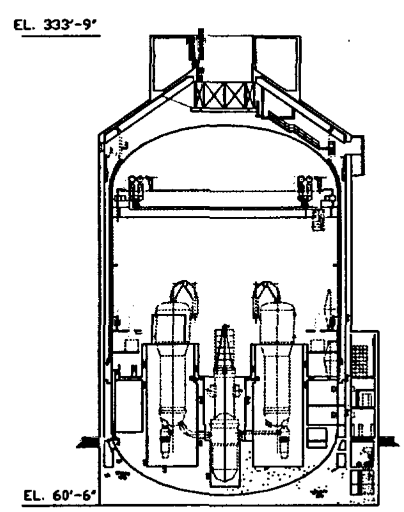


BNFL Westinghouse

AP1000 vs AP600 Structures

AP1000

- **Containment vessel, shield building raised 25'6"**
- **PCS tank capacity increased ~50% to 800,000 gal.**
- **PCS air inlets reconfigured to 12' x 6.5'**
- **Polar crane raised and capacity increased**
- **RCS equipment increased in size**
- **Steam generator and pressurizer compartment walls raised**
- **Fuel pit floor elevations lowered by 18.5"**

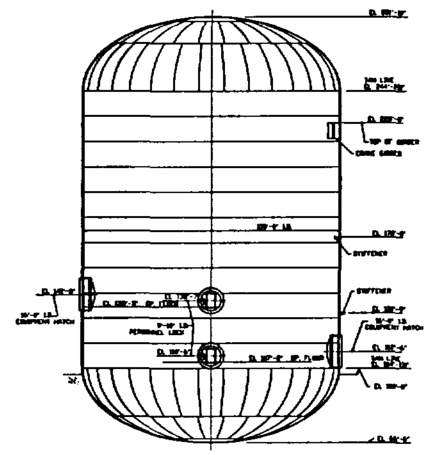


BNFL Slide 18 Westinghouse

AP1000

Containment Vessel General Outline

- Diameter: 130 feet
- Height: 215 feet 4 inches
- Design Code: ASME III, Div. 1
- Material: SA738, Grade B
- Design Pressure: 59 psig
- Design Temperature: 300°F
- Design External Pres: 2.9 psid

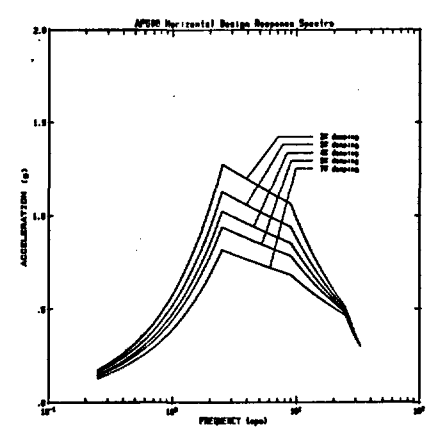


BNFL Slide 19 Westinghouse

AP1000

Seismic Design Basis

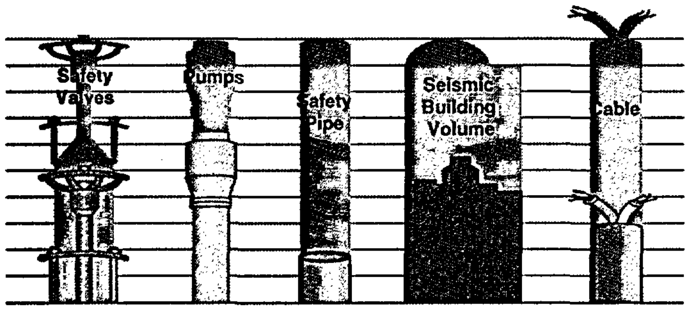
- 0.30 g SSE at foundation level
- Hard Rock foundation
- RG 1.60 response spectrum amplified at high frequencies



BNFL Slide 20 Westinghouse

AP1000 Simplifications Drive Economics and Construction Schedule

AP1000



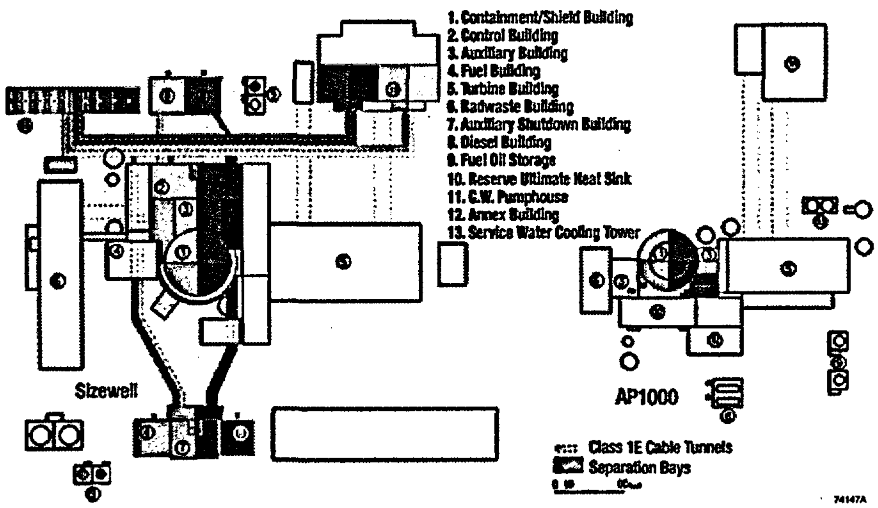
- **Reduced Number of Components:**

	1000 MW Reference	AP1000	Reduction
- Safety Valves	2844	1400	51%
- Pumps	280	184	34%
- Safety Piping	11.0×10^4 feet	1.9×10^4 feet	83%
- Cable	9.1 mil. feet	1.2 mil. feet	87%
- Seismic Building Volume	12.7 mil. ft^3	5.6 mil. ft^3	56%

BNFL Slide 21 Westinghouse

AP1000 is Smaller and Dramatically Simpler than Evolutionary Plants

AP1000

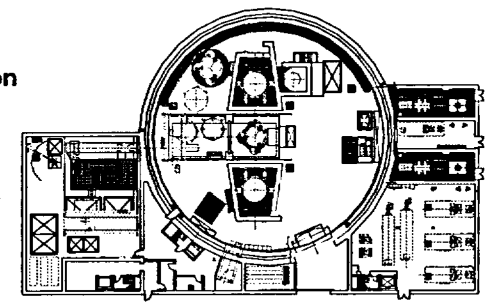


BNFL Slide 22 Westinghouse

AP1000

Improved General Arrangement

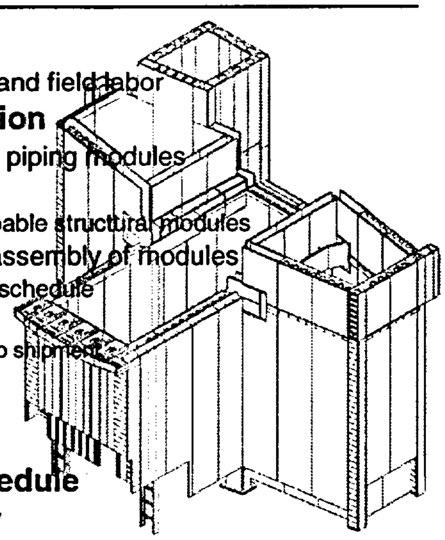
- **Same as AP600**
- **Improved Separation**
  - Radioactive vs nonradioactive
  - Fire areas, especially inside containment
  - Safety vs nonsafety
- **Improved Maintenance / Inspection**
  - Increased laydown area inside containment
  - Access platforms provided for equipment maintenance / inspection
- **Improved Access to Containment**
  - Equipment hatches access from auxiliary building
  - Equipment hatches and personnel airlocks at both grade and operating deck levels



AP1000

AP1000 Improved Construction

- **Simplification of Systems**
  - Major reduction in bulk materials and field labor
- **Maximize Use of Modularization**
  - 300 rail-shippable equipment and piping modules
  - 50 large structural modules
    - Assembled on-site from rail-shippable structural modules
  - Factory based manufacture and assembly of modules
    - Predictable, short manufacturing schedule
    - Improved quality control
      - Pre-testing and inspection prior to shipment
  - Streamlined field installation
    - Modules reduce field labor
    - Use of detailed work sequencing
- **36 Months Construction Schedule**
  - Confirmed by independent review



AP1000 Design Certification Nearing Completion

Past Milestones	Target Schedule	
1. W Submits Application	3/28/02	☑
2. Staff Issues Requests for Additional Info (RAI)	9/30/02	☑
3. W Provides Responses to All RAI's	12/2/02	☑
4. NRC Identifies Potential Open Items	2/28/03	☑
5. W Addresses Potential Open Items	4/15/03	☑
6. NRC Issues Draft Safety Evaluation Report	6/16/03	☑
Future Milestones	**NRC Target**	
7. NRC Issues Final SER	September 2004	
8. NRC Issues Final Design Approval	September 2004	
9. NRC Issues Design Certification	August 2005	

BNFL Slide 25 Westinghouse

AP1000 Safety

- AP1000 Comfortably Meets NRC and Industry Safety Standards for Future Plants
  - Both deterministic and probabilistic
- AP1000 Final Design Approval Will Enable Next Steps to Realizing New Plant Construction
  - As proposed by Nu-Start Energy Consortium

BNFL Slide 26 Westinghouse

AP1000 Review Status

June 25, 2004

ACRS Future Plant Subcommittee Briefing

John Segala, Senior Project Manager
Office of Nuclear Reactor Regulation

Introduction

- Purpose
  - Provide summary of the staff's review
  - Provide current status of the AP1000 project
  - Discuss major schedule milestones

- Success
  - Understand areas reviewed and resolution
  - Understand the current status
  - Understand the future milestones

Previous Review Milestones

- March 2002 - Completed pre-application review
- March 28, 2002 - Westinghouse (W) submitted DC application
- June 25, 2002 - NRC accepted the application for docketing
- June 16, 2003 - NRC issued DSER with 174 Open Items
- May 18, 2004 – NRC provided responses to the issues in the ACRS interim letter
- May 25, 2004 – Sent advanced copy of FSER to ACRS

Past ACRS Meetings

Subcommittee Meetings

Thermal Hydraulic Phenomena
5 Meetings
March 2001- February 2004

Future Plant Designs
3 Meetings
February 2002 - June 2004

Reliability and Probabilistic Risk Assessment
1 Meeting
January 2003

Full Committee Meetings

9 ACRS Meetings

August	2000 (Pre-Application)
April	2001 (Pre-Application)
March	2002 (Pre-Application)
November	2002
February	2003
April	2003
October	2003
March	2004
June	2004

Remaining Schedule Milestones

- July 7, 2004 – ACRS Full Committee Meeting
- July 17, 2004 – ACRS issues final approval letter
- August 6, 2004 – Division Directors Concurrence
- August 13, 2004 – OGC no legal objection
- August 30, 2004 - EDO memo to Commission w/FSER/FDA attached
- September 13, 2004 – FSER/FDA issued
- December 2005 – Final Design Certification Rule issued

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Sullivan, Edmund
Sun, Summer
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Trehan, Narinder
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Ward, Leonard
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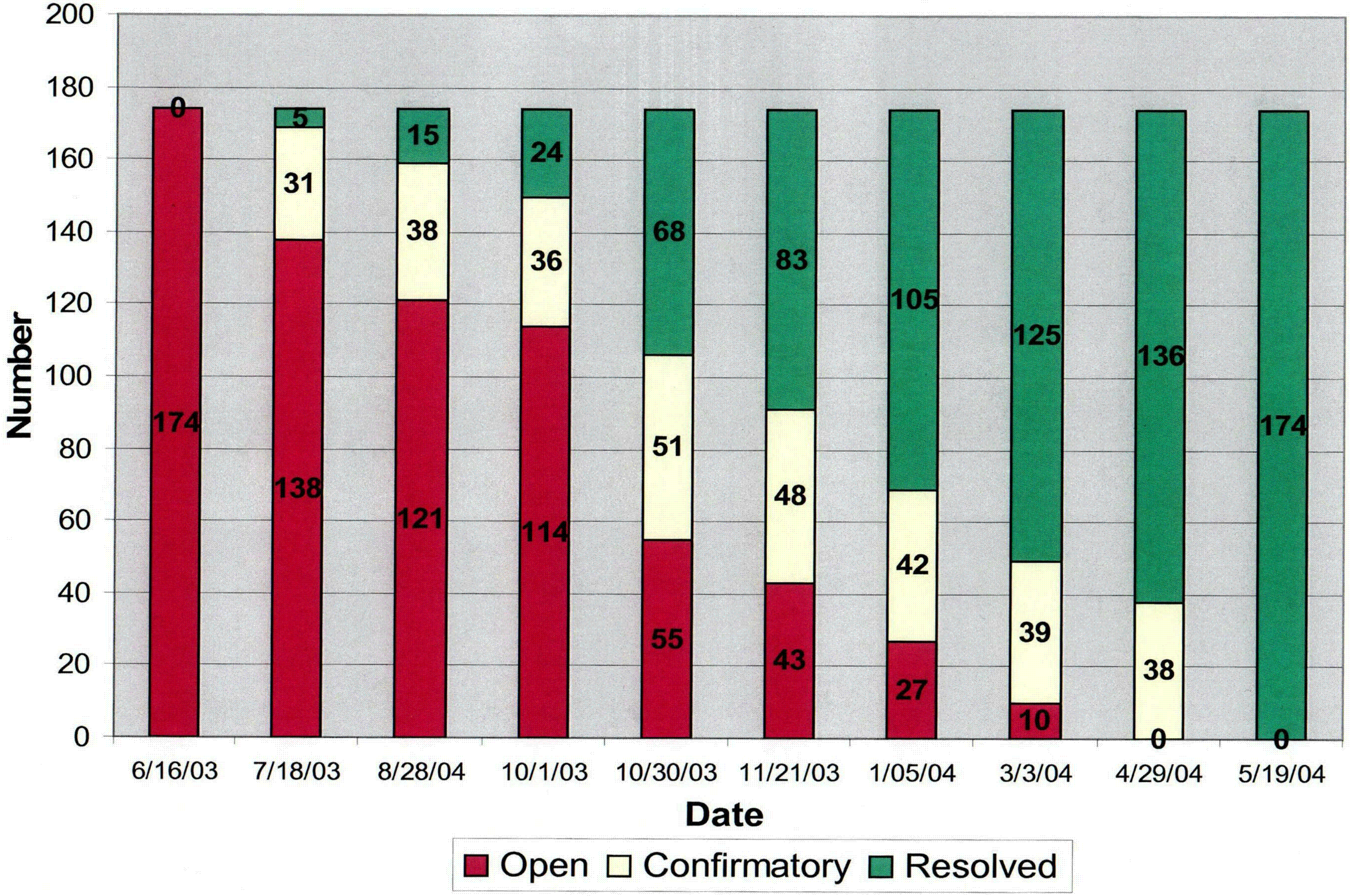
Contractors

- Brookhaven National Laboratory
  - Mechanical and Civil/Structural Engineering
- Information Systems Laboratories, Inc.
  - RELAP5 Input Development
- Energy Research, Inc.
  - Severe Accidents
- Carl J. Costantino Engineering Consultants
  - Structural and Earthquake Engineering
- Sandia National Laboratory
  - Aerosol Removal

RAIs

- We issued 742 RAIs
  - General - **3**
  - Mech. Eng - **70**
  - Structural Eng. - **19**
  - Seismology - **23**
  - Hydrol. and Meteor - **5**
  - Geotech. Eng. - **3**
  - Inservice Inspection - **3**
  - Component Integrity - **29**
  - Materials Application - **12**
  - QA and RAP - **8**
  - Emergency Preparedness - **3**
  - Containment Systems - **11**
  - Technical Specifications - **53**
  - ITAAC - **1**
  - Initial Test Program - **18**
  - Fire Protection - **11**
  - Chemical Technology - **4**
  - Auxiliary Systems - **22**
  - Instrumentation & Controls - **48**
  - Electric Power - **15**
  - Reactor Systems - **189**
  - Meteorology - **8**
  - Effluent Treatment - **11**
  - Radiological Impact - **13**
  - Radiation Protection - **11**
  - Human System Int. - **44**
  - PRA - **99**
  - Generic Issues - **6**

AP1000 DSER Open Item Status



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DSER Open Items

174 Open Items

- (as compared to over 1300 for AP600 DSER)

- Chapter 1 (Introduction) - - - - - - - - - - - - - 3
- Chapter 2 (Site Envelope Char) - - - - - - - - - 6
- Chapter 3 (Structures, Comp., Equip.) - - - 30
- Chapter 4 (Reactor) - - - - - - - - - - - - - - - - - 3
- Chapter 5 (Reactor Coolant System) - - - - 3
- Chapter 6 (Engineered Safety Features) - - 9
- Chapter 7 (I & C) - - - - - - - - - - - - - - - - - - - 0
- Chapter 8 (Electric Power Systems) - - - - - 1
- Chapter 9 (Auxiliary Systems) - - - - - - - - - - 7
- Chapter 10 (Steam and Power Conv.) - - - - 3
- Chapter 11 (Radioactive Waste Man.) - - - - 0
- Chapter 12 (Radiation Protection) - - - - - - 0
- Chapter 13 (Conduct of Ops) - - - - - - - - - - - 3
- Chapter 14 (Verification Progs) - - - - - - - - - 43
- Chapter 15 (Transient & Acc. Anal.) - - - - - 6
- Chapter 16 (Technical Specs) - - - - - - - - - - 3
- Chapter 17 (Quality Assurance) - - - - - - - - - 5
- Chapter 18 (Human Factors) - - - - - - - - - - - 7
- Chapter 19 (Severe Accidents) - - - - - - - - - 36
- Chapter 20 (Generic Issues) - - - - - - - - - - - 2
- Chapter 21 (Testing & Comp Code Eval.) - - 4
- Chapter 22 (RTNSS) - - - - - - - - - - - - - - - - - 0
- Chapter 23 (Review by the ACRS) - - - - - - 0
- Chapter 24 (Conclusions) - - - - - - - - - - - - - 0

Design Acceptance Criteria

- Instrumentation and Controls
- Human Factors (Control Room)
- Piping

Exemptions

- Westinghouse requested 3 exemptions for the AP1000 (dated 12/3/02):
  - 50.34(f)(2)(iv) re: additional TMI-related requirements (requires SPDP)
    - Approved in FSER Chapter 18, "Human Factors Engineering"
  - 50.62(c)(1) re: ATWS requirements (requires diverse and auto initiation of AFW)
    - Approved in FSER Chapter 15, "Transient and Accident Analysis"
  - App. A, GDC 17 re: Electric power (requires 2 independent offsite power sources)
    - Approved in FSER Chapter 8, "Electric Power Systems"

AP1000 Status Summary

- All DSER open items resolved
- All ACRS issues addressed
- NRC staff still on schedule to issue FSER by September 13, 2004
- Questions or comments?

AP1000 Open Items

June 25, 2004

ACRS Future Plant Subcommittee Briefing

John Segala, Senior Project Manager
Office of Nuclear Reactor Regulation

Introduction

- Purpose
  - Provide summary of the staff's review
  - Provide summary of the staff's resolution of DSER open items
- Success
  - Understand areas reviewed and resolution
  - ACRS agreement with resolution of open items

DSER Open Items

174 Open Items

- (as compared to over 1300 for AP600 DSER)

- Chapter 1 (Introduction) - - - - - - - - - - - - - 3
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- Chapter 18 (Human Factors) - - - - - - - - - - - 7
- Chapter 19 (Severe Accidents) - - - - - - - - - 36
- Chapter 20 (Generic Issues) - - - - - - - - - - - 2
- Chapter 21 (Testing & Comp Code Eval.) - - 4
- Chapter 22 (RTNSS) - - - - - - - - - - - - - - - - - - 0
- Chapter 23 (Review by the ACRS) - - - - - - 0
- Chapter 24 (Conclusions) - - - - - - - - - - - - - 0

Supplemental DSER Sections

- The DSER identified 5 potential supplemental DSER sections:
  - Chapter 21 – Testing and Computer Code Evaluation
  - Section 14.2 – Initial Test Program
  - Section 13.6 – Security
  - Section 3.6.3.4 – Leak-Before-Break
  - Section 3.3 – Wind and Tornado Loadings
- The staff concluded that it was not necessary to issue supplemental DSER sections since all issues were resolved

DSER Chapter 1 Open Items

- DSER based on Revision 3 of Design Control Document (DCD)
  - W submitted latest DCD revision on June 24, 2004
  - Expect no additional technical changes
- Tier 2* information
  - Staff has reviewed DCD Tier 2* information and finds acceptable
- Combined license (COL) action items
  - Staff has reviewed COL action items and finds acceptable

Post DSER Open Items

- Core Shroud Susceptibility to Stress Corrosion Cracking (SCC)
  - W stated that based on operational experience, no inspections required beyond ASME requirements.
  - Staff agrees
- Alloy 52/152 Weldment QA Criteria
  - W proposed to use 100% volumetric examination of all partial penetration J-groove welds in the vessel.
  - Staff found acceptable.

Post DSER Open Items (cont.)

- High-Chromium Nickel-based Alloys Susceptibility to low-temperature crack propagation
  - W concluded four conditions are necessary for the occurrence of LTCP:
    - relatively high concentrations of hydrogen in the environment and in the metal
    - relatively low temperatures
    - the presence of a sharp crack tip
    - the presence of loads which rise at a moderate rate to levels great enough to fail the flawed material
  - W concluded that the conditions necessary for the occurrence of LTCP cannot take place in the AP1000 design.
  - The staff found acceptable.

Post DSER Open Items (cont.)

- ADS-4 Squib Valve Notch Susceptibility to SCC
  - W stated that shear section designed to ASME Code and environment is not susceptible to SCC.
  - Staff agrees
- Chemical Effects on Sump Screens
  - Related to issuance of RG 1.82, Revision 3
  - W added COL Action Item to consider generation of chemical debris
  - Staff found approach acceptable

Inspections, Tests, Analyses, and Acceptance Criteria (ITAAC)

- 35 ITAAC related DSER open items
  - Some proposed new ITAACs or change to existing ITAACs
  - Some related to the resolution of open items in other chapters

- All open items related to ITAAC are resolved

Quality Assurance (QA)

- 5 QA related DSER open items

- QA Inspections
  - QA Test Control Implementation Inspection at Oregon State University
  - Inspection of the Implementation of the Project-Specific Quality Plan at Westinghouse

- All violations, non-conformances, and open items related to QA are resolved

Leak-Before-Break (LBB)

- 2 LBB related DSER open items
- Major open items include:
  - Alloy 690/52/152 susceptibility to PWSCC
    - Results from sensitivity study using SCC crack morphologies indicate that margin exists in LBB applications
  - Acceptability of W LBB approach
    - W used a combination of qualitative assessment and quantitative evaluation to evaluate all AP1000 candidate AP1000 LBB piping subsystems
      - 1 LBB analysis (DVI-A subsystem)
      - Assessment of AP1000 LBB subsystems using AP600 analyses and scaling factors for pipe diameters and response spectra against bounding analysis curves

Leak-Before-Break (LBB)

Acceptability of W LBB approach (cont.)

- W considered in LBB assessment statistically based material properties, more sensitive leakage detection capability and inclusion of pipe whip restraints
- Staff concluded approach acceptable

- All open items related to LBB are resolved

Sump Screen Performance

- 6 sump screen related DSER open items
- Open items related to:
  - debris loading of IRWST screens and recirculation screens
  - debris through reactor coolant system break
- All open items related to sump screen are resolved
- Staff concludes that the screen design is acceptable, based on the following:
  - Containment recirculation screens redesign
  - Screen design is robust to prevent screen blockage.
  - ITAAC verifies as-built screen design
  - COL Action Items
    - Cleanliness program
    - RG 1.82 evaluation

Structural/Seismic Design

- Review Methodology:
  - Decision based on review of critical sections selected by the staff
  - Similar critical sections reviewed for AP600

- Design Constraints:
  - Hard rock site
  - Fixed base model for seismic analyses

Structural/Seismic Design (cont.)

- 38 structural/seismic related DSER open items
- Major open items include:
  - Basemat uplift
  - Completion of containment design
- The staff performed several audits of specific W calculations throughout review
- All open items related to structural/seismic design are resolved
- The staff concludes that the AP1000 structural design is acceptable.

Thermal Hydraulics

- Five ACRS Thermal Hydraulic Phenomena Subcommittee Meetings
  - from March 2001- February 2004
- 4 thermal hydraulic related DSER open items
- Major open items include:
  - liquid entrainment
  - core swell
  - long term cooling
  - boron precipitation
- All open items related to thermal hydraulics are resolved
- The staff concludes that the AP1000 design meets 10 CFR 50.46, and is acceptable

Probabilistic Risk Assessment (PRA)

- January 23-24, 2003 - ACRS PRA Subcommittee Meeting
- 24 PRA related DSER open items
- Notable open item topics:
  - PRA input to design certification process
  - PRA input to RTNSS process
  - Impact of uncertainties on PRA results and conclusions
  - Success criteria and thermal-hydraulic uncertainty
  - SAMDA evaluation
  - Reactor vessel insulation design
  - Shutdown risk
- All open items are resolved

Evaluation of Aerosol Deposition

Michelle Hart
Dose Assessment Team
NRR/DSSA/SPSB

Westinghouse Analysis

- Westinghouse initially intended to use AP600 removal rates for AP1000 aerosol
- BE analysis using MAAP calculated T-H and aerosol mechanistic code STARNAUA
  - Credit was given for gravitational settling, diffusiophoresis and thermophoresis
- Staff accepted these phenomena as removal mechanisms, however questioned the Westinghouse calculated removal rate values

DBA LOCA T/H

- T-H scenario and aerosol models are not specified by NUREG-1465
- Westinghouse calculation based on a single T-H scenario and mechanistic aerosol model
- Adopted scenario (3BE- 1) is a double-ended DVI 4" line break with a failure to activate the intact train

LOCA T/H Scenario

- Scenario acceptance based on :
  - 3BE-1 representative of the "3BE" accident class, which is the dominant contributor to CDF for the AP1000
  - T- H conditions typical for majority of severe accident sequences (fully depressurized and reflooded)
  - Revised source term was intended to be representative of low pressure core- melt accidents

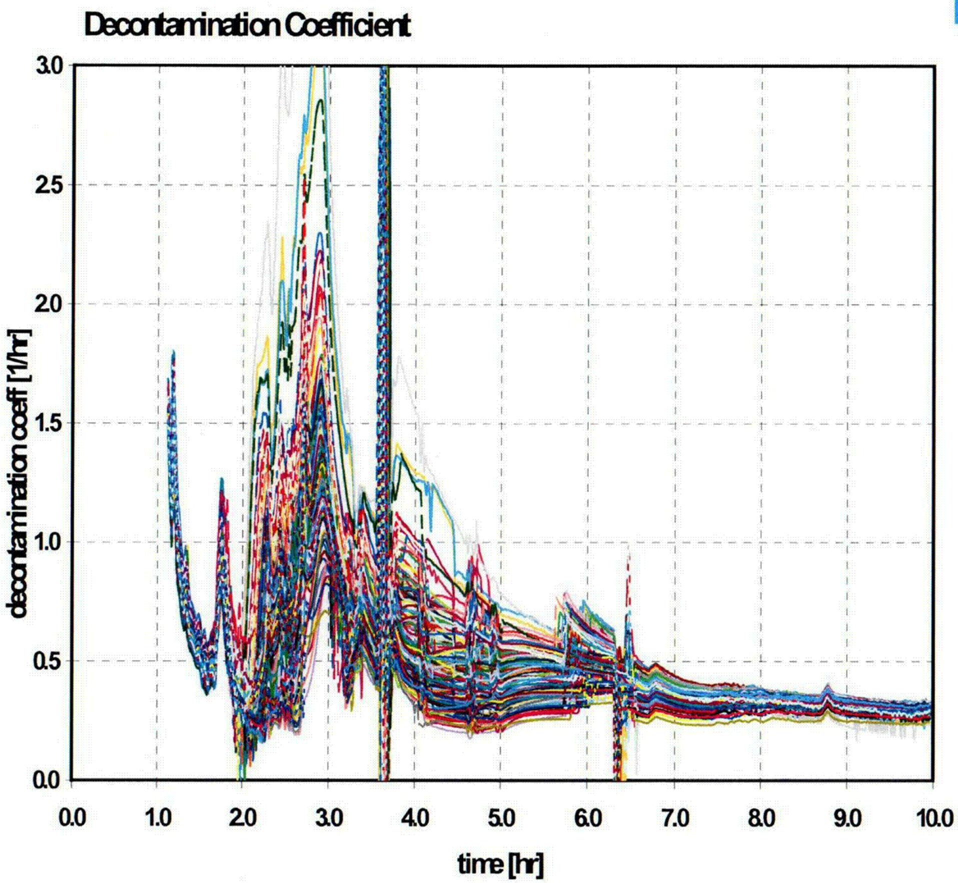
Staff Independent Analysis

- Monte Carlo sampling using MELCOR T/H and aerosol deposition modeling
- 13 parameters affecting aerosol behavior were sampled to achieve 95% confidence level
- Engineering judgment was used for the choice of parameters as well as for the range and distribution of their values

Sampled Parameters

- aerosol mass mean diameter
- geometric standard deviation
- aerosol void fraction
- particle shape factors
- aerosol material density
- non- radioactive aerosol mass
- particle slip coefficient
- sticking probability for agglomeration
- boundary layer thickness for diffusion deposition
- thermal accommodation coefficient for thermophoresis
- ratio of thermal conductivity of particle to gas
- turbulent energy dissipation
- multipliers on heat and mass transfer to containment shell

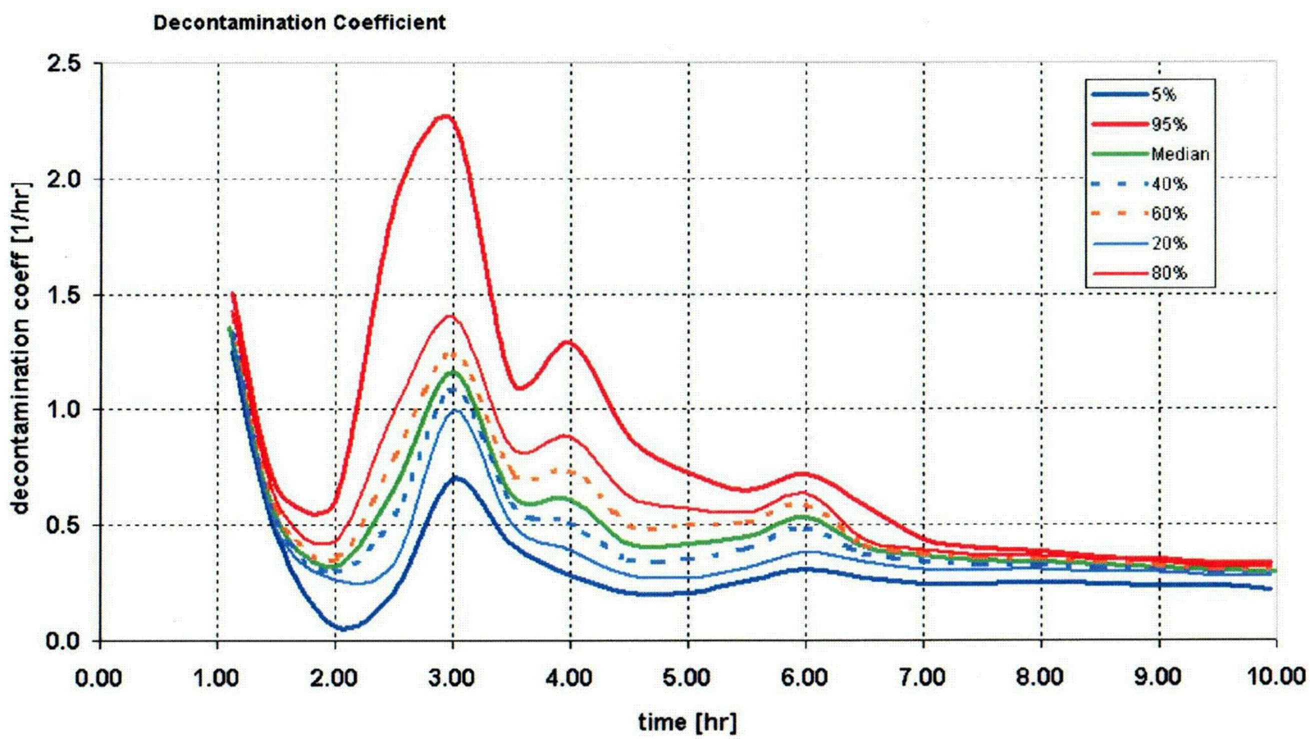
Decontamination Coefficients



- Decontamination coefficients vary with time
  - Hydrogen burns cause transient spikes – increased thermophoresis
  - Late time values converge to around 0.3 hr^{-1}

C02

Uncertainty of Aerosol Removal Coefficients (Lambdas)



Confirmatory Dose Calculation

- Staff did not base acceptance on Westinghouse values for aerosol removal coefficient
- Staff performed independent dose analysis of LOCA
  - Staff median aerosol removal coefficient
  - DCD X/Qs
  - DCD values for all other analysis inputs
- Met 10 CFR 50.34 and GDC-19 dose criteria

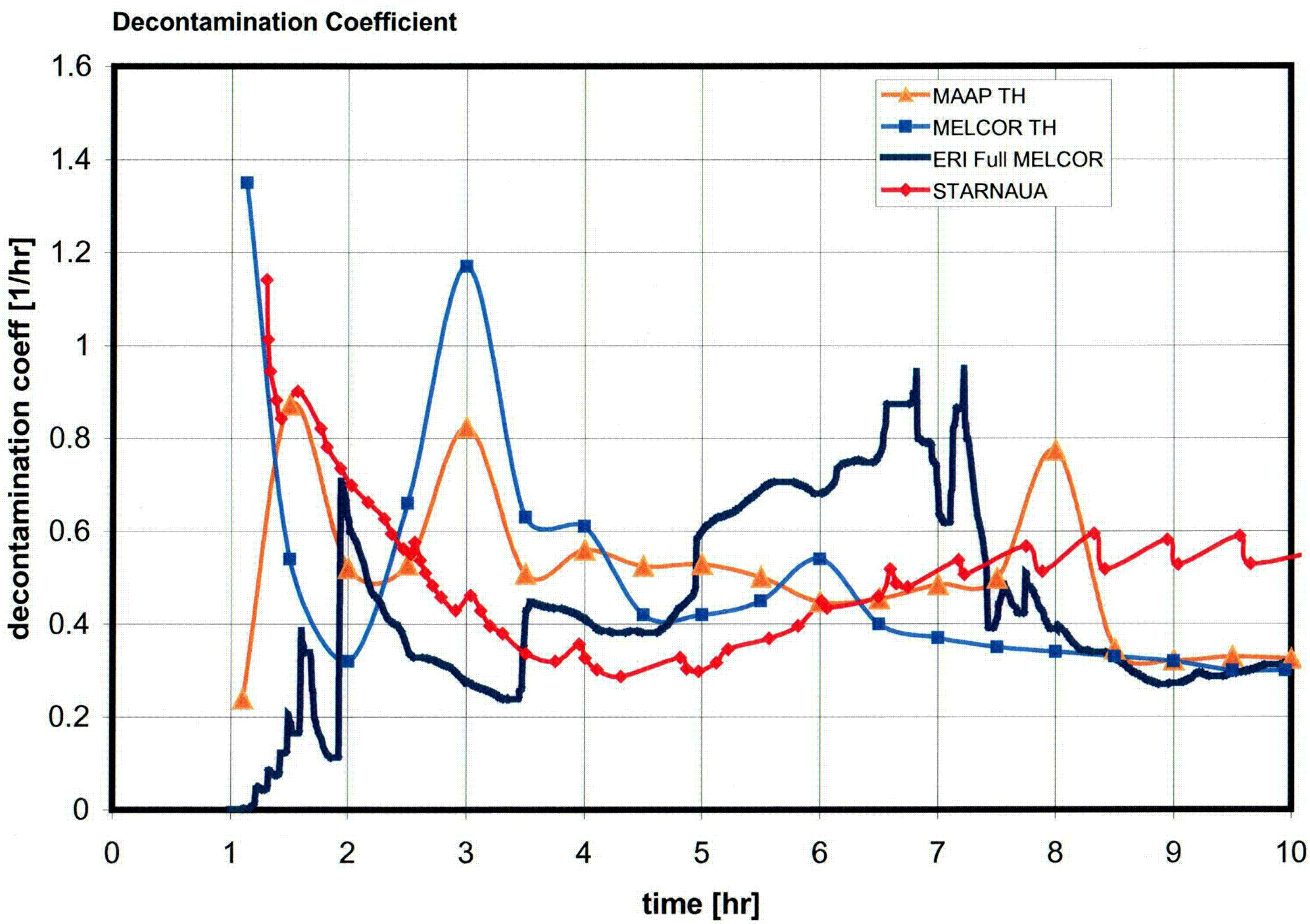
Use of Median Values

- Traditional regulatory approach is to accept a "bounding" value.
- Staff used median value for calculation
  - selected scenario belongs to a "worst case" category
  - median value is the least affected by the user's subjective judgment
  - staff introduced a "conservative bias" in choice of the initial ranges and distributions of the selected parameters
  - precedence in steam line deposition evaluation for Perry
  - staff's dose calculation code requires yet another "averaging" of the removal rates for the specified time periods
  - the fully integrated MELCOR calculated removal rates are mostly well above the 5 percentile

Additional Study

- Monte Carlo sampling using MAAP T/H and MELCOR aerosol deposition modeling
- Shows reasonable agreement with DCD values.
- Shows reasonable agreement with uncertainty analysis with MELCOR T/H

Decontamination Coefficients
Using MELCOR TH, MAAP TH, Full MELCOR ERI Analysis and MAAP-STARNAUA



AP1000 Open Item Summary

- All DSER open items resolved
- NRC staff still on schedule to issue FSER by September 13, 2004
- Questions or comments?

ACRS Interim Letter Issues

June 25, 2004

ACRS Future Plant Subcommittee Briefing

John Segala, Senior Project Manager
Office of Nuclear Reactor Regulation

Introduction

- Purpose
  - To discuss the staff's resolution of the ACRS interim letter issues
  - Provide update of recent staff activities
- Success
  - Understand the resolution of interim letter issues
  - ACRS agreement with resolution of interim letter issues

Issue 1 - Automatic Depressurization System (ADS)-4 Squib Valve Function

- ACRS Interim Letter Issue:
  - Agreed with the staff that ITAAC assures the valves meet the design basis specifications
- NRC Staff Resolution:
  - Simple design - ASME Code Section III Class 1
  - Redundant and Diverse Actuation
  - PRA Sensitivity Study
    - Increase in failure probability not change PRA conclusions
  - ITAAC (Squib Valve Type Test required)
    - Tests or type tests of squib valves will be performed that demonstrate the capability of the valve to operate under its design conditions.
    - A test report exists and concludes that each squib valve changes position under design conditions and that the as-installed squib valves are bounded by the tests or type tests.

Issue 2 - Assurance of Long-Term Cooling (Strainer Blockage)

- <u>ACRS Interim Letter Issue</u>:
  - AP1000 is a robust design to prevent screen blockage.
  - Recommended ITAAC to ensure compliance with GSI 191
- <u>NRC Staff Resolution</u>:
  - Containment recirculation screens redesign
  - Screen design is robust to prevent screen blockage.
  - ITAAC verifies as-built screen design
  - COL Action Items
    - Cleanliness program
    - RG 1.82 evaluation

Issue 3 - Code Deficiencies

- ACRS Interim Letter Issue:
  - When deficiencies are identified in codes, the weaknesses should be corrected.
- NRC Staff Resolution:
  - TRACE code is being assessed using APEX AP1000, ATLATS, and UPTF data.

Issue 4 - Range of Pi-Group Values

- ACRS Interim Letter Issue:
  - The staff should verify that a Pi group range of 0.5 to 2 is appropriate.
- NRC Staff Resolution:
  - This range has been used as a de facto standard in scaling analyses.
  - This issue is generic, not an issue specific only to AP1000.

Issue 5 - In-Vessel Retention/Fuel-Coolant Interactions

- ACRS Interim Letter Issue:
  - IVR assessment needs to consider the effects of exothermic intermetallic reactions.
  - Would like to review the FCI models and justification that intermetallic reactions will not result in energetic FCI that could fail the containment.
- NRC Staff Resolution:
  - Staff provided the ACRS a copy of their contractors IVR and FCI report for AP1000

Issue 6 - Organic Iodine Production

- ACRS Interim Letter Issue:
  - Water film pH determines iodine behavior
    - pH < 7 leads to production of elemental iodine some of which is subsequently converted into organic iodine
    - To prevent organic iodine production the film pH should be maintained above 7

Organic Iodine Production (cont.)

- W calculations determined:
  - Film pH is maintained above 7, assuming the amount of CsOH present in the DBA source term
  - A minimum of 270 g of CsOH (0.1% of available CsOH) is sufficient to keep pH above 7
  - The DBA dose criteria still met, even if assume no CsOH present
    - Increased amount of assumed organic iodine in containment from 0.15% to 0.33%
- Staff audited W calculations
  - Staff found the calculations to be acceptable
  - Staff agreed with W conclusions

Issue 7 - Catastrophic Failure of the Steel Containment

- ACRS Interim Letter Issue:
  - A free-standing steel containment can fail in a catastrophic manner when its failure pressure is exceeded. This failure mode can lead to rapid depressurization and resuspension of deposited fission products.
  - Like to see a sensitivity study on the fission product source term to assess the effect on the risk of latent fatalities as compared to the Safety Goal.
- NRC Staff Resolution:
  - Frequency of catastrophic containment failures are small
  - Resuspension would not have a noticeable impact on the Commission's safety goals.

AP1000 Summary

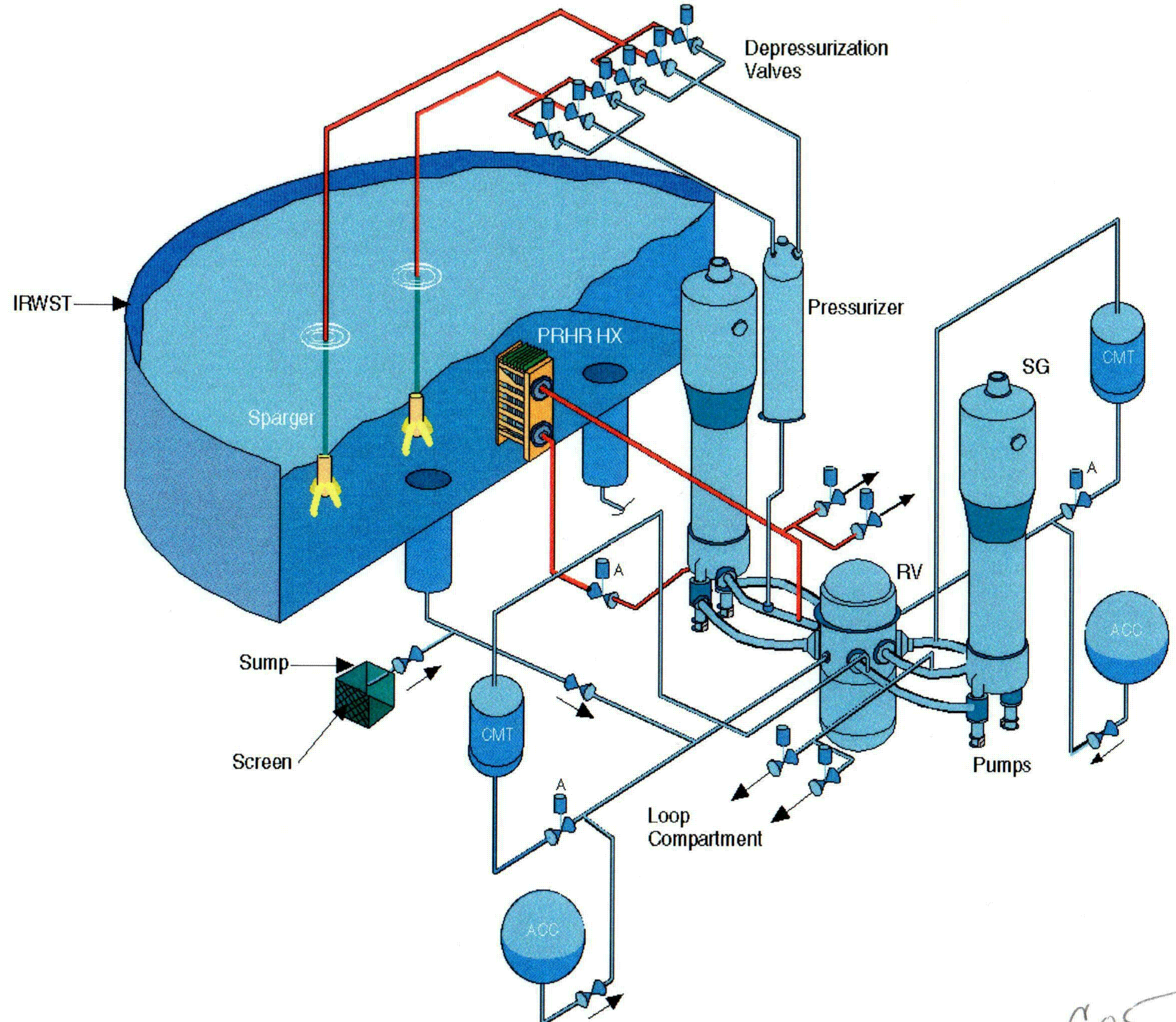
- All DSER open items resolved
- All ACRS issues addressed
- NRC staff still on schedule to issue FSER by September 13, 2004
- Questions or comments?

Background Slides

Leak-Before-Break

	Piping/Support	HELB	LBB	Benchmark Problem
ABWR	DAC	DAC	N/A	NUREG/CR-6049
System 80+	DAC	DAC	- DAC (bounding curves) - NRC reviewed 4 LBB calcs	NUREG/CR-6128
AP600	essentially complete (except support details)	essentially complete (except PW restraint details)	- DAC (bounding curves) - NRC reviewed 5 LBB calcs - LBB confirmatory analysis	NUREG/CR-6414
AP1000	DAC	essentially complete (except PW restraint details)	- DAC (bounding curves) - 1 LBB evaluation completed - Assessment of all other LBB piping	Same as AP600 (NUREG/CR-6414)

Aerosol Removal



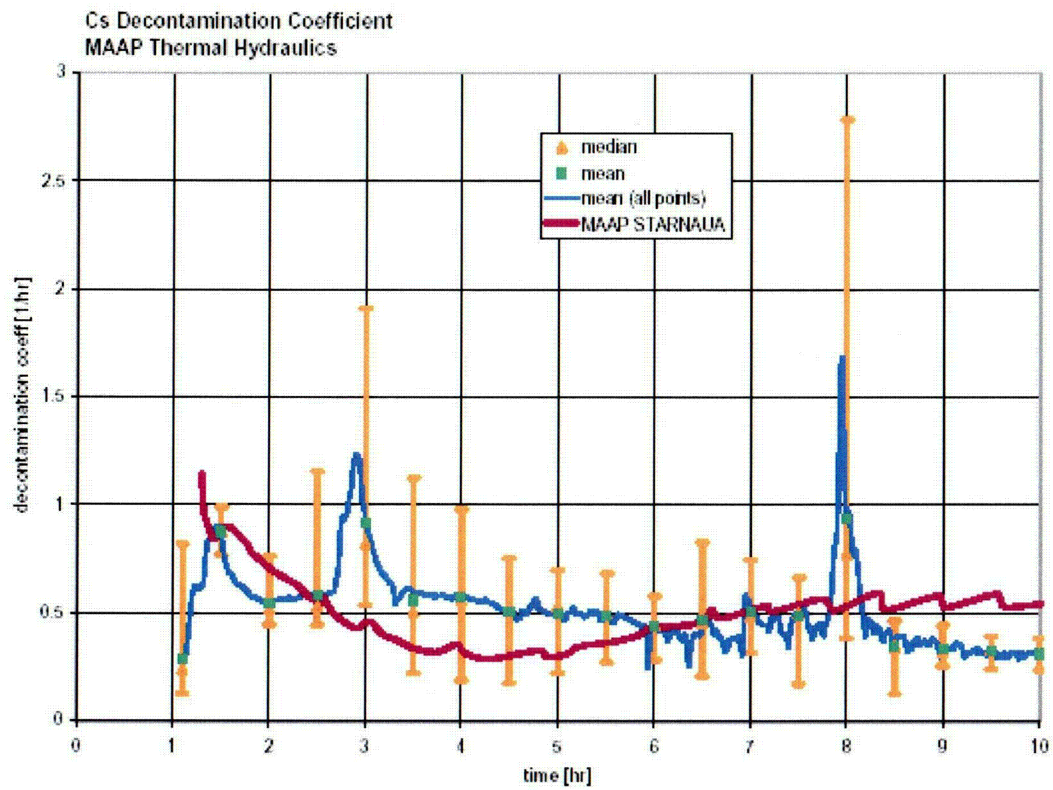
Depressurization
Valves
IRWST
PRHR HX
Pressurizer
SG
CMT
Sparger
A
A
RV
Sump
ACC
CMT
Screen
A
Pumps
Loop
Compartment
ACC

C05

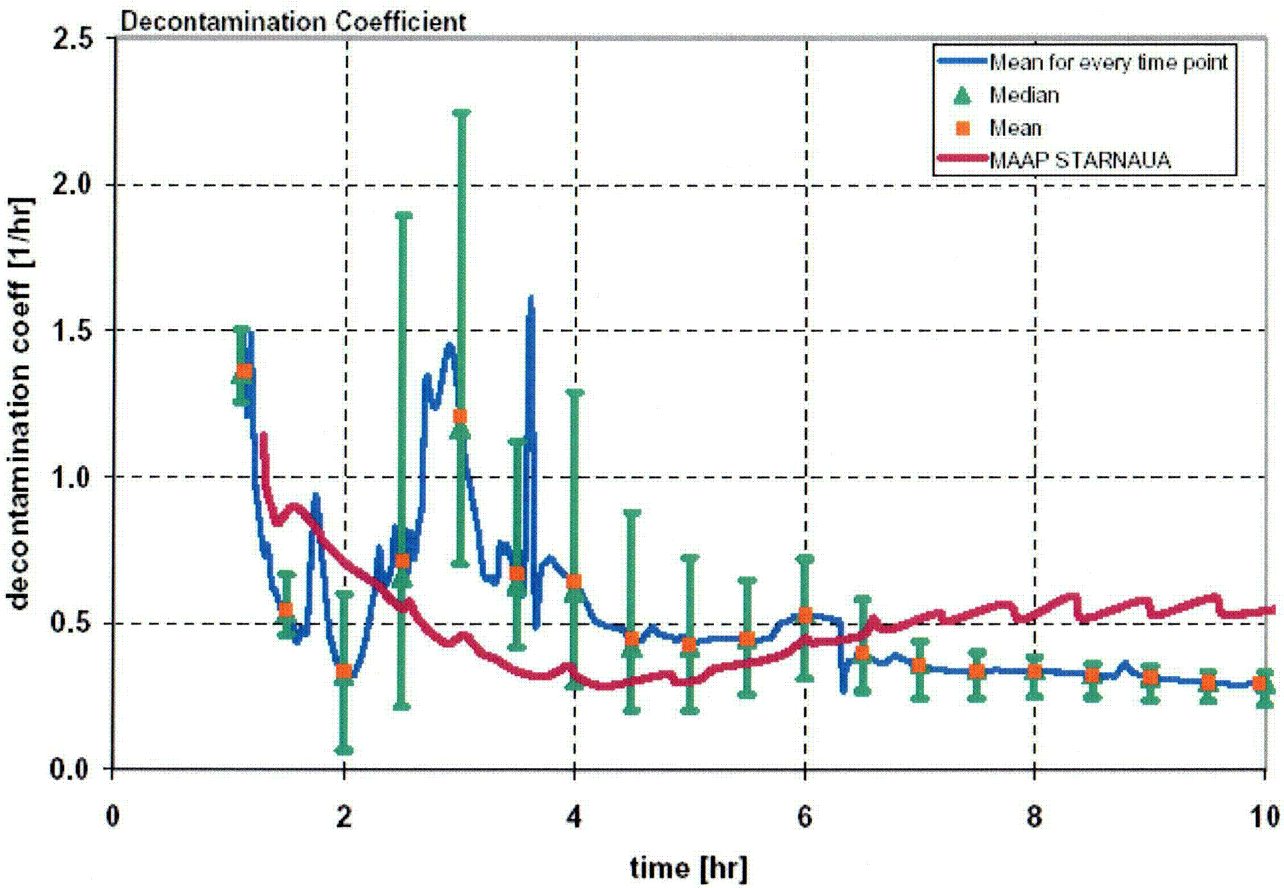
Parameter Distributions

Non-radioactive Mass	50 – 300 kg	uniform
Aerosol Mass Mean Diameter	1 – 4 μm	uniform
Geometric Standard Deviation	1.2 – 3	uniform
Aerosol Shape Factors	1 – 5	beta (bias to 1)
Particle Slip Coefficient	1.2 – 1.3	beta (normal)
Agglomeration Sticking Prob.	0.5 – 1	beta (bias to 1)
Boundary Layer Thickness	5 – 20 μm	uniform
Thermal Accommodation Coeff.	2.2 – 2.5	uniform
Thermal Conductivity Ratio	0.006 – 0.06	log-uniform
Turbulent Energy Dissipation	0.00075 – 0.00125	uniform
Aerosol Material Density	1000 – 5000 kg/m^3	beta (bias to 2000)
Heat and Mass Transfer Mult.	0.75 – 1.25	beta (a=1.5, b=1.5)

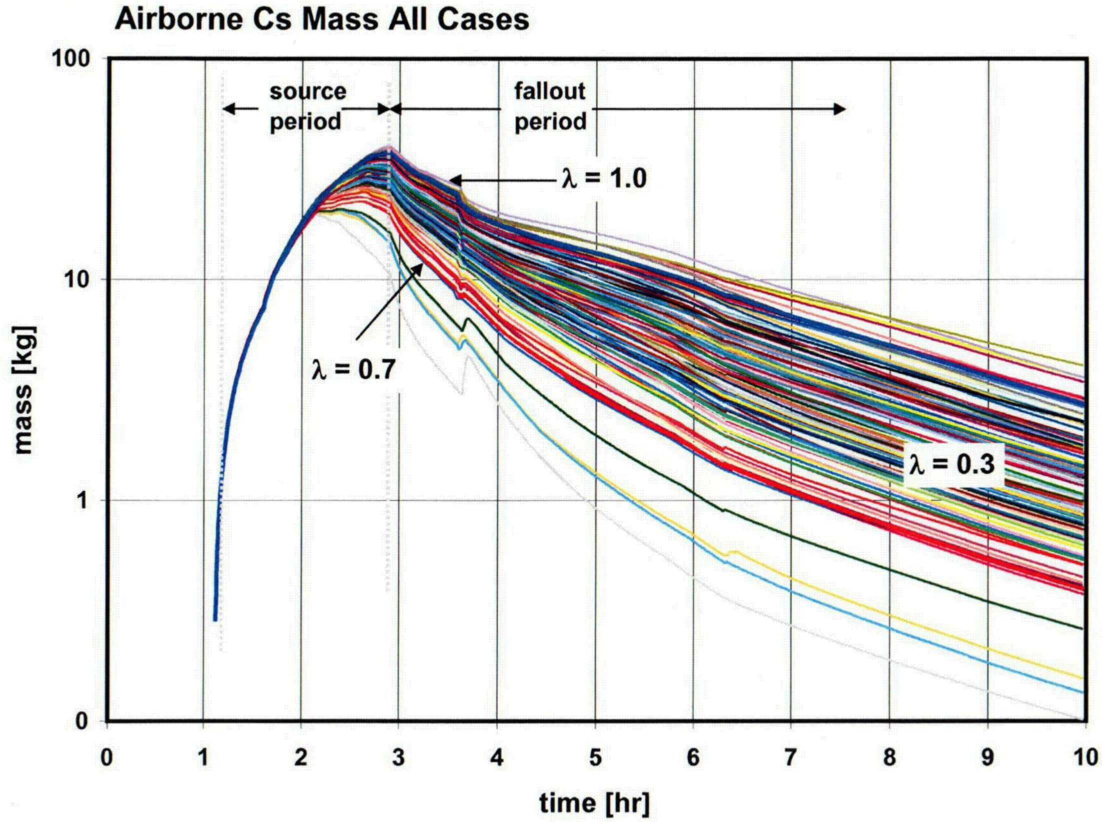
MAAP T/H with MELCOR Aerosol Calculation



MELCOR Analysis



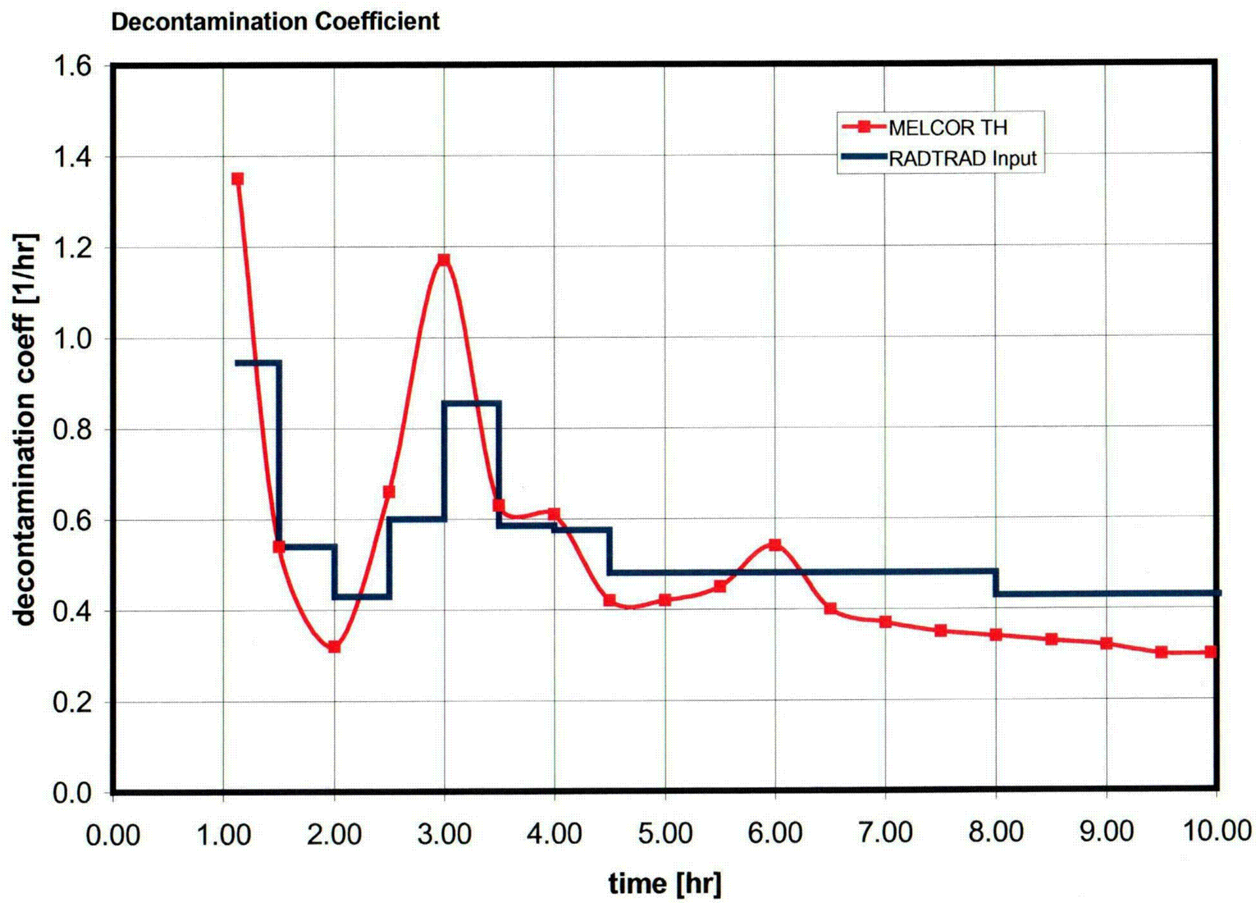
Behavior of Airborne Mass



- Suspended mass increases during aerosol sourcing period
- Initial depletion rate constant (lambda) during fallout period varies between 0.7 hr^{-1} and 1.0 hr^{-1}
- Late in time, all depletion constants in neighborhood of 0.3 hr^{-1}

C08

MELCOR Thermal-Hydraulics and RADTRAD Input



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