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NUCLEAR REGULATORY COMMISSION

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ADVISORY COMMITTEE ON REACTOR SAFEGUARDS

(ACRS)

U.S. EPR SUBCOMMITTEE MEETING

OPEN SESSION

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TUESDAY

APRIL 5, 2011

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ROCKVILLE, MARYLAND

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The Subcommittee met at the Nuclear Regulatory Commission, Two White Flint North, Room T2B3, 11545 Rockville Pike, at 8:30 a.m., Dana A. Powers, Chairman, presiding.

COMMITTEE MEMBERS:

DANA A. POWERS, Chairman

SANJOY BANERJEE, Member

HAROLD B. RAY, Member

MICHAEL T. RYAN, Member

JOHN W. STETKAR, Member-at-Large

WILLIAM J. SHACK, Member

NRC STAFF PRESENT:

SURINDER ARORA, NRO/DNRL/NARP
JASON CARNEAL, NRO/DNRL/NARP
JOE COLACCINO, NRO/DNRL
ANNE-MARIE GRADY, NRO/DSRA/SPCV
CHRISTOPHER JACKSON, NRO/DSRA/SPCV
WALTON JENSEN, NRO/DSRA/SPCV
JOHN McKIRGAN, NRO/DSRA
JAMES O'DRISCOLL, NRO/DSRA/SPCV
GETACHEW TESFAYE, NRO/DNRL
DEREK WIDMAYER, Designated Federal Official

ALSO PRESENT:
RONALD CONLEY, AREVA NP
TERRY DAUGHERTY, AREVA NP
MARK FINLEY, UniStar
DARRELL GARDNER, AREVA NP
GREG GIBSON, UniStar
LEN GUCWA, AREVA NP
DANIEL KLEIN, AREVA NP
ALFRED MAASS, AREVA NP
BRIAN McINTYRE, AREVA NP
CHRIS MOLSEED, AREVA NP
DAN PATTON, UniStar/Bechtel Power
PEDRO B. PEREZ, AREVA NP
JAMES P. RANSOM, AREVA NP
MARY RICHMOND, UniStar/Bechtel Power
ROBERT SALM, AREVA NP
ROBERT SANDERS, AREVA NP
LILIANE SCHOR, AREVA NP
SANDRA M. SLOAN, AREVA NP
TIM STACK, AREVA NP

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

8:30 a.m.

CHAIRMAN POWERS: The meeting will now come to order. This is a meeting of the Advisory Committee on Reactor Safeguards, USEPR Subcommittee. I'm Dana Powers, Chairman of the Subcommittee.

ACRS Members in attendance are Professor Sanjoy Banerjee, Dr. Bill Shack, Harold Ray, John Stetkar, Dr. Michael Ryan, Derek Widmayer of the ACRS Staff is the Designated Federal Official for this meeting and has all the power.

The purpose of the meeting is to continue our review of SER, with open items resulting from the reviews of both the U.S. EPA Design Certification Document and the Calvert Cliffs Unit 3 Combined Operating license.

Today we will hear presentations on and discuss Chapter 6, Engineered Safety Features, from both reviews.

The Subcommittee will hear presentations by and hold discussions with representatives AREVA NP and the NRC Staff and other interested persons regarding these matters.

The Subcommittee will gather relevant information today and plans to take the results of this review, along with the results of the SER with open items, reviewed by Subcommittee in other Subcommittee meetings and the full committee at a future full committee meeting.

Which, in fact, is this month, yes?

MR. WIDMAYER: Not for this chapter.

CHAIRMAN POWERS: Not for this chapter but for some stuff.

MR. WIDMAYER: Some, lots of stuff.

CHAIRMAN POWERS: The rules for participation in today's meeting have been announced as part of a notice of this meeting, previously published in the Federal Register.

We have received no requests from members of the public to speak at today's meeting. A transcript of the meeting is being kept and will be made available as stated in the Federal Register notice.

Therefore, we request that participants of the meeting, use the microphones located throughout the meeting room when addressing the subcommittee.

Participants should first identify themselves and speak with sufficient clarity and volume so they may be readily heard. Copies of the meeting agenda and handouts are available in the back of the meeting room. A telephone bridge line has been established with the meeting room today, and I understand we have participants from UniStar on the line in the afternoon.

Do any of the members have opening comments they would care to make? I don't see any. We will now turn Getachew Tesfaye, the NRO Project Manager for the review of U.S. EPR DCD for some introductory remarks. Sir.

MR. TESFAYE: Thank you, Mr. Chairman. Good morning everyone. My name is Getachew Tesfaye, I'm the NRC Project Manager for U.S. EPR Design Certification Project.

Today we will continue our presentation of open items. For the record, I'll briefly summarize our activities which began approximately a year and a half ago.

Today we have completed the phase three presentation, so 11 of 19 chapters. We present the chapter 8, electric power and chapter 2, site characteristics. And number 3, 2009, and chapter 10, steam power conversion system, and chapter 12, radiation protection on November 19, 2009.

On February 18 and 19 of 2010, we presented chapter 17, quality assurance, and portions of chapter 19, probabilistic risk assessment and severe accident evaluation.

On March 3, 2010, we presented chapter 4, reactor and chapter 5, reactor cooling systems and connective systems. On April 6, 2010, we presented chapter 11, radioactive waste management and chapter 6, technical specifications.

On April 8, 2010, we briefed ACRS full committee on seven chapters that were completed through March, 2010. On April 21, we completed the chapter 19, presentation. On April 21, 2010, received a letter from ACRS full committee Chairman, on the seven chapters that were completed through March, 2010.

The letter indicated that ACRS has not identified any issues that merit further discussion. On May 27, 2010, the staff submitted its reply to ACRS. On November 30, 2010, we presented chapter 17.

On November 7 and 8 of this year, we presented group 1 of sections, group 1 sections of chapter 15, transient and accident analysis.

On March 23, 2010, we began the chapter 15, group 2 presentation was realistic LOCA topical report presentation. Just a reminder, phase 2 and phase 3, reviews of chapter 15, sections are broken up into two groups.

We hope to complete group 2 presentation in June of this year. Today we'll be presenting chapter 6, engineered safety features. On May 11th, we will be presenting chapter 18.

Our current scheduled course for completing the phase 3 presentation by mid-October, 2011. Thank you, Mr. Chairman, that completes my opening remarks.

CHAIRMAN POWERS: Very succinct. At this point we will turn to the ever lovely Ms. Sloan.

MS. SLOAN: Thank you. We are here to continue a series of discussions with the ACRS Subcommittee. As Getachew mentioned, we were most recently here talking about realistic large-break LOCA for EPR, just a couple of weeks ago.

And today we're here to go over chapter 6. I did want to note that the scope of this presentation does exclude two areas. That includes topics specifically related to GSI-191, and Section 6.2.2, which has some of the subcompartment analysis in there. So that is out of scope for today.

CHAIRMAN POWERS: And we're going to go closed in this presentation, as well?

MS. SLOAN: Yes, we are, we are. So we'll start in the first part of the presentation which will be the open session, and we'll cover about half the material.

We have brought AREVA subject matter experts in the areas that you see listed here. That will be about half the discussion and then we will go into a closed session to talk in more detail about the containment analysis.

And where we get into proprietary information very quickly, is talking about the containment analysis methodology, and so that will be in the second part of the discussion. And also, if there are questions that come up during the open portion of the session that the presenters feel like involve proprietary information, Dr. Powers, we will ask to defer those detailed questions to the closed portion and plan to address it then, at the end.

And I will capture those for discussion later in the meeting. Our presenters today are Chris Molseed, Ron Conley, Terry Daugherty, and Fred Maass. And as they start their presentations, consistent with past practice, we've asked them to provide just a brief bio, so you understand their background and why they were selected to present this material.

CHAIRMAN POWERS: We like to know who

we're listening to.

MS. SLOAN: Very good, all right. So we'll start with Chris Molseed.

MR. MOLSEED: Thank you. My name is Chris Molseed, I'm the supervisor of the containment analysis group. I have my bachelors from North Carolina State University, Nuclear Engineering.

I've been the safety analysis, containment analysis group for 13 years with AREVA, and in the past five years have been the supervisor for containment analysis specific to the EPR.

I'm going to present to start a brief overview of the EPR's engineered safety features, and then we'll get into more detail as we present through the specific FSAR sections.

Starting off, section 6.1 of the FSAR speaks specifically about the ESF materials. Metallic materials conform to the 10 CFR 50.55(a), and are treated using the ASME Pressure Vessel Code Section 3.

Organic materials carry a service level one, two or three designation, as appropriate and there's a QA program that treats those coatings appropriately.

Brief overview of the containment design itself, familiarize everybody with it.

CHAIRMAN POWERS: Let me ask a question about your coatings. There's a standard for these codings, at the most severe service levels. And requires, among many other things, a gigarad of exposure. How do you do that?

MR. MOLSEED: Actually, I'm not certain how --

MS. SLOAN: Hey, ask, is there any expert from AREVA who can answer the question? I think we're going to have to come back that, Dr. Powers.

CHAIRMAN POWERS: That would be good.

MR. MOLSEED: A brief overview of the U.S. EPR containment design, familiarize everyone with the structure itself. It's a two-building design, if you will. The internal building, where's the mouse, is the actual containment building itself.

It's a post-tensioned concrete building with a steel liner plate and serves, that's the reactor building boundary. The outer building is the shield building, it's made of reinforced concrete and protects from external hazards.

The internal containment free volume is 2.8 million cubic feet, the inside diameter of 153 and a half feet. The wall thickness of the building, the internal building is 4.3 feet thick and it was a design pressure 62 pounds gauge.

Notable to the design is an in containment refueling water storage tank at the bottom of the building. Well, its approximately 500,000 gallons of water, borated water.

And we'll discuss the IRWST in a little bit of detail shortly. Notable is the two-zone containment. The containment has separated into two regions. The inner area shaded in the slide here represents the equipment area and is not accessible during operation.

The outer region, which is not shaded is accessible during operation for nominal maintenance and for pre-outage staging. The two zones have their own HVAC systems to maintain the appropriate temperature.

And the zones are separated either by physical structures, concrete walls or, at certain elevations, by the CONVECT system, which we will get into some detail as we progress through the presentation.

The CONVECT system consist of rupture and convection foils at the top of the steam generator compartments and mixing dampers down in the lower elevation, near the IRWST.

These systems and components open following a design basis accident or a high energy line break. Also included in the design are passive hydrogen reduction systems, which we'll discuss in some detail.

MEMBER RYAN: Chris, at some point could you talk a little bit about the criteria for access and no access and how you made that decision? Not right now, but if there's an appropriate point, if you could go through that, that would be good.

MR. MOLSEED: We'll take a note of that. I'm not the individual for that, but thank you. Notable, the EPR design does not rely on safety related fan coolers or safety related sprays to mitigate a containment accident.

A brief introduction to the ECCS design features. We have four independent front line safety systems, LHSI, MHSI, etcetera. There's an automatic partial cool down of the steam generators, which is initiated on a safety injection signal.

It reduces the primary pressure to the discharge head of the medium-head safety injection pumps. We do not rely on high-head safety injection pumps, therefore this system is a safety related system.

The in containment refueling water storage tank where IRWST is the single source of water for the ECCS system. It eliminates the need to switch to a sump in the building when you've emptied an external tank, so we do not have a recirculation signal.

It provides sufficient head to the suction of the safety injection system. It also is the inventory during shutdown to fill the reactor cavity, the storage pool transfer areas, etcetera.

In a severe accident space, it provided inventory for flooding, and we won't get into severe accidents today. Notable for the containment analysis is the manual alignment of the low-head safety injection system to the hot leg nozzles to terminate steaming.

Schematic to help orient everybody into the ECCS. I'll go through this quickly. We have accumulators, they're connected to the cold legs via common header for all safety injection system.

There is a medium-head safety injection system in the purple. It draws suction from the IRWST, it's pumped into a common header that again flows into the cold legs.

Notable is a recirc line for the medium-head safety injection system that recircs back to the

IRWST. Low-head safety injections shown in blue. Again, draws suction from the IRWST, pumps to a common header in the cold leg and then connects, or a common header and then connects to the cold leg.

Like the MHSI I also has a circulation loop. This loop has an important role in that it cools the IRWST via the low-head safety injection heating exchanger.

So it provided cooling to that pool of water in the bottom of the containment. There's also the ability to align the low-head safety injection to the hot legs, which we can do as an Operator action following a LOCA, where we preferentially split the flow 75 percent to the hot legs, 25 percent either to the cold legs or to the recirc lines.

A little bit more on hot leg injection. In terms of suppressing steaming following a containment accident in LOCA, we rely on manually aligning the OHSI to the hot legs within 60 minutes.

It's injected into the hot leg nozzles, mixes in the upper plenum of the reactor vessel, reduces the exit enthalpy of the fluid, falls through the core, continues to mix in the core and actually it's been shown to completely suppress steaming at a point in time into the event.

CHAIRMAN POWERS: When you say, it's been shown, how do you show that?

MR. MOLSEED: We have completed a number of benchmarks and we compared to test data from 2D, 3D program. Most notably the UPTF test program.

CHAIRMAN POWERS: So you really haven't tested with at full scale?

MR. MOLSEED: Well, actually UPTF was a full scale test.

MEMBER BANERJEE: The heat sink for the LHSI heat exchanger --

MR. MOLSEED: Yes, the LHSI, the heat exchanger, the RHR LHSI heat exchanger eventually goes to the ultimate heat sink through the, Tim, is that the component cooling water system? Thank you.

MEMBER BANERJEE: How much heat does that remove?

MR. MOLSEED: There's a value in the FSAR in Table 621-3, I don't have it off the top of my head.

MS. SLOAN: We'll look it up.

MR. MOLSEED: Sorry, I don't have that one.

CHAIRMAN POWERS: I'd like to get that, remind the number it's in, it's in one of those tables right here.

MR. MOLSEED: 621-3. Yes, sir. If I may, I'd like to --

MEMBER BANERJEE: You've gone over the previous slide real fast. So, let me try to understand. First, why do you need to suppress steaming?

MR. MOLSEED: Well in, if I may, I'll remind you that there are no sprays in the containment itself. At some point you need to take the steam from the break, in a traditional containment, saturate it and drop it into the floor.

Since we do not have sprays in the U.S. EPR, we have to find another way to take that steam and transition it into a liquid phase and put it on the floor.

Suppressing the steaming in the reactor vessel meets that. So, instead of a containment spray, we're essentially doing it inside the reactor vessel.

MEMBER BANERJEE: You don't have air coolers or a containment spray?

MR. MOLSEED: That is correct.

MS. SLOAN: And we'll talk more about the containment response in the closed portion. Not that your questions are necessarily proprietary, but there's a more detailed discussion.

And Chris is going to walk us through some of the containment response next.

MEMBER BANERJEE: And that's the reason you have to align?

MR. MOLSEED: Well, it serves for multiple purposes. Certainly for boron dilution, boron precipitation is beneficial. But suppressing the steaming essentially terminates the LOCA event, by not introducing steam into the containment and taking energy out of the containment, the pressure is going to decrease.

MEMBER BANERJEE: Do you have a bunch of, is there any distributor, or are you just injecting into the hot leg and it just comes back?

MR. MOLSEED: It's injected into the hot leg and it penetrates into the reaction vessel and into the core. It mixes in the upper plenum and then drops through core.

It mixes with the fluid in the core, and then actually returns back up into the upper plenum.

MEMBER BANERJEE: So when you day UPTF, were there tests of this nature done in UPTF?

MR. MOLSEED: Yes.

MEMBER BANERJEE: So you looked at mixing or somebody did?

MR. MOLSEED: Yes, somebody did. And there was a series, I believe it was referred to as TRAM in the UPTF, a test program that specifically looked at this.

And it's actually, it's discussed in the technical report we'll speak to in the closed session.

MEMBER BANERJEE: We can probably come back and look at the slides as the mixing. There's no, it mixes so that the flow patterns are more or less like showing here?

MR. MOLSEED: Yes, more or less. This is a cartoon, obviously.

MEMBER BANERJEE: But some region there is an up flow for the steam condenser and there's a down flow.

MR. MOLSEED: That is correct. And we can get into more detail in the closed session on that.

MEMBER BANERJEE: And there's counter current flow in the hot leg?

MR. MOLSEED: Yes, there is. Or there can be, if there's still steam leaving, early on, after you've initiated hot leg injection, the steam will be going to the generator and the ECCS will be going in toward the vessel.

Since we don't have sprays or fan coolers to force the air and the steam mixture, throughout the building, we rely on the natural circulation patters in the building. And I'd like to just kind of go through that briefly, if I may.

We'll look at, in this cartoon, we'll look at a break in the RCS piping, although a steam line break will behave similarly. When the break opens, we fill the equipment area very rapidly with steam.

When that steam tends to increase the pressure in the equipment area, we open rupture or convection foils at the top of steam generator towers that are part of the CONVECT system.

That allows steam to mix throughout the rest of the containment. Shortly after those foils open, the dampers down at the IRWST open, as well, which forms a complete circulation loop within the equipment area and accessible space.

At some point during the transient, it happens very rapidly in a large break LOCA, you begin to condense steam on the heat structures in the building. That condensate will drain or rain throughout the building, collect on a horizontal surface and then begin to drain back to the IRWST.

The EPR design is specific in that there are limited obstructions. The intent is to return all of that water back to the IRWST. These intermediate floors, if I could get a mouse. The intermediate floors are actually cantilevered. There's, between the edge of the floor and the liner plate is a grated material, so that the water can drain back along the reactor building wall, down to the lowest annular floor, and there back into the IRWST.

So we're going to take all the water and we'll turn it back to the IRWST that's condensed in the building. After we initiate hot leg injection, we reduce the amount of steam going into the containment.

Condensation continues and we reduce the volume of steam in the building, and as such the pressure continues to decrease. Briefly, the surface area is important.

The total surface area of the heat structures is approximately 700,000 square feet and it's distributed throughout the containment. As I said, the floor grating allows for all water to drain back to the IRWST and that we rely on termination of steaming, either in a LOCA via hot leg injection, or in a steam line break via the termination of feed water or depletion of the generator to essentially limit the pressure excursion.

MEMBER BANERJEE: If you take all the surface from all the structures which can serve as heat sinks in the containment --

MR. MOLSEED: Yes.

MEMBER BANERJEE: -- how much of the, let's start with the blow down. You've got a certain amount of stored heat in the system.

MR. MOLSEED: Yes.

MEMBER BANERJEE: I don't know how many, but let's take a number. What fraction of that can come out from the true heat conduction into the structure?

MR. MOLSEED: During blow down you're not going to see a lot. I mean blow down is nearly instantaneous, 30 seconds or so of the event. You're essentially emptying the RCS and putting back energy --

MEMBER BANERJEE: The pressure is going up, right.

MR. MOLSEED: -- in the building and you're limited by the volume of the building at that point, the 2.8 million cubic feet. And we can probably defer a lot of this to the closed session as we talk through the phases.

MEMBER BANERJEE: But some part of that heat comes out later, of course.

MR. MOLSEED: Absolutely. The thin metal will reach a, I'm going to say a saturated condition, that's not really right. It's going to reach thermal equilibrium very quickly during blow down.

The thicker concrete and the heavier thicker metal will take longer, but there is a significant amount of stored energy that the concrete will accept.

MEMBER BANERJEE: It would be useful to get an overall feel for how the heat flows in the system. So you're putting in a certain amount of heat.

MR. MOLSEED: Yes.

MEMBER BANERJEE: How often is it coming in through, you know, the stored heat in the fuel and other structures? Some of it, of course, much later on, will come through the decay heat, but what is the heat flow like, in the system.

Some of it is going to structures and some of it has to go to, you know, just to --

MR. MOLSEED: In essence, it all goes to structures.

MEMBER BANERJEE: It all goes to

structures.

MR. MOLSEED: And then, as condensation, you know, so I'm condensing the steam, the liquid energy is returning back to the IRWST and is extracted by the heat exchangers.

The structures will store a lot of that energy, yes.

MEMBER BANERJEE: And not that much comes from convection through the annulus?

MR. MOLSEED: No. Actually --

MEMBER BANERJEE: So it's mainly the structures?

MR. MOLSEED: Yes. And when we get into closed section, I'll, I can address how we do it.

MEMBER BANERJEE: I'd just like to get a feel for the numbers, you know.

MR. MOLSEED: I don't have --

MEMBER BANERJEE: Taking these are lump parameters.

MR. MOLSEED: I don't have percentages off the top of my head.

MEMBER BANERJEE: No, I'm not looking for precision, I'm looking for the feel for, the fractions, where it's going. And it doesn't have to be now.

MR. MOLSEED: Okay. I think when we look at the pressure trace it will be a little bit more evident.

MEMBER STETKAR: Chris?

MR. MOLSEED: Yes, sir.

MEMBER STETKAR: Before you get too far into the actual containment response, when is it appropriate to ask questions about the mixing dampers, themselves?

Were you going to cover that at some time?

MR. MOLSEED: I have another slide where we'll get into it a little bit.

MEMBER STETKAR: Okay, I'll wait.

MR. MOLSEED: In fact, I think it's coming --

MS. SLOAN: Two slides.

MR. MOLSEED: -- in two slides.

CHAIRMAN POWERS: -- hydrogen that's an issue?

MEMBER STETKAR: No, I just want to know how the stupid dampers work.

(Laughter.)

(Simultaneous speaking.)

MEMBER STETKAR: I don't understand hydrogen, I understand dampers.

CHAIRMAN POWERS: I don't understand hydrogen and would like to. You do have a condensation indicator on your roof? I do a quick back of an envelope calculation and say, gee, I believe we can get a concentration up in that upper head unless we circulate it out.

MR. MOLSEED: Concentration of?

CHAIRMAN POWERS: Hydrogen. How can we, how do we circulate out of that upper dome?

MR. MOLSEED: How do we circulate the hydrogen out?

CHAIRMAN POWERS: Yes. If you're condensing steam in there and we have some evening in DBA, if I take the regulatory limits on the DBA, which is what I did. Whether you get there or not will lead to another discussion. I end up with a mixture up there if I don't circulate it out. How do you keep it, how do you circulate it out?

MR. MOLSEED: Well, for the hydrogen concentration, I'm not the appropriate individual. I think we could get someone else from, either Bob Sanders to address that.

MS. SLOAN: Bob or Daniel, who would like to, just introduce yourself, Daniel.

MR. KLEIN: My name is Daniel Klein, I'm

a System Engineer for the combustible gas control system. I have a diploma degree from the University of Applied Science in Germany, Wiesbaden, Germany. If you would repeat the question.

CHAIRMAN POWERS: Well, he's bringing steam up through his upper dome. That steam will carry along some hydrogen. He condenses out the steam, that water flows down into his IRWST and, but the hydrogen is left lonely, unwanted and unloved up in the dome unless it convects out. And I don't know how he convects it out.

MR. KLEIN: If we're talking about DBA scenario?

CHAIRMAN POWERS: Yes.

MR. KLEIN: The amount of hydrogen that gas released is low compared to a severe accident. So our calculations show that they stay below four percent or five percent total, in the containment, because of their free volume, what we have in the U.S.

CHAIRMAN POWERS: Yes, the trouble is this is not mixed in the whole three volume high calculated up 16 kilograms, when I ran my back of the envelope here real quickly.

And if I put it up there at the head of the dome, I'm at 11 percent hydrogen.

MR. KLEIN: Yes, we have recombiners installed not. We have recombiners installed on top of the polar frame.

MEMBER BANERJEE: Top of the what?

MR. KLEIN: On the polar frame.

(Simultaneous speaking.)

CHAIRMAN POWERS: -- polar frame and its not going to get there on the flow up.

(Simultaneous speaking.)

MR. KLEIN: -- all over the containment. Now, as soon as you have hydrogen in your ambient air, the recombiners start to work. They start off at two percent of hydrogen.

So, even in DBA scenarios. But in case we have hydrogen, the recombiners would start immediately to deplete the hydrogen.

CHAIRMAN POWERS: Only if the hydrogen convects enough to get to it. If it's just sitting up in the dome, we don't have a recombiner on.

MR. KLEIN: But on the way to the dome, we --

CHAIRMAN POWERS: -- this flow is very bad.

MR. KLEIN: And also we have our combat system that dilutes the hydrogen concentration.

CHAIRMAN POWERS: That's what I want to see, is your analysis that shows you convect out of that dome. Otherwise, it's sitting up there like a little bubble -- buoyancy.

MR. KLEIN: That's not the case.

CHAIRMAN POWERS: Well, that's what I'm asking to see.

MS. SLOAN: Okay.

CHAIRMAN POWERS: Is why that's not the case.

MS. SLOAN: And we'll take an action, Dr. Powers, and maybe we need a follow up discussion or providing additional, more detailed information about the calculations.

CHAIRMAN POWERS: It's the most crucial thing about this whole design. Because if that just sits up there in a bubble, now, I'll admit, I've got a little problem up there because I don't offhand see a lot of ignitors, ways to ignite it up there, but I get to hypothesize ignition, you know, in this thing. And I think you've got a problem.

Because if it's just sitting up there, you've got 416 kilograms of TNT equivalent, sitting up there.

MS. SLOAN: We'll working Derek to figure out if it's a follow discussion or meeting or if you'd like to see some of the details of the calculations.

CHAIRMAN POWERS: Well, I think I want to see calculations and experiments here on this, because this is, you're fighting buoyancy and fighting it really hard.

And this is a fairly crucial aspect of the designs.

MS. SLOAN: Okay, and we have made PRA files available for ACRS review and we can certainly do that for these calculations.

MEMBER BANERJEE: So the calculations which Dana is referring to, I assume they, you did some form of CFD to show this and tried to validate it against experiments, where there aren't that many same experiments.

CHAIRMAN POWERS: Yes, the trouble is I'm not going to be wild about CFD and condensation and condensing environment. And, I mean this is kind of a crazy thing to do, because you see how flat that dome is. I'm not sure you're going to get a real vigorous convection up there and I can always be surprised.

But this seems like a fairly crucial aspect of this design for the DBA system.

MS. SLOAN: Unless our folks have anything else to add, we'll take that as an action to provide the calculation files for review.

MEMBER BANERJEE: Are you going to talk about the methodology in your closed session? Or the calculation methodology?

MS. SLOAN: For the containment analysis?

MEMBER BANERJEE: For the condensation mixing.

MS. SLOAN: Yes.

MEMBER BANERJEE: So we'll take it from there, all right.

MR. MOLSEED: We've got a brief animation here to demonstrate the principles of circulation, and I'll go ahead and start it. You'll notice in the bottom right corner, there's a time displayed there, so you can see where we are.

This is a two-way LOCA, it's a double-ended guillotine cold leg break on a LOCA. The scale is steam concentration, water concentration. Blue being very low, red being very high. Let's see if it will go.

CHAIRMAN POWERS: Does this mean you start with the containment filled with water?

MR. MOLSEED: It's a zero, it's a zero.

CHAIRMAN POWERS: Okay.

MR. MOLSEED: So, what we see is we're seven seconds in, the steam concentration very high in the equipment's face. We've seen the foils open, steam plume up into the dome.

We're now 80 seconds in, we see the concentration beginning to equal out throughout the containment itself.

We're approaching one hour and it stopped abruptly. It wasn't supposed to, I apologize.

MEMBER BANERJEE: So, initially, this is just a hot plume rising?

MR. MOLSEED: Yes.

MEMBER BANERJEE: And venting, well initially it's like a jet, correct?

MR. MOLSEED: It's very much --

MEMBER BANERJEE: Can you repeat that?

MR. MOLSEED: I'd be happy to, I don't know if I can pause it. There, I think I paused it.

MEMBER BANERJEE: And there you're getting pretty good mixing because it's just a jet?

MR. MOLSEED: Yes.

MEMBER BANERJEE: Then you're going to natural convection at some point, because the pressures equalize.

MR. MOLSEED: It will take, we'll get through the end of blow down here. There we go, now we're starting to get into it.

MEMBER BANERJEE: Okay, now hold it there.

MR. MOLSEED: I think I did, there you go.

MEMBER BANERJEE: When you start to get some what looks notionally like convection cells up there --

MR. MOLSEED: There's still, even at --

MEMBER BANERJEE: And you're still getting some --

MR. MOLSEED: There's a lot of steam coming out.

MEMBER BANERJEE: Yes, you still get some steam coming. But, as you go on of course, it becomes natural convection driven, and we use the picture, I guess it could be interesting to look at the velocity it gets.

MR. MOLSEED: Yes, it would.

MEMBER BANERJEE: Yes, all right. I think Dana's question is what we have to follow up on this.

MR. MOLSEED: Yes, once you get 300 seconds or so in --

MEMBER BANERJEE: Right.

MR. MOLSEED: -- you're in a buoyancy

driven flow.

MEMBER BANERJEE: And then you've condensation occurring locally.

MR. MOLSEED: Condensation occurs locally and you get locally induced flows from that.

CHAIRMAN POWERS: That dome region is steam inerted.

MR. MOLSEED: Pardon?

CHAIRMAN POWERS: At this point that dome region, if I'm reading your scale right, is steam inerted. Shortly thereafter, that's when you're going to have the problem which will no longer be steam inerted up there.

MR. MOLSEED: There is a significant surface area of the dome for condensation. So you are going to have local flow up there to condense the steam, remainder of steam from the rest of the building is going to fill that void.

So you are going to see some flow there. But it's certainly not as high as you had during blow down.

MEMBER BANERJEE: Do you have an animation with velocities? I know you could easily do it.

MR. MOLSEED: It would be chaotic.

(Laughter.)

MR. MOLSEED: We've looked at it, it is very chaotic and it's hard to see in a simple x/y plane like this. You don't get the full feel for it.

MEMBER BANERJEE: Is it because of your model or is it because you expect there are no plumes?

CHAIRMAN POWERS: You just need to take another, he needs a view down from the top.

MR. MOLSEED: Through various elevations, yes. Yes, we'd wind up with eight or nine little graphs on the page. We've done it, but it is chaotic and it's hard to orient yourself within the building to see those velocities.

MEMBER BANERJEE: There is no preferred convection plume?

MR. MOLSEED: Well, there is, the preferred path is through the steam generator towers. I've broken those foils.

MEMBER BANERJEE: So you're saying time average this over a certain time slice. You don't see a prevailing --

MR. MOLSEED: Well, there is, there is, and that's what we were looking at on the previous slide. It goes up and then continues back down, and that's why the dampers are at the bottom, is to allow a circulation loop, really, to form.

The steam goes up through the tower, condenses, returns back through the lower area and you continue to see that loop form.

MEMBER BANERJEE: You see it when you average your velocities?

MR. MOLSEED: You do see that pattern, yes.

MEMBER BANERJEE: But when you say it's chaotic, it's locally chaotic or chaotic at a time instant?

MR. MOLSEED: Well, to try and generate an animation like this one, would be, what I'm saying is it would be difficult to have all of the --

MEMBER BANERJEE: You'd have to time average.

MR. MOLSEED: -- velocity vectors demonstrated on there, yes.

MEMBER BANERJEE: Okay.

MEMBER RAY: I'm trying to figure out what the cool down of the steam generators, what effect that has?

MR. MOLSEED: The coolant.

MEMBER RAY: Yes, the, when you blow down the automatic partial cool down of the steam generators.

MR. MOLSEED: Okay.

MEMBER RAY: Does that not create any contribution to this flow or circulation we're talking about here?

MR. MOLSEED: No, the steam generator, it's done through the main steam relief train, which is external to the containment.

MEMBER RAY: So it's not going to the --

MR. MOLSEED: It's not going into the containment data.

MEMBER RAY: Okay, all right. Somehow I thought it was being cooled by the, the cool down was taking place internal of the containment in the gas chambers, but that's obviously not true.

MR. MOLSEED: The next slide. Combustible gas control system. We've talked about CONVECT and its importance in the circulation patterns. The foils and dampers are part of the combustible gas control system, which allows for the conversion of the two-zone containment to a single mixed homogeneous atmosphere.

It controls the concentration of combustible gases. It is important that it is a combination of both safety and non-safety related equipment.

The rupture foils and convection foils, which are relied on following a DBA, are safety related. The mixing dampers, which are also relied on, are safety related.

The passive autocatalytic recombiners are non-safety related. I've got a couple of pictures here to help orient everybody into what the rupture foils and convection foils look like.

In the lower left corner, is a rupture/convection foil in a test frame. What we see is the foils in the frame. There will burst in approximately 1 psi or less, delta P across the foil.

They're physically attached to the center frame and then will rupture along the other three sides, so there are no loose parts. In the case of the convection foil, the frame is held together by a fusible link.

When the temperature in the compartment exceeds the melting point of that protective solder, the frame will drop into an open condition. In this picture here, the frame is hinged and it's attached to a pair of cables, so it won't become debris within the building.

And it allows for free flow through the rest of the frame. Pictured in the lower right is a hydrogen mixing damper. These are, you can almost think of these as a large butterfly valve or a fire damper.

They are spring-loaded and held in a closed position by an electrical solenoid. They're installed on a central pivot point. When they are de-energized or power is lost, the damper goes into an open state.

It pivots along its central axis and we see flow through the damper there.

MEMBER STETKAR: Now, I'm going to ask. These aren't the design of this system, as best as I can tell. It's not described in the FSAR, is that correct? Or, if it is, could you point me to where they are described?

MR. MOLSEED: Well, certainly they're going to be --

MEMBER STETKAR: Other than a sentence here and there about that they exist.

MR. MOLSEED: Section 625 and Section 622, where you're going to find the most information on the mixing dampers.

MEMBER STETKAR: Okay, that's, other than a sentence here or there that says they exist. I see varying pieces of information about these things.

They're ultimately called passive devices, which I don't necessarily agree with that term.

They're held closed by a solenoid, that's pretty clear. I see some statements in the SER, and perhaps the staff could explain this. But that these things open on a loss of off-site power, is that correct?

MR. MOLSEED: That's correct. When you lose power.

MEMBER STETKAR: No, no, loss of off-site power. I'm being very specific about what I'm talking about. This is a quote, they open on loss of off-site power. Not on-site power, not safety related dc power, not safety related ac power, it says off-site power.

Do they open on loss of off-site power, yes or no?

MR. MOLSEED: Daniel, can you address that question?

MR. KLEIN: Yes, that's right, they open on loss of off-site power.

MEMBER STETKAR: The power for the solenoids is non safety related power, is that correct? Even though these are safety related devices?

MR. KLEIN: I have to get back to you.

MEMBER STETKAR: Oh, okay. I want an answer to this, because I want to precisely know how these things work.

MS. SLOAN: So, John, your question is, is the power supply --

MEMBER STETKAR: I want to know what the power supply to those solenoids, that keep these things closed, is it safety related ac power? Is it safety related dc power?

Or is it non safety related ac power that is automatic, you know, by definition, de-energized when you lose off-site power?

That would be a strange design in these were de-energized if you lost off-site power simply because they're safety related pieces of equipment. But, it could be.

Now, the second question is, if power is available, there are statements that say that these things receive a signal to open on a differential pressure between the equipment space and the service space, or a preset containment pressure signal.

So these solenoids, the power to them actually goes through some type of logic that de-energizes the solenoids.

Is there any description of that logic? I couldn't find it in chapter 7 anywhere.

MR. KLEIN: Yes, we added that in one of our latest responses to the RAI response. So, now the INC function is described in section 635 and 73, you will find information. But if --

MEMBER STETKAR: Apparently not in Rev 4 of the DCD, anyway.

MS. SLOAN: Well, we'll have to give you the RAI number.

MEMBER STETKAR: I mean we don't --

MS. SLOAN: Beg your pardon?

MR. MOLSEED: 221.

MS. SLOAN: 221 and we'll get you the question number.

MEMBER STETKAR: Okay, thanks, I appreciate it. The last question I had is there's eight of these things total. How many must open for success? What's the functional success criteria?

MR. MOLSEED: For a design basis accident, so for a LOCA or a steam line break, we considered them as a single failure component. So could they be the limiting single failure?

And the answer was they were not the limiting failure. If we failed one of them to open, we actually saw far better results than if we failed to the main steam isolation valve falling in a steam line break or if we failed a train of ECCS in the case of a LOCA.

So we did credit all eight of them to open, but they were part of our single failure analysis.

MEMBER STETKAR: That doesn't quite answer the question that I asked.

MR. MOLSEED: Okay.

MEMBER STETKAR: I was asking a thermal question.

MR. MOLSEED: Okay.

MEMBER STETKAR: And that is how many most open for success? Can I win if two open? Can I win if three open? Can I win if four open? Only.

MS. SLOAN: I think we're going to have to follow up, because I, I'm going to look back at Bob Sanders. We may have done that as part of our PRA analysis, but I have to check.

MEMBER STETKAR: I don't remember, you know, I didn't look at the level 2 part of the PRA. This would be in the level 2 part of the PRA, and I didn't look at that. I appreciate that.

MS. SLOAN: We'll follow up.

MEMBER STETKAR: And finally, there's a statement. This again is from the SER so I'm not sure the scope of it. It says that these dampers receive a signal to open for most accident scenarios, which to me implies that for some accident scenarios they don't open automatically.

I'm curious about what the scenarios are that they don't open automatically, and if that's the case, if the Operators must open them manually, what sort of guidance is provided to the Operators? Again, this is from, quoting from the SER.

I didn't actually find that statement in the FSAR, but these things aren't really described all that well. And I'll grant you, they'll get a signal to open where the design base is large LOCA, in which everybody's design base is large LOCA center.

I like to think about small LOCAs and things like that.

MR. MOLSEED: We did analyze the number of small break LOCAs and in all of those cases we went down to a three inch break. In those cases, there was still a pressure signal generated that did open them.

We looked at small steam line breaks, down to one inch. And, in that case, they still opened. There was enough of a pressurization of the building to cause them to open.

If you don't see that containment pressurization, I'm not sure the importance of them opening.

MEMBER STETKAR: That's true, I was just curious, the way it's characterized, at least in the SER, it says for most accidents, and that left me a bit uneasy.

MR. MOLSEED: It may be that the Operators do have the ability to open them from the Control Room, maybe that was the intent. I can't really guess at what somebody else's thought process was.

MEMBER STETKAR: Well you said down to a three inch LOCA and a one inch steam line.

MR. MOLSEED: Down to a three inch LOCA. That's correct. Because they open on an absolute pressure in the building.

MEMBER STETKAR: Yes, yes, okay, thank you.

MR. MOLSEED: I guess the only other comment I would add on the mixing dampers is their safe condition is the open condition. So, I mean, if they lose any power to open in the safe condition as the --

MEMBER STETKAR: I'm just trying to figure out what power do we need to lose.

MR. MOLSEED: I completely understand. It's a fair question.

CHAIRMAN POWERS: Let me ask a question about categorization. Earlier I asked a question about hydrogen accumulation in the upper dome do to steam condensation.

And in the response there was a discussion of passive autocatalytic recombiner. But now I see that autocatalytic recombiners are not rated as safety so they cannot figure in that analysis.

MR. MOLSEED: That is correct, they are non-safety. We will get into the passive autocatalytic recombiners later in the presentation, and I think we identify there the events that were credited in.

CHAIRMAN POWERS: I'm going to be fascinated by your discussion on autocatalytic combiners for a lot of reasons. Now I'm just looking at the elements of the kabuki dance that appear for design basis analysis.

And I don't, I didn't accept the autocatalytic combiners playing a role in the hydrogen accumulation in the upper dome that it takes to get there.

But, nevertheless, they were element as the response to my question, but they don't seem like they should be an element of response, because they're non-safe. Am I right?

MS. SLOAN: Yes, that is correct.

MR. MOLSEED: Yes. Section 6.2.7 is the discussion of the fracture prevention for the containment pressure vessel and steel liner plate, but the liner plate is subject to ASME Code Section 3, Article CC2520.

And materials used in Section 3, Division 1 attachments and appurtenances meet the fracture requirements of article NE-2300.

CHAIRMAN POWERS: And I think you told us previously that the lower regions, all right, easier to start. This liner was painted with a zinc primer and at the lower regions of it, have an overcoat of an epoxy, but the upper regions are left with the zinc primer?

MR. MOLSEED: I'm not the coatings expert.

MS. SLOAN: I'm not sure we have someone to address the coatings issue.

CHAIRMAN POWERS: I don't think you need to, I think you've addressed it previously. And I'm just trying to see if my memory is correct. And you will, of course, have a certain amount of hydrogen generation hanging on because of the steam on that zinc primer, but that's, I think that the upper regions is zinc primer and the lower regions, the places where people can get to have an overcoat of epoxy.

MS. SLOAN: Do you want us to confirm that, Dr. Powers?

CHAIRMAN POWERS: If it's convenient, but do not knock yourself out, because I think I can walk back to my desk and pull the view graphs you've used previously.

I think I can confirm perhaps as fast as you can. One more question on things that look like doors.

MR. MOLSEED: Things that look like doors.

(Laughter.)

CHAIRMAN POWERS: And I'll use the word door. Are you going to talk about the doors in the pressurizer compartment, at some time?

MR. MOLSEED: We can, they're not part of the presentation right now. We certainly can in the closed session, we'll talk about the LOCAs and the methodology.

CHAIRMAN POWERS: I'll wait then.

MR. MOLSEED: Let's see, in-service inspection described in section 6.6. We follow the section 11 edition of the code. For any high energy system there's inspection requiring 100 percent volumetric examination of the wells, circumferential and longitudinal.

The COL Applicant has an action there, also as part of the ASME section 11 code to do pre-service and in-service inspections in accordance with the Code of Federal Regulations.

And, with that, I will turn the presentation over to Ron Conley.

MEMBER RAY: Well, let me try again. I got mixed up in my question earlier, let me see if I can keep this one straight.

Does this plant, is it designed to have a full load rejection capabilities so that, for example, if there was a loss of off-site power you'd be able to keep the reactor critical?

MR. MOLSEED: Tim.

MEMBER RAY: You better introduce yourself.

MR. STACK: I'm Tim Stack from AREVA, do you want a bio again, or just continue on with the answer?

MS. SLOAN: Go ahead.

MR. STACK: Very good, the answer is yes, you have 100 percent above your rejection capability.

MEMBER RAY: Okay, I would have expected that. So I'm just pondering what John raised. If, in deed, these dampers open on a loss of off-site power, I'm just wondering what the sequence of events is then, with regard to these foils and other things, which would presumably see some pressure differential.

Not because of the load rejection, but because of just the fact that the dampers have opened. And I guess we'll hear more about that when you come back and discuss the issue of whether these dampers open on loss of off-site power.

But it would seem like it would, if they do, there would be consequences that would be more than just, oh well, the dampers opened, let's close them again. And, well, because you have these foil barriers that are designed to open when the compartment pressurizes, now you've opened a normally closed damper down here and I'm wondering what pressure differential exists across those foils.

And if you're intending to bring the unit back, which is why I asked the full load rejection question. It seems like you would then have to not just close the dampers, but make sure that the foils haven't been affected.

That's basically where the final questioning was going.

MR. MOLSEED: Fair question. Again, Bob Sanders has a response? Okay.

MR. SANDERS: I'm Bob Sanders, I can answer the question quickly or give my bio?

MEMBER RAY: Answer it quickly.

MR. SANDERS: If you go back to your slide, it's important to remember that there are drains underneath the dampers, so there won't, there should not be any differential pressure across the mixing dampers during the sequence.

They're very small drains, but they should provide any type of pressure relief that occur between the two in normal operation.

MEMBER RAY: So the integrity of the foils up at the top of the steam generator compartments, don't depend on the dampers staying closed?

MR. MOLSEED: No, they shouldn't.

MR. SANDERS: If you keep going back, I think it was like your first of second slide.

MR. MOLSEED: Yes, I'll have to go way back to do that.

MEMBER RAY: No, that's all right, I have, it just appeared to me that the opening of the dampers was, would be associated with some change in that pressure differential, that may affect the --

MR. MOLSEED: It certainly could.

MEMBER RAY: -- integrity of the --

MR. MOLSEED: But I don't think it's larger enough to.

MEMBER RAY: Okay.

MR. MOLSEED: There's a pressure difference between the two zones.

MS. SLOAN: Daniel.

MR. MOLSEED: Daniel, okay.

MR. KLEIN: Maybe we have to clarify it a little bit. So the mixing damper has a slight delay and they get triggered by 0.7 psi data pressure. And the convection and the rupture point, they are both at the same pressure. So what, in the case where we have for large break LOCA, they have jet flow basically running through your steam generator compartment. It opens the ports immediately. And then a couple of seconds later the hydrogen mixing damper open to the port flow convect. The data pressure is mainly gone all ready. And if you have a --

MEMBER RAY: Wail, let me interrupt you.

Because I'm just talking about a loss of off-site power, you get a load rejection, the reactor is still critical, the dampers came open for the reason that John said.

And I'm just asking the question, does that create a pressure difference because the dampers are now open, instead of closed, across the foils at the top of the steam generator compartment.

If the answer is it's small and you've considered it, that's fine.

MR. MOLSEED: I think we'll have to get back to you on that. There is a pressure difference between the compartments, obviously, for the HVAC system, there is a slight difference.

When you open the dampers, that pressure equilibrates throughout the building. The question would be, what is that pressure difference and is it significant enough to open the foils?

MEMBER RAY: You have to worry about the effect of the dampers opening. Maybe the point was they're very robust because when they're needed to open, the pressure is really large and so we don't have to worry about small differences in pressure affecting them.

MR. KLEIN: May I make one more statement.

Could you show a picture of the hydrogen mixing damper, please? On the lower right corner I see an open mixing damper, and that has a horizontal axle.

And whenever you have a delta pressure on and it opens back like that, you have the axle. And though that supports you, that helps to open the hydrogen mixing damper and it does matter at least, it opened against the slide delta pressure.

MS. SLOAN: I think we have the question. We have the question of follow up on how big is the Delta P across the foils? And does that damage the integrity or effect the integrity of the foils in any way?

MEMBER RAY: Right, and again it all arises just from John's original question, which was do these things really open on a loss of off-site power?

MEMBER BANERJEE: What are the foils made of?

MR. MOLSEED: What are the foils made of?

MEMBER BANERJEE: Yes, the convection --

MR. MOLSEED: That's stainless steel.

MEMBER BANERJEE: And how thick are they?

MR. KLEIN: It's 33 millimeters approximately.

MEMBER BANERJEE: And they're held in place by? I'm confused about the design.

MR. KLEIN: Okay, can I step in front of you and show you a picture of --

MS. SLOAN: Daniel, let me ask you one question. Are any details of the foil design proprietary? If so, we may need to move this into the closed session, rather than have this on the public record. So think about that before you respond, please.

MR. KLEIN: I think we can move that to the closed session.

MS. SLOAN: I would prefer to do it that way. We're getting into a level of design detail that I believe would be held closely by AREVA.

MR. KLEIN: But be sure to address it, in case I forget, which is most likely.

(Laughter.)

MR. MOLSEED: And with that, I will turn the presentation over to Ron Conley.

MS. SLOAN: Let me make a pause and just note where we are in the presentation. The agenda has us finishing the open session in about ten minutes and there's quite a few topics there, I don't know how you want to handle that, with regards to the schedule for the day.

I can make a suggestion. A suggestion would be if the members have specific questions in the topic areas, we could field questions on these topics. We can go ahead and walk through our presentation, but it could take longer.

CHAIRMAN POWERS: Let's walk through your presentation. We are under no great time constraints.

MS. SLOAN: We will do that.

MR. CONLEY: I'm Ron Conley --

CHAIRMAN POWERS: It's okay, we have until midnight.

MR. CONLEY: I'm Ron Conley, I have a mechanical engineering degree from Purdue University. I have worked in the nuclear --

CHAIRMAN POWERS: How great, a boiler maker working on --

(Laughter.)

CHAIRMAN POWERS: You've found your calling here, that's good.

MR. CONLEY: And I've worked in the HVAC nuclear industry for about 30 years. I started my first eight years designing on the new plant design for Catawba and McGuire Nuclear Station.

And when the nuclear new bill process kind of got, went slow, then I went into the plant system operations. So I worked about 22 years as a system, HVAC System Engineer doing all kinds of interesting things.

It's something you design and develop and build and then you get to work with the people who operate it and the maintenance people who have to fix it.

CHAIRMAN POWERS: So they know who to curse.

(Laughter.)

MR. CONLEY: I've heard a lot of comments. So it was a wonderful opportunity.

CHAIRMAN POWERS: This is a positive feedback system here.

MR. CONLEY: Yes, sir, it was a wonderful opportunity for me to see how these things affect folks on the operating and maintenance side, and for them to understand some of the basis behind why we did some of these things.

I'll go through three different areas today. I'll go through the reactor shield building, annulus ventilation system, the control room habitability, control room ventilation, also.

And I'll go through the ESF filtration,

carbon filtration units or designs at EPR. I also have worked here at AREVA for three years as lead HVAC Engineer, as well.

And my former work was with Duke Energy and Duke Power. Okay, for the first slide, again, we're in the containment building, we have the containment building wall and we have the reactor shield building, and that area in between it is the annulus volume.

The annulus volume in our design is in some of the U.S. plants, especially the ice condenser type plants. Our annulus area is approximately 700,000 cubic feet, and we, the bottom half of the annulus is surrounding by other areas which are maintained at a negative pressure and filtered by ESF filtration systems.

The upper portion, the upper 100 feet is outside environment. So the bottom portion is completely surrounded by either the safeguards building, which is filtered, or the fuel building, which is filtered. Go to the next slide, please. As far as the annulus ventilation system, the normal operating system is basically a, it's, we provide non-safety cool supply area into the annulus during normal operation, and we exhaust air from the annulus during normal operation.

We exhaust more air than we supply. WE supply into this base, air which is pressure-controlled to maintain a negative pressure in the annulus during normal operation.

Go ahead to the next slide. This shows, this little schematic shows our supply of air coming in, we have multiple locations. We have two isolation motor-operated dampers there to shut it off in case we go from normal operation to accident operation.

And then, at the top, you'll see the exhausted air coming out of the annulus and going back through. We have, again, two motor-operated isolation dampers that will isolate in a LOCA.

Go to the next slide. And the next slide shows the annulus shelf ventilation system, which is fairly typical for annulus systems. Basically, what we do with this system is we maintain a negative .25 inches of pressure in the annulus, or less than that.

We maintain the barrier to meet 10 CFR Appendix J, in leakage. We maintain and we have the standard secondary containment and leakage, the secondary containment out leakage during accident from primary containment.

This is the accident exhaust and we have two 100 percent ESF filtration trains. Our ESF filtration trains are completely redundant, completely independent.

They each have the standard components for an ESF filtration system. During an accident, as I mentioned before, during an accident that normal system will isolate with those supply, isolation dampers going to supply an exhaust.

And these will automatically come on to maintain a negative pressure in the annulus. We draw down the annulus to a minus .25 inches within 305 seconds, about 6 minutes with, that's with one train running and if we continue running with one train, we can draw the annulus down to minus 2.5 inches in about 500, well, longer, I'm not sure exactly what that time period is.

I think it's more about 4 or 5 minutes. And then we can draw it down to a greater need of pressure after that, like a minus 6 inches negative pressure. And with both fans running, we can draw the pressure down to approximately minus 12 inches. And basically what these filters do is, when we get a LOCA, that exhaust fan operates, both the exhaust fans will operate, we'll draw the annulus down and we'll just keep drawing it down.

So we really draw our annuluses down to a real high negative pressure, so that any potential leakage from containment goes into that annulus and it's filtered prior to being released to the unit vent stack.

The exhaust of that air goes through unit vent stack is a location right to the stack, it's separate from the other discharges to the stack. And our stack is safety related seismic one. Next slide, please.

CHAIRMAN POWERS: Could I ask what your loading capability on your pre-filters?

MR. CONLEY: On our pre-filters, on our pre-filters. We meet our standard ASHRE, there's like efficiencies for pre-filters. We have loading on our epi-filters, we have identified loading on epi-filters and, but pre-filters we just meet, we meet standard ASHRE testing requirements for pre-filters.

I'll have to, I have to get back with you exactly how much that is.

CHAIRMAN POWERS: And your HEPA is a kilogram?

MR. CONLEY: Sir?

CHAIRMAN POWERS: Your HEPA is a kilogram loading?

MR. CONLEY: Kilogram loading?

CHAIRMAN POWERS: Yes, particulate loading on your HEPA is --

MR. CONLEY: Right, right.

CHAIRMAN POWERS: -- kilogram is the standard HEPA?

MR. CONLEY: Right, about a gram of, a kilogram from that.

MEMBER SHACK: So that the half percent leakage that you have from the containment in design basis is into the minus 12 inches?

MR. CONLEY: It would be, it's, okay the half a percent across the HEPA and the carbon, we have a 99.95 percent efficiency of leakage bypass across that HEPA in the carbon filter.

The half percent that you're talking about is, let's see, let me get back with you on that.

MEMBER SHACK: Yes, I guess that's sort of what my question is. Is where is that half percent measured at.

MR. CONLEY: Okay. Pedro, do you, would you --

MR. PEREZ: Good morning, my name is Pedro Perez with AREVA. In the half percent that you're referring to --

MEMBER SHACK: Is the leakage from the containment?

MR. PEREZ: I thought it was, well, I know it's 0.25 weight percent a day.

MEMBER SHACK: Okay, and I saw sub 0.5 somewhere.

MR. PEREZ: That's --

MEMBER SHACK: That's what?

MR. PEREZ: I believe that may be a European number, the 0.5. Ours is 0.25 weight percent a day. And that, that basically after the annulus has run down, that leakage rate will go into the annulus.

MEMBER SHACK: Okay, but that leakage rate is against the minus 12 inches that he's pulling.

MR. PEREZ: It gets drawn in, yes.

MEMBER SHACK: Yes, okay.

MR. PEREZ: Yes.

MEMBER SHACK: And it's .25?

MR. PEREZ: Yes, it is.

MEMBER STETKAR: Ron, a couple of questions before you get to the control room.

MR. PEREZ: Yes.

MEMBER STETKAR: Is the annulus ventilation system exhaust lines, are they hard piped or are they duct work?

MR. CONLEY: They're duct work, like you have 14 gauge ducting, we have pretty heavy ducting.

MEMBER STETKAR: But they're not hardened against hydrogen explosions, for example.

MR. CONLEY: They're seismic 1 design.

MEMBER STETKAR: But that's support.

MR. CONLEY: Right.

MEMBER STETKAR: In the interest of time, I'll let you go on to the control room.

CHAIRMAN POWERS: Our primary focus is to get all the information we need. You don't have a time slot.

MEMBER STETKAR: Yes, the other question --

CHAIRMAN POWERS: That's --

MEMBER STETKAR: Let me ask you one other question, then.

CHAIRMAN POWERS: I knew you had one.

MEMBER STETKAR: The shield building, the annulus space is relatively narrow in an absolute sense.

MR. CONLEY: Right, yes, it's only about six feet.

MEMBER STETKAR: A little less than two meters, yes. Is there any other equipment in the annulus, and it's got all the penetrations running through it. It's got the discharge plenum from the normal ventilation. It's got, you know, the inlet lines for the, but those are passive.

Does it contain any equipment? Are there sump pumps in there? Are there any other valves? Are there any electrical things in there?

MR. DAUGHERTY: Yes, there is a sump in the annulus with wood pumps.

MEMBER STETKAR: Okay, thanks. Well, I need to think about a couple of things. Thank you.

MR. CONLEY: Okay, continuing on, the, for control room habitability, go on to the next slide. These are some of the design standards that we utilize for control room habitability, 1.8 for hazardous chemicals, 1.196 for control room habitability, 1.197 envelope integrity, and GDC 4, 5 and 19, standards.

The next slide. Some of the design functions for control room habitability are missile protection, control room emergency filtration, pressurization of control room, cooling of the control room.

Radiation shielding, protection from toxic gases and fire protection systems. We have two COLAs out there on control room one for toxic gas sensors, and we have another one that deals with the radiation exposure in a main control room occupants and the design basis accident in a nearby unit with multi-sites, is founded by radiation exposure.

The next slide --

CHAIRMAN POWERS: Did you foresee in your design of the control room an occasion when Operators would have to operate using breathing apparatus?

MR. CONLEY: Well, they do have breathing apparatus available to them, like talking like during a fire or something like that?

CHAIRMAN POWERS: It could come from any of a variety of things, but let's take a case from a spilling of ammonia release. When you design and think about the control room, do you think how I will have the Operators operating in packs or something like that? Or do you try to prevent that?

MR. CONLEY: Well, we would certainly try to prevent that if it's possible. Our toxic gas issue is an open issue right now with, in our evaluation.

MEMBER STETKAR: Ron, have you thought about normal C02 buildup?

MR. CONLEY: Yes, we have.

MEMBER STETKAR: How do you vent the control room space? I know that the outside area is safe from accident conditions is 1,000 cfm?

MR. CONLEY: Right.

MEMBER STETKAR: You recirculate about 3,000, you've got about 1,000 make up. The whole thing is designed to isolate. Is the only normal exhaust path through the kitchen and twilight area exhaust?

MR. CONLEY: Twilight area exhaust is one area. Another area is just cracks and things like that, even penetration.

MEMBER STETKAR: But let's say they did things really well, they sealed it all up.

MR. CONLEY: We'd have to find some holes in it.

MEMBER STETKAR: No, seriously, my question is for habitability. I understand how you maintain, you know, a temperature condition environment in there.

I don't see anything that takes out CO_2.

MR. CONLEY: Well, we, with 1,000 cfm, that's per train, and we normally have two trains --

MEMBER STETKAR: Going in?

MR. CONLEY: Right.

MEMBER STETKAR: You have to exhaust --

MR. CONLEY: Right.

MEMBER STETKAR: -- roughly 1,000 cfm --

MR. CONLEY: And we will exhaust that area. Our exhaust from our bathrooms and --

MEMBER STETKAR: That gets isolated though, from what I saw in the radiological event, that's isolated.

MR. CONLEY: Well, on a radiological event that is isolated. We do have exhausts from penetration and things like that.

MEMBER STETKAR: Do you rely strictly on the exhaust?

MR. CONLEY: Yes, we do.

MEMBER STETKAR: From CO2?

MR. CONLEY: Yes.

MEMBER STETKAR: And this area does contains the control room and the technical support center, so you may have, the technical support center is designed for 25 people plus whatever complement of normal Operators you have in the control room.

So we're talking about, probably somewhere ballpark 30 people or so.

MR. CONLEY: Yes, sir, we are.

MEMBER STETKAR: In this area.

MR. CONLEY: Yes. We are and that is an area where we are looking into an issue into that right now and the recirculation of CO_2.

MEMBER STETKAR: On CO_2, in particular?

MR. CONLEY: Yes.

MEMBER STETKAR: Okay, maybe I'll ask the staff a little bit then if they've thought about it, since you do have -- about CO_2 in particular, because I know they've asked questions about toxic gas coming in from the outside.

But you say there is an ongoing discussion, okay.

MR. CONLEY: There is a question on it about CO_2, yes.

MEMBER STETKAR: Okay, thank you.

MR. CONLEY: And this shows a schematic of a plant, just a general overview. The building there is a safeguards building, it's a multistage building. Near the top is the control room, but going from left to right, the actual building, we have an accident.

We'll have penetration going from reactor building over into annulus. And then we have the annulus ventilation system pulling out of there. And then we have, in the safeguards building itself, we have the ECCS conference down below, going into ESF filters, the blue boxes are ESF filters going over to the unit bent stack again.

And there's also a draw from the fuel building to that safeguards building filtration system as well. So every, each of the areas that's potentially radiologically contaminated, has a, has maintained at a negative pressure and it's discharged through an ESF filtration unit to the unit bent stack.

From the unit bent stack, you know, we could get potential atmosphere dispersion over to the control room, but we do have ESF filtration units to clean the carbon or clean the air before it enters in the control room. Next slide, please.

This is just a standard for habitability. Habitability during normal operation is simply left to right with bringing outside air in.

It's preheated as necessary, we bring it down and it is supplied into the control room, the CRE is the control room envelope. And the air comes back with the green arrow shown at the top.

Back through the recooling cycle again. And so we maintain that under 1,000 cfm outside air in there, just like you had mentioned, John.

The next slide is the control room operating in an accident alignment. During an accident, we bring the air into, from the outside it goes through the carbon filtration unit and is supplied into a plenum which goes to the coolers.

It comes back from the coolers, on that green line at the top, from the control room envelope and it goes back through the carbon filtration unit again.

So we have 3,000 cfm of recirc from the control room, and 1,000 outside mix that goes into the control room during the accident.

We receive a containment isolation signal to do that. We receive high radiation, it will go into that filtered alignment. And the next area is one of the areas that we were just talking about, is the control room envelope.

It consists of a lot of different areas. It's not only the control room, but it is the tech support center, the restrooms, controls, instruments and controls, and that's all under elevation 53.

And just above it is our HVAC equipment room, which is also a part of that total envelope for the control room envelope. Next slide.

And we have, again, 1,000 cfm from outside. Something different on that is accident alignment. We have 40 cfm boundary leakage and 10 cfm ingress and egress.

We have a tight accident alignment for

leakage. So unfiltered leakage, that's for leakage back into the control room. That's not leakage from the control room. And we're dealing with 30 people in the control room during that design condition.

CHAIRMAN POWERS: An operational problem that we've had with a variety of existing reactor is with unfiltered, these things could creep up with time. In the design have you had that problem?

MR. CONLEY: Yes, we have. I've had to do testing of that unfiltered --

CHAIRMAN POWERS: I bet you did.

MR. CONLEY: Yes, sir, that's a real challenge. We have had to, plants had to seal up all kinds of things and put rigorous ducting penetration through areas so the ducting doesn't flex.

But, for our designs we have doors which were very high to ceiling. More like a marine door in a submarine or a naval vessel. So you go into it, it's got a, you have to kind of step over, it's got a seal to where it will close, it's sealed really tight.

And we have double entry on the control room, two doors going in, go in, depressurize and then open the door into the control room. So we do that as well. So we do have some real nice design features on the control room, to keep that envelope tight.

And for the ESF filtration units, we designed a course to remove, limit the fission products during both normal and during accident operations, the design basis accident, or during a fuel handling accident. Next slide, please.

ESF filtration systems units are used again in the control room or filtration with outside air coming into the control room. Habitability for use in the annulus to remove any particulates from the annulus, as we had talked before.

They are removed to a containment building purge and also utilized for safeguards building ventilation system, which as two separate functions.

In the safeguards building, cleaning up the ECCS pump rooms and then also force from the fuel building. The nice thing about our ESN filtration units is that our units are there in standby.

We have normal filtration units that do all this filtering during normal operation, and we only used the ESF filtration unit, if there's an accident or if when testing alignment.

So we don't sit there and wear them out all the time. Our filtration units as standard components. We designed completely for Reg Guide 1.52, Rev 3. We had, we've got them all in exactly the same sequence that they're supposed to be design for in that Reg, Reg Guide 1.52.

And moisture separators, air heaters, pre-filter, post-filters, HEPA filters, carbon filters. And all of our carbon units have four inch carbon beds, four inch thick carbon beds.

I guess that's an extra efficiency of 99 percent. And with that, I'm complete on this session. And now Terry Daugherty will take care of the next session.

MR. DAUGHERTY: Thanks, Ron. Good morning, my name is Terry Daugherty, I'm a graduate of the United States Navy Nuclear Power Program. I've subsequently worked approximately 38 years in the commercial nuclear industry.

I've served the last five and a half, nearly six years on the design U.S. EPR with responsibilities for the containment isolation system and the containment leakage testing program.

This morning I will be presenting two of the features of a containment isolation system and the containment leakage testing program, as described in the SFAR, section 6.2.4, 6.2.6, respectively.

The containment isolation system design is classified as safety related, Quality Group B, Seismic

Category 1. We have approximately 340 penetrations in the building that range in size from an eighth of an inch to upwards of 39 inches, excluding the equipment hatches the personnel hatches.

We have one dedicated penetration, that is a spare and it is in accordance with the requirements of 10 CFR 50.34. Those systems that are used for accident mitigation, are required for a safe shutdown identified as the central systems and the CIV, the containment isolation valves in those systems do not receive a containment isolation signal, but they be remotely operated by the Operator in the main control room for first accident operations.

Those lines that penetrate the building, that communicate with the reactor coolant pressure boundary or directly to the containment atmosphere, are designed as configured in accordance with General Design Criteria 55 and 56.

That includes safety injections, CVCS, SAHRS, IRWST suction lines, and the containment building ventilation and purge lines.

Those lines that penetrate and are, form a part, are a part of closed systems, those valve configurations, the designs conform to General Design Criteria 57.

The containment isolation valves in those lines, are provided with capability for detecting leakage from the valve stems or bonnet seals. The system actuation for the containment isolation, the signal is generated from the protection system.

It sends a containment isolation signal, either stage 1 or stage 2. It automatically isolates those essential lines. The isolation valve closure times are designed in accordance with the standards, ANCY ANS 56.2.

Our low flow containment building ventilation system purge lines will be designed to close within five seconds. Electrical power supply to the CIVs, the buses, they're supplied by redundant class 1-E power sources.

The buses for the inner-containment isolation valves are backed up by the emergency diesels and the emergency uninterruptible power supply systems battery.

The buses for the outer-containment isolation valves are backed up by the diesels. The buses are supplied from the station blackout, the diesel generators during SBO conditions. And alternate feeds are provided both normal and standby power when certain electrical components have been taken out of service, such as a diesel generator for maintenance.

The penetrations are protected for over pressure conditions from thermal expansion when both valves are isolated. We have either check valves or pressure relief valves to relieve that potential pressure back to the containment.

Lines that have inboard containment isolation valves, have a natural, inherent protection feature to relieve that pressure. Next slide, please.

The containment leakage testing program described in section 6.2.6. There's integrated leakage rate test program that comprises type a, b and c tests, that are all conducted in accordance with 10 CFR 50, Appendix J, Option B.

And using the guidance of Regulatory Guide 1.163. The testing intervals are based on the NEI 94-01, and in accordance with the Regulatory Guide 1.163. The containment leak rate testing program. Requirements acceptance criteria a described in the technical specifications on the FSAR and the acceptance criteria state therein, is that leakage rate shall be less than or equal to 1.0 L sub a, during the first startup and following testing.

The acceptance criteria is .75 L sub a.

The type b and type c testing program, the acceptance criteria is .6 L sub a, combined for all of those leakage paths. L sub a, as was previously described or stated is .25 weight percent of mass per day for the containment.

And that's at the design basis LOCA pressure. That concludes that section.

MEMBER STETKAR: Terry?

MR. DAUGHERTY: Yes, sir.

MEMBER STETKAR: A couple of questions. One is there's sort of one unique line that comes, actually four, lines that come out of the containment. Those are the suction lines from the IRWST to the safety systems.

They have only a single isolation valve and three little suction valves. If I get a pipe breakout in the safeguards building, in one of those divisions and that valve is not closed, do I drain the entire IRWST into the safeguards building and have an open release bath from the containment disabling my ability to cool the core and insulate the containment?

MR. DAUGHERTY: No, those lines are contained within guard pipes.

MEMBER STETKAR: Those are guard pipes, I'm not talking about anything that damages the line, I'm talking if played out in the safeguards building it cannot be isolated by closing the one single valve.

Do I drain the intact IRWST into the safeguards building and had a 16 inch line open outside the containment to release all of my now damaged core material because I can't cool the core anymore because I have no IRWST. Say yes.

The question is why aren't there redundant isolation valves on that line to prevent that type of event, because that would seem to be a rather severe event in terms of trying to protect the core and the containment.

MR. DAUGHERTY: I would have to look at that a little bit further to give you a better answer on that on the isolation valve, or the double.

MEMBER STETKAR: I'm going to ask the staff an awful lot about this because I didn't see them asking any questions. I see an awful lot of recurrences to design criteria and, you know, things that I didn't get a law degree to take care of.

It wouldn't look like a good day if that happened. The second question I had is the SAHRS system has, does have two series isolation valves, in fact, so does CVCS.

Everything except the safety system as two series isolation valves on the suction line from the IRWST, so things that, those, the SAHRS valves, as I understand it, receive a stage 2 containment isolation signal. And you're probably going to refer me to INC people here, but let me get the question on the table.

They get a stage 2 containment isolation signal, I verified that. The question is if I need to reopen those valves, can I, I can see where I can reset in the logic, a containment isolation signal, but if containment pressure remains high, above the stage 2 isolation set point, can I actually reset that signal and reopen those valves?

MR. DAUGHERTY: I don't know the answer to that question.

MEMBER STETKAR: That's, and I can't find the interlocks. Does anybody here from AREVA have an answer to that?

Because it strikes that the time that I really want to us that, I might have continuing high containment pressure.

MS. SLOAN: I don't think we have the right person to take that.

MEMBER STETKAR: Take that as a takeaway, because I can see where you could reset the signal, but I don't know whether or not you can actually reset if the pressure still is reading high.

MR. DAUGHERTY: Correct, very good question. With that, that's all I have, I'll turn it over to Fred Maass.

MR. MAASS: Hello, my name is Fred Maass. I have a BS in mechanical engineering from Purdue University, so I took Ron's chair. I've been involved with Nuclear Island systems for the past 25 years with AREVA and I'm currently the manager of EDR in Nuclear Island Systems Group.

What I wanted to discuss today is the combustible gas control system and given a brief overview of it.

Combustible gas control system consists of ruptured foils, convection foils, mixing dampers and the passive autocatalytic recombiners in the hydrogen monitoring system itself.

It's designed to mix the atmosphere and make a homogeneous mixture of gases within the containment after the event of a design basis accident.

It will maintain the total hydrogen concentration below the threshold for combustion during a design basis accident. In other words, we don't need to the passive autocatalytic recombiners to operate during that scenario.

For severe accidents we do require the passive autocatalytic recombiners to operate, to keep the hydrogen below the threshold for combustion.

CHAIRMAN POWERS: What do you take as that threshold combustion?

MR. DAUGHERTY: The percent value is ten percent, for combustion as far as the concentration of hydrogen.

CHAIRMAN POWERS: That thing has combusted a lot less than ten percent hydrogen.

MR. DAUGHERTY: Well, that's our design criteria for this. So, they'll start working, the PARs will start working, as I mentioned earlier, at about two percent.

CHAIRMAN POWERS: Is that your understanding of it? You have to explain it. Ten percent hydrogen is an awful lot.

MS. SLOAN: We have someone.

MR. SANDERS: Bob Sanders again. Dr. Powers, the, we actually, in the calculation for the low we do take into account the AICC pressure from burning that low percentages.

CHAIRMAN POWERS: So what you're saying is that you can tolerate a combustion event as long as it doesn't involve more than 20 percent hydrogen?

MR. SANDERS: The ten percent is the 10 CFR requirement. And the PARs, we found demonstrations that show that the value remains below ten percent and then we allow math in to calculate the results of the burn pressure and the ultimate AICC pressure temperature.

CHAIRMAN POWERS: And then calculated the transition from the degradation to a detonation.

MR. SANDERS: We don't detonate.

CHAIRMAN POWERS: I guess the question is, not what you will do, but what the hydrogen can do.

MR. SANDERS: We do not assume detonation.

CHAIRMAN POWERS: There must surely be some reason for that?

MR. SANDERS: Oh we believe that where you remain below the DBT threshold.

CHAIRMAN POWERS: And why do you believe that?

MR. SANDERS: We base the threshold for detonation on the results that are documented in MELCOR. And I don't remember the exact value right off hand. Let me get back to you on those values.

CHAIRMAN POWERS: None of this is very comforting because MAP (phonetic) is a computer code

MELCOR is a computer code. Neither one of which purport DBT.

MR. SANDERS: I can get you, those are based on test data. I can get you that information. I don't have it first hand.

CHAIRMAN POWERS: If there was anything we know about detonations and transitions to detonations, is their geometry-dependent. And I'm not aware of any experiments, then again I can always be, I'm not confident I'm aware of every experiment, but I'm not aware of experiments that look at this particular geometry.

MEMBER BANERJEE: Is the geometry primarily, relatively open geometry at the dome? Is that geometry?

MR. SANDERS: The hydrogen migrates through the containment starting out in the lower region of the reactor coolant pump area. It's mainly through the pressurizer relief tank and tail pipes, and which are directed towards the floor.

It starts out, vibrates through the steam generator up into upper containment.

MEMBER BANERJEE: So if drew a concentration map of this, are there high combustible mixtures in relatively confined geometries?

MR. SANDERS: The mixture starts out at a high concentration in around the lower part of the steam generator and there are PARs located in that area that start lowering a hydrogen concentration at that point.

And then they're staged along that area up to ultimately, into upper containment, where the PAR is located on the polar frame.

MEMBER BANERJEE: Right, but what is the sort of concentration like in these confined areas? Is it getting to ten percent?

MR. SANDERS: We do not, we do not see, the calculations were done, we ought to see ten percent and generally we show that we predict fairly well mixing within the containment.

MEMBER BANERJEE: But mixing actually doesn't stop the, turbulence pushes things to detonation, as you know.
So, the problem is if it's turbulent it will detonate most likely.

And confinement certainly gives you detonation. So there's a run up to detonation within this geometry.

The issue I think which we should understand, is what are the concentrations in the ingredients that you're calculating? And I don't know if you can take credit for recombiners or not, there you are saying they're not safety.

MR. SANDERS: Well not in the DBA, but you access to that.

CHAIRMAN POWERS: I mean it seems to me the place where you're getting the hydrogen is the area where you're most likely to have turbulence.

And then you're at ten percent hydrogen.

MEMBER BANERJEE: Then we call the catalytic combiners ignitors.

MR. SANDERS: Initiators.

MEMBER BANERJEE: Yes, you see it in pipeline.

CHAIRMAN POWERS: And when it propagates into dome, depends on the intensity of the detonation.

MEMBER BANERJEE: Because that itself gives rise to turbulence. That's right, it should go from sort of geometry like this into an open geometry.

MR. SANDERS: Well, the turbulence is due to, I mean the hydrogen production is going to be late in the acts of, during core degradation. And so if you have typically in the severe accident we'll have the depressurization valves open, so the hydrogen flow path will be from the core to the pressurizer through the tail pipe in the pressurizer relief tank and then ultimately out the tail pipe which are directed towards the floor of the rooms.

So the overall -- it's not going to be turbulent like a line break or that high of a turbulence. The jet will then pinch on the floor and slowly vibrate and then the --

CHAIRMAN POWERS: But that's exactly what it's going to give the detonation, the transition. It is that flow right there.

MEMBER BANERJEE: See, once it starts, it pushes. Detonation will self-propagate because it pushes the next thing traveling in front of it as it goes.

MR. SANDERS: But you have to have a mixture of oxygen in the turbulence, as well. The jet will be a steam hydrogen mixture hitting the floor and then it will have to mix with the oxygen and you have PARs located right there at that location.

Which will then provide a driving force up the steam generator column.

MEMBER BANERJEE: So that's mainly filled with steam and hydrogen?

MR. SANDERS: There's no oxygen there. I don't remember the exact concentration of oxygen. I don't remember the exact concentrations. I can get you those plots.

MEMBER BANERJEE: Well, it would be useful to know what the concentrations are like. And where they are.

MR. SANDERS: Okay, I can get you that.

MEMBER BANERJEE: You know this sort of issue arose in one of the other catalytic systems when we started to look at potential for detonation.

MS. SLOAN: So the action --

CHAIRMAN POWERS: Recent events have made me convinced that I don't know they're going to detonate.

MS. SLOAN: So the action I'm capturing goes back to an action from earlier in the discussion, which is to provide the details of the analysis and the results of those analysis.

CHAIRMAN POWERS: Yes, I think this all falls in from where we started off earlier. Maybe a little out of the scope right now. But I think you get the trend?

MS. SLOAN: We do.

CHAIRMAN POWERS: Okay. Then we can chat more about that. Please continue.

MR. MAASS: Okay, the PARs, there are 47

located throughout containment, 41 of which are large, and six are small PARs. PARs use a palladium/platinum plate as a catalyst on the plates and they operate fairly, well they operate effectively in a steam saturated environment.

And we've protected them against direct containment spray from severe accident to heat and rule system, to spite their configuration of the container that they're in.

The schematic of the PARs itself shows that we have hydrogen steam and air mixing in and flowing up through the catalyst-coated plates and goes out the top of a lateral flow area.

And as the catalyst heats up it will increase the convection flow through the PAR unit itself. So that's a phenomenal capability of how the PARs works.

So it relies on initial convection flow through it and then it increases its flow rate due the heat of the catalyst.

CHAIRMAN POWERS: Have you chosen a vendor for this catalyst?

MR. MAASS: No, we haven't. We're developing, well we've developed specifications that will be used to select the vendor.

CHAIRMAN POWERS: Okay, the one thing we're aware of is the platinum/palladium respect. How do you hedge against contamination during normal operation that degrades performance?

MR. MAASS: I was talking such as maybe during an outage operation.

CHAIRMAN POWERS: I would just guess without thinking about it very carefully, that an outage with somebody painting, it would probably be the most devastating thing I can think of for a catalyst, just because of the solvents evaporating and condensing onto the, they will find the palladium. They will hunt it down.

MR. MAASS: We do have an open RAI on that particular comment that we're trying to, that we're answering at this point, so we haven't provided our answer yet. But we are aware of the issue.

CHAIRMAN POWERS: Are you aware of a test conducted in France, where samples of palladium, platinum type catalysts were placed in a simulation of a severe accident environment and failed to come to temperature?

MR. MAASS: I'll have to ask Daniel if he's aware of that.

MR. KLEIN: Can you repeat the question?

CHAIRMAN POWERS: I am aware of tests conducted in a program called Phoebus, I believe, where palladium and platinum catalysts that could not ignore a particular design since you haven't selected a design, but nominally, generically, they were placed in an environment purported to simulate that of a severe accident for PWR type accident.

And the catalyst failed to come to the expected temperature.

MR. KLEIN: You're talking about Phoebus test. There were different vendors attending to the test and there were different results. Not all, as far as I know, not all of the catalysts, a, none of them had their data starting behavior, but they are not ready to laid.

CHAIRMAN POWERS: Well, certainly my impression was that none of them, some of them failed to ignite at all. And one particular failed to ignite at all. But none of them came to the expected temperature.

MR. KLEIN: You need to have tests. If there was only one plate tested or a copper plate. It makes a difference if you have copper plates and not, or you don't have the kind of domino effect, it heats up the remaining plate and the whole part starts.

CHAIRMAN POWERS: The problem as I understand is this particular general assembly was tested in the radiation environment and performed fine, but when they put it in a simulated radioactive environment of the Phoebus experiment the things failed.

MR. KLEIN: I don't have the test results in front of me so I really cannot comment.

MS. SLOAN: Do you, Daniel, do you know what test there is, what Dr. Powers is referring to, so we could look it up?

MR. KLEIN: Yes, I'm pretty sure I know what test you're talking about.

CHAIRMAN POWERS: This particular experiment that I'm thinking of, it's really two experiments. And then they did an experiment where the melted down fuel assembly, injected the results in a simulation of a containment.

Then they inserted an array of these various catalytic materials and my recollection and that can be indeed faulty is that one catalytic material failed altogether to rise up in temperature. And that none of them came up to the expected temperature. Indicating that there were not generating as much heat as you would expect and consequently not being as catalytic as you would have expect.

It raises the question: will these devices actually perform in a severe accident environment.

MS. SLOAN: And I think we can look into that, as long as I get a head nod that we know what tests series specifically that you're referring to. And do you believe you have enough information to find it?

MR. KLEIN: Yes, I think we have enough information. Maybe I have to come back and ask for that specific test that you're talking about. And you're talking about the recombiner didn't create enough heat and we have to what the hydrogen depletion rate of that catalyst and so on.

It's hard to discuss the task right now, without having all the input information available. So before we commit anything, we need a close look in that specific test.

MS. SLOAN: So we'll take an action to try to identify the tests series and we'll work through Dr. Powers to have you validate that we're looking at the right set of data.

CHAIRMAN POWERS: I will do my best. The issue comes down to, do these things actually perform as planned, one has to think about how they're degraded during the operation and how they poison under the accident conditions.

MR. KLEIN: All I can tell at the moment that they are doing the past 20 years a lot of tests specific for severe accident scenarios, helping perform all over the world, Patel Institute and so on. And there is a lot of operational or severe accident experience for the recombiner. And for that reason they are installed 90 power plants all over the world.

CHAIRMAN POWERS: The problem I have is that I'm also aware that palladium/platinum catalysts have been in use since certainly the 1930s. And there are entire articles written on these catalysts in these kinds of environments. And none of that literature seems to make its way into the nuclear community. And the kind of testing that's done on poisoning does not parallel at all the kind of testing that's done to expose the poison of these catalysts in chemical environments.

We see these anecdotes and episodic tests in which they say, gee it came to temperature, well yes it will but how long does it stay there? And how is the surface being degraded at that time.

And then multiple things taking place

during operation, there is loss of surface area and catalytic material and there's actual chemical reaction. And the system seems to be poison surfaces catastrophically are sulfate compounds.

MS. SLOAN: I can understand the general concern and the need to demonstrate performance characteristics. That concludes the open portion.

CHAIRMAN POWERS: And I think we will take a break at this point for about 15 minutes and marshal our strength to march forward to a closed session. So why don't we return at a quarter of.

(Whereupon, the proceedings went off the record at 10:26 a.m. and came back on at 12:59 p.m.)

AFTERNOON SESSION

12:59 p.m.

CHAIRMAN POWERS: Let's come back into session. We're running a little late, but I'm not terribly concerned about that. It's more important that the Subcommittee get as good an understanding as possible on things.

Because we are much more constrained in full committee meetings, then we are in Subcommittee meetings. So, do not, don't rush the presentations because of some arbitrary time schedule. It's more important to get, make sure the committee has a good understanding of everything. And I'll turn it to Jason Carneal.

MR. CARNEAL: Yes.

CHAIRMAN POWERS: And you will discuss all the same stuff from the staff's perspective, right?

MR. CARNEAL: Yes, that's correct.

CHAIRMAN POWERS: This is Chapter 6, Engineered Safety Features.

MR. CARNEAL: Thank you, Dr. Powers, my name is Jason Carneal. I received a bachelors and masters from Virginia Tech in Engineering, Science and Mechanics, in 2001 and 2004.

CHAIRMAN POWERS: You're a baby.

MR. CARNEAL: Yes.

(Laughter.)

MR. CARNEAL: As far as it goes, yes. After my education I spent four years at the Naval Surface Warfare Center, Carderock Division, doing hydrodynamic experimentation on advanced, all forms of compulsors.

After which I came to NRC. I've been here about two and a half years now, serving as a Chapter PM in the EPR Projects Branch and currently I'm responsible for chapters 4, 6, 15 and 17, of the review.

So today's presentation from the staff will cover the Safety Evaluation Report with open items on chapter 6, Engineered Safety Features.

Our review team is comprised of a group of multi-disciplinary experts from several branches. The majority of the work for chapter 6, falls under the review of the Containment and Ventilation Branch, however there are sections where we had other technical branches involved or even leading the sections.

We've had support from the Reactor Siting and Accident Consequence Branch, Component Integrity Branch and the Reactor Systems Nuclear Performance and

Code Review Branch.

And we'll be hearing from many of these today. Just an overview of the progress of our review. Here I have a table broken down by section, listing the number of questions in each section.

For 6.1.1, metallic materials. We have 21 questions asked, zero open items. 6.1.2, organic materials. We asked a total of 11 questions with two open items remaining.

And I will make a note here that for section 6.1, the staff does not have a dedicated presentation. The two open items that we have remaining are mostly administrative in nature.

They arose during chapter day when working with OGC. So it's more of a language issue than a technical issue. So if the Committee has any specific questions on 6.1, ESF materials, we have staff here available to support that discussion.

Section 61, containment functional design. We asked 114 questions, we have 12 unique open items in this section. I will note that the staff did not deliver section 6.2.1.2, subcompartment analysis in phase two, as we currently do not have enough information on the docket to complete our phase 2 review.

We are also not delivering at this time, section 6.2.2, containment heat removal, largely due to the issues associated with GSI-191, and we're currently planning to deliver that product in phase four of this review.

Section 6.2.3, secondary containment functional design.

CHAIRMAN POWERS: Is that because of any particularly complicated with the, with your design or are you just waiting about a resolution on the GSI?

MR. TESFAYE: It's the resolution of the GSI, it's a generic issue, nothing specific.

CHAIRMAN POWERS: Okay, it's not peculiar to me, any design you would have to defer because the GSI is just going through a resolution and things like that?

MR. TESFAYE: That's correct. Specifically the downstream effects.

CHAIRMAN POWERS: Downstream effects.

MR. CARNEAL: I will note that we have recently received a revision to the technical report, ANP-10293, Revision 3, in which the Applicant is addressing issues associated with some performance, as well.

So that's currently under review.

CHAIRMAN POWERS: Good.

MR. CARNEAL: For section 6.2.3, secondary containment and functional design, total questions eight, number of open items, three. And then we have two open items in section 2.4, containment isolation system.

This sums up the rest of the chapter. All tolled, we have a total of 228 questions with 35 open items. The staff's presentation today, with the exception of section 6.1, will focus on those questions where we have open items and where we still have significant technical issues remaining.

So, I just wanted to point that out. So for the section 6.2.6, 6.2.7, and 6.6, again, we don't have dedicated slides, but if we have any questions, the staff is prepared to entertain those questions from the Committee.

And I will also note that this total does not include references to open items in other sections or chapters. For example, we have cross-cutting issues in 6.2.2, and other chapters, but we have not included that in these totals.

CHAIRMAN POWERS: You've covered those elsewhere?

MR. CARNEAL: Yes.

MR. MCKIRGAN: Pardon me, Mr. Chairman, John Mckirgan for the staff. I would like some clarification. I believe the agenda had us in an open session at this point?

CHAIRMAN POWERS: I think we're in an open session.

MR. MCKIRGAN: So, if I could just remind my staff and I'm sure the committee doesn't need reminding that, I think the slides are open, but as we go into discussion, if we start to venture into proprietary areas, perhaps I could ask the Applicant to assist us to make sure we stay clear of that.

And I assume there might be some flexibility if we do need to move to a closed session towards the end, we can defer those details. Thank you.

CHAIRMAN POWERS: I'm sure we can do that somehow. And we're absolutely dependent on the Applicant to tell us if we're straying into the dark side.

MR. CARNEAL: Okay, before we move into section 6.2.1, I'd like to ask the committee if they have any specific questions on section 6.1?

CHAIRMAN POWERS: We'll get to them.

MR. CARNEAL: Okay. All right. Well,

with that, I'll turn the floor over to Walt Jensen, he'll be leading the first discussion.

MR. JENSEN: Okay, Walton Jensen and I work in the Containment and Ventilation Branch of the Office of New Reactors. And I have a bachelor's degree from Mississippi State in Nuclear Engineering.

A masters degree from Catholic University in Nuclear Engineering, and I'm a graduate of the Oakridge School of Reactor Technology.

So, okay, we've got the first slide up. This is our confirmatory calculation, and as best we could, we tried to use the same input in MELCOR code as we would use with GOTHIC.

And so this is a code to code comparison and it shows fair margin to the design pressure and also that the containment pressure depressurizes the lower half of the maximum calculated pressure as recommended by the standard review plan.

We also did confirmatory calculations with VTT in Finland, using their ATWS code and we developed a separate model for that and it gave similar results.

So, this is with AREVA's 30-node model that we're using here. I don't think that's proprietary. And both AREVA and the staff did separate noding sensitivity studies and found that the

30-node model does a pretty good job.

CHAIRMAN POWERS: In this comparison between GOTHIC and MELCOR, is that a comparison with the same noding?

MR. JENSEN: Yes, it is.

CHAIRMAN POWERS: But you did an independent noding?

MR. JENSEN: We did. We did a noding study and we also did a completely independent noding, with a different code, the ATWS code with the help of VTT in Finland.

With the loss of coolant accidents, the break being low in the containment, set up a nice circulation pattern with the coils rupturing and the dampers opening and there was a mystery there was some thermal stratification, but this settled out fairly quickly.

Whereas steam line breaks occurring higher in the containment, these caused a good deal more stratification which lasted for a long time, as you can see in this graphic of the containment temperature from the largest main steam line break.

And it stayed stratified and this is the section going up through the service space of the containment. As breaks become smaller, steam line breaks become smaller, the peak occurs later in time and it spreads the stratification out, so that, I would like to go to the next slide, Jason.

And show, this is a locus of the peak temperature as calculated for the spectrum of main steam line breaks in the FSAR. It stays at the temperature, it's fairly high. I think the design temperature for this plan is like 338. So AREVA is working on an EQ curve for the instrumentation.

And they're still developing that and they're trying to make a composite of all the potential main steam line breaks and LOCAs of various sizes.

CHAIRMAN POWERS: Is this a uniform temperature or is there a peak in a particular location?

MR. JENSEN: This is the peak, and this is AREVA's calculation, and I don't know where these peaks are. They could well be in different parts of the containment.

They probably in the dome, somewhere in the dome, I would guess.

MR. MOLSEED: Yes, this is Chris Molseed with AREVA, again. Walt is correct. This is a peak temperature and it's reported throughout the building.

It's not necessarily from a single node. The peak temperature may vary in location depending upon the break size and the time in which the peak occurs.

MR. JENSEN: Then I have a list of the remaining issues from containment modeling. We've asked for documentation for, more documentation on the convect system, which is described fairly well in various RAI responses. But it needs to be put into the FSAR. And we're looking for proof of concept testing results for the foils and the dampers.

We believe they've been tested in Europe, but we haven't seen the results.

CHAIRMAN POWERS: You're really honestly looking for experimental tests on these?

MR. JENSEN: Yes, we are.

CHAIRMAN POWERS: You're answering one of the questions that I have had. At what point does staff ask for experimental verification? So now we know at least one occasion. One of those thresholds, when it's critical to a safety system, it's got to be tested. Very good.

MR. JENSEN: We have outstanding RAIs on the comparison of the 30-node model as compared with plant dimensional data. AREVA has given us a draft

RAI response now and I think last week and we're still looking at it.

We've asked for additional LOCA scoping calculations with the 30-noded model. There was a whole section of scoping calculations, but a lot of those were done with the one node model and for effects that occur further out in time, we think that the multi-noded model would be better. And lastly, AREVA needs to complete the equipment qualifications and present that to us so our equipment qualification people can be evaluating the instrumentation.

And they promised that for the end of May.

MEMBER STETKAR: Walt, before you get to hot leg injection, I think this is the appropriate time to ask, but tell me it isn't, if I'm wrong.

As part of the, your review of the containment minimum pressure analysis, there's, I guess, an open item, let me read it here. It says, in RAI-437 question, the staff requested the Applicant provide them ITAAC requirement to ensure that the as built containment heat structure inventory does not exceed the heat removal capability assumed in FSAR, tier 2, section 6.2.1.5, RAI 437, question 06.02.01-96, it being tracked as an open item.

This, to me, that says that you want an

ITAAC that limits the heat removal capacity of the as built containment structure, such that that heat capacity remains below an assumption in an analysis. Is that correct?

MR. JENSEN: Yes, sir. We're thinking about a window that says --

MEMBER STETKAR: Okay, but isn't it better to have a lot more heat removal capacity and redo an analysis, then to actually constrict a designer or constructor to physically limit the heat removal capacity?

MR. JENSEN: Probably so. I was thinking maybe that once the heat structures were checked, and if they were found to be too, greater than assumed in the analysis, I would expect that the analysis --

MEMBER STETKAR: I don't know what the ITAAC says, because this is still an open item. But the way I read this, it sounds to me that if I were building the plant and counting up surface area and volumes and what all is done to do all those thermal calculations, and I got to a certain point, now what do I do?

I started insulating things so that I get less effective heat transfer simply because, you know, I need to stay within the constraint of an analysis?

MR. JENSEN: I would hope not. And we've talked --

MEMBER STETKAR: Have you, I know it's still an open item, I just wanted to try to understand kind of the thrust of this. It doesn't say ITAAC requiring a re-analysis if, in deed, the heat transfer capacity exceeds that was used in the analysis.

It seems to say you want an ITAAC that makes sure that it's limited to a maximum amount, which might be good for that little calculation, but probably not feeling good in the grand scheme of things here.

MR. JENSEN: I think AREVA agrees with you. I don't think we're going to get an ITAAC, is what I understand from discussions.

MEMBER STETKAR: Well, I mean, but an ITAAC to redo that calculation, if in deed the as built passive heat sink capacity is greater than what was assumed, would seem, you know, perfectly reasonable.

MR. JENSEN: That would be much better.

MEMBER STETKAR: That's ITAAC, part of it is an analysis. Anyway, I recognize this is an open item, you're still under discussions with the Applicant, but I would certainly hope that there's no implication that the as built design is going to somehow actively limit that heat sink capacity.

MR. JENSEN: That would surely be a shame.

MEMBER STETKAR: Okay, that would, okay, thanks. It's perhaps a myth, but sometimes these things develop a life, and when people are actually constructing the plant, you know, they can have unexpected implications.

MR. MCKIRGAN: If I may, John McKirgan from the staff. The purpose of the ITAAC, of course, is to verify the as built. And so we don't want to get into a situation where the ITAAC says to redo the analysis that might then be, need to be reviewed again.

And so we want all the licensing decisions made once, and then the ITAAC then just verifies that. So I appreciate the sensitivity --

MEMBER STETKAR: And that actually gives me more pause of concern, that statement, then our previous discussion.

MR. MCKIRGAN: But we want the ITAAC to be very clear, very verifiable and inspectable. And so we're very sensitive that way. I appreciate the sensitivity you've raised about how the ITAAC is phrased.

And we'll work on that going forward, but we don't want to try and re-review things during construction or when we go into as built.

MEMBER STETKAR: Understand.

MR. JENSEN: All right, hot leg injection. This is initiated, as you've heard, 60 minutes post LOCA. The core boric acid control and steam quenching.

And I have AREVA assumes condensation only in the upper plenum and I hope that's not proprietary. They showed the condensation efficiency they used to be conservative.

Our test data, separate plume calculations with CFD STAR-CD code and with multi-noded core analysis, using CATHARE-3D. And the staff performed an analysis with RELAP and a multi-noded core model with TRACE, that we set up just to look at the cross flows in the core, with hot leg injection and evaluate the mixing.

And I have a nice hot leg injection picture, which shows the cold water coming in and pouring down the core periphery. We looked at the effect that a nozzle gap might have, because we were concerned that some of the cold water would float through the nozzle gap, into the downcomer, and not be available to quench steam.

And this was evaluated in TRACE and determined, we determined it had no effect at all, because the nozzle gap set up an internal vessel circulation pattern.

And we also observed mixing and condensation in the core, as well as the upper plenum. This is --

MR. CARNEAL: Walt, before you go on, I would just like to point out that we did have a change in this slide and we passed out a new one, at the beginning of this meeting.

So I just wanted to confirm that the members have the correct slide, slide 12.

MR. JENSEN: So what this shows, red line is TRACE. At the time we did the TRACE calculation, hot leg injection was still to be at 90 minutes, so that's why it continues out before the steaming rate drops.

And what this slide is, by the way, this is not the total mass release, it's the steam that's come out of the break. It's the hot superheated water that's flushed, plus anything that comes out as pure steam, is added together and it's the steam that pressurizes the containment.

So what I'm trying to show here is the

conservatism of AREVA's model and in terms of the steam released to the containment. The black line is what you would get if you just did a boiling pot calculation in the core.

And it shows how the effect of hot leg injection is to condense this steam coming out of the core, so this does not enter the containment as steam, but it's hot water.

CHAIRMAN POWERS: I guess I'm having a hard time understanding which of the curves is the FSAR?

MR. JENSEN: That's the blue curve.

CHAIRMAN POWERS: The blue curve.

MR. JENSEN: Yes, sir.

CHAIRMAN POWERS: So after about 100 seconds it is tentatively conservative compared to the calculation to save the one region with RELAP? And then RELAP seems to go into a classic numerical instability.

MR. JENSEN: Yes, indeed.

CHAIRMAN POWERS: -- condensation phenomena at low flows.

And I in fact see the calculation in which credit was given to the numerical instability.

MR. JENSEN: Now what we want to do here, Dr. Powers, is to cool the core cause we want to take the heat out and put it into the containment.

And so it looks like that both of the RELAP cases are taking more heat out of the core during the blow down period, than is TRACE.

And then TRACE is hotter during the reflow period and puts more steam in. The peak occurs here at about 30 seconds, which is right about here and so with this double log plot, the excess steam flow is dropping way down.

CHAIRMAN POWERS: So what you're saying is that the FSAR curve is taking out more steam and recalculating?

MR. JENSEN: More than the TRACE. It's taking more, it's taking, it looks like it's having, this is my guess. I guess it's having more heat transfer during the blow down than is TRACE.

And these calculations are done specifically for containment analysis. And there's one we're going to look at the core heat up, you do not want to use these assumptions.

Because there's a specific recommendation in SRP 6.2.1.3, that recommends that the core be left in nuclear boiling during the analysis.

CHAIRMAN POWERS: It might be good to have a linear plot that first 30 second region.

MR. JENSEN: While the plots tell you some things, but they also hide them.

CHAIRMAN POWERS: They do hide things, and that's when most of the steam comes out.

MR. JENSEN: Well, there's a lot of steam coming out further on and it's coming out fast then.

CHAIRMAN POWERS: Yes.

MR. JENSEN: But then there's a second peak way out there in time, well right before the, right at 3,600 seconds for this case, that's when hot inflection occurs.

And all the steaming rate is lower, the heat structures are in code red. And so, anyway, that's when the second peak occurs. LOCA remaining issues are RELAP, as you know, Dr. Powers, it oscillates and sometimes it wants to have reverse flow in from containment and we've asked how the reverse flow might suck in non-condensables and perhaps reduce then condensation.

And AREVA has promised this and asked for that on April the 28th. And we've asked them to investigate two-phase level swell. From their assumptions that they're using in their analysis to get to a more mechanistic calculation of two-phase level swell and the post reflood, that's the level that swells up from the core and two-phase for entering the steam generator and be a source of additional steam to the containment.

And they sent us a draft and right now that we are evaluating. And in this same calculation they're assuming an even flow split of the water between the floor loops.

And we've asked them to justify that, also, and that's also in the draft. All right, main steam line break, remaining issues.

The main steam line, this is the mass and energy release. Not the containment analysis itself, but one of the significant features in the mass and energy release analysis, is the initial mass, assumed to be in the steam generator. This is greatest at hot zero power and less at full power.

And we've asked for justification of AREVA and promised to give us in May. And, of course, we need, let's see, we've been comparing the chapter 15 main steam line break cases with the chapter 6 cases.

AREVA uses different assumptions or they showed us at the chapter 6 analysis method, reduces the higher containment pressures, but the chapter 15 analysis provides for a long and more drawn out excursion, and so we've asked if, how the temperature has been kept, is it kept at 15 assumptions with following the EQ curve.

And AREVA has added a high containment pressure steam generator isolation symbol to help mitigate small breaks. And we've asked that that be turned in with the safeguards in chapter 7.3, and we have a draft in on that.

CHAIRMAN POWERS: I guess I'm not sure what this means.

MR. JENSEN: Okay.

CHAIRMAN POWERS: A high containment steam generator isolation?

MR. JENSEN: Your highest containment pressure, you get a high containment pressure, you isolate the steam generator. And the purpose of that is because the other signals are low containment, low steam generator pressure.

CHAIRMAN POWERS: I think it's a general high containment pressure, containment isolation seemed all right.

MR. JENSEN: It isn't always a steam generator.

CHAIRMAN POWERS: Just a steam generator isolation?

MR. JENSEN: Because we want to isolate the generators to stop the steam flow coming in through the containment from the three intake steam generators.

MEMBER STETKAR: MSIV closure, so yes.

MR. JENSEN: Or a break small enough where most of it just keeps running, and not know it was there. At least that's my understanding, if AREVA would like to correct me.

So, conclusions. Well, we've discussed these open issues with AREVA and we think they can be resolved. And we don't see any showstoppers.

MR. CARNEAL: I think that's the conclusion of the staff's presentation on section 6.2.1. I'd like to ask if there are any additional questions for Walt?

MR. MCKIRGAN: This may be your last opportunity. After a very long and distinguished career, Mr. Jensen might be moving on.

CHAIRMAN POWERS: Is that so?

(Laughter.)

MR. MCKIRGAN: Sorry, Walt. It's not his first appearance before the ACRS and he's been a welcome presenter many times.

MR. JENSEN: Thank you.

CHAIRMAN POWERS: Congratulations.

MR. JENSEN: Thank you very much. I was at a meeting with Gary Holahan, my boss, and he mentioned how I'd been here longer than the water.

(Laughter.)

MR. CARNEAL: Any other questions on this section?

CHAIRMAN POWERS: It's going to be interesting to have this run. I haven't got my hands fully around this yet, and it's interesting to see how this resolves itself.

MR. CARNEAL: All right, thank you very much, Walt. For section 6.2.3, Secondary Containment Functional Design, Jim O'Driscoll will be leading the presentation, so I'll turn it over to Jim.

MR. O'DRISCOLL: Good afternoon, my name is Jim O'Driscoll, I work the Containment and Ventilation Branch in the Office of New Reactors. I'm a 1992 graduate of SUNY Maritime College in New York and I have a masters in Mechanical Engineering from Manhattan College, also in New York.

CHAIRMAN POWERS: And so you can compete on offers they don't refuse, right?

(Laughter.)

MEMBER STETKAR: In New York they just

work it out.

(Laughter.)

CHAIRMAN POWERS: Fuhgeddaboudit, I've learned this new term, fuhgeddaboudit.

(Laughter.)

CHAIRMAN POWERS: Go a head, sir.

MR. O'DRISCOLL: There are three open items for secondary containment. The first two open items focus on the Applicant's analysis submitted to demonstrate the function of a secondary containment.

For the third open item the staff is requesting that the Applicant incorporate the details of the containment leak off system, which were provided in response to a previous RAI in the FSAR. The next slide.

Okay, in order to evaluate the secondary containment meets GDC-16 requirements for functional capability, the SRP guidance directs the staff to review an analysis of the pressure and temperature response of the secondary containment to a LOCA in the primary containment. SRP criteria 1-A through 1-E, specifically provides review guidance on this analysis.

Criterion A, states that the conductive heat transfer and the radiant heat transfer to the secondary containment, should be considered.

In Criterion B, it states that a boundary condition should be assumed for the surface of the secondary containment structure exposed to the outside environment.

Criterion E, states that no credit should be taken for secondary containment out leakage. The staff's review so far, has found the Applicant's analysis results are focused on the heat transfer to the annulus space surrounding the primary containment.

Consequentially, the Applicant considers radiant and conductive heat transfer insignificant due to the large mass of concrete in the reactor building and the time period considered.

The staff notes that a large opening, such as equipment and personnel hatches, which penetrate through the annulus space, and terminate in either the safeguards buildings or the fuel building, haven't been discussed.

The staff is uncertain if the Applicant has addressed the radiant conductive heat transfer through these penetrations to those spaces.

A draft response to RAI-378, question 6.2.3-6, which requests a clarification on the issue of conducting heat transfer through a large opening, only discussed the heat transfer to the annulus space.

It did not discuss heat transfer in other areas that could be considered secondary containment spaces, in accordance with the Branch Technical Position 6.3, which discusses what criteria should be used for credit to be a secondary containment space.

RAI-462, question 6.2.3.7, requests further clarification on treatment of these spaces, in order for the staff to make its determination on acceptance Criterion A.

It also requests the Applicant provide the GOTHIC input deck for the analysis of the secondary containment. Staff review of the input deck, should allow the staff to come to a determination of acceptance Criterion B and E.

Next slide. The staff is unclear how the secondary containment out leakage and bypass leakage is considered. In the containment leakage testing section of the FSAR, that's 6.2.6, in the special testing requirements section, the Applicant states that there are zero bypass leakage from the secondary containment.

So, in other words, 100 percent of L sub a, is filtered through an ESF filtration system at 99 percent efficiency at 305 seconds after an accident.

That's what we, that's what we're crediting in the dose analyses.

The SFAR description 6.2.6, states that any bypass leakage to the safeguards building and the fuel building, is processed by the fuel building and the safeguards building ventilation systems.

So, as discussed in the previous slide, in 6.2.3 section of the FSAR, the Applicant discussed the function of secondary containment, only in terms of the annulus ventilation system and the annulus building.

The EPR and FSAR, does not clearly describe a safety-related function for the fuel building and safeguards building, to act as a secondary containment space. The staff has not evaluated these building against Branch Technical Position 6.3 criteria for secondary containment structures, therefore the staff cannot yet make a determination of zero bypass leakage for secondary containment, should be credited for the U.S. EPR. The RAIs previously discussed, address the staff's concern on this issue. Next slide.

MEMBER STETKAR: Jim, before you leave the bypass, reading some things it sounds like at least some of the penetration, I don't what they are, are equipped with some sort of bypass leakage capture system that routes flow back into the annulus. Is that --

MR. O'DRISCOLL: Well, there was an RAI response on this bypass leakage system that described it in about a paragraph. And what we requested is that description be included in the FSAR.

But it's still unclear to me how that system will, you know, diverts everything back to the annulus space.

MEMBER STETKAR: Right. Well, my question was, I mean I understand less of it than you do. My question was the things that I was reading said, well, you know, such a system, whatever its configuration is, exists.

And I, you know, I understand the philosophy because the annulus is kept at a negative pressure, and that its functionality would be tested during Appendix J leak rate tests, I'm not personally intimately familiar with all of those leak rate tests, but if in deed that system exists and if in deed credit is taken for that system, do we effectively channel bypass leakage back to the annulus and hence through a, you know, a safety related filtration system.

Is there anything in the Appendix J leak rate tests that confirms that those bypass leakage lines are open? If those lines are plugged, you can pass all kind of leak rate tests, because nothing is necessarily going out.

MR. O'DRISCOLL: The description of the special testing requirements does not go into details. But also it should note that the description of the special testing requirements do not mention any kind of testing of the bypass leakage system.

MEMBER STETKAR: The system itself, to see whether functionally --

MR. O'DRISCOLL: Right, I --

MEMBER STETKAR: That was my question --

MR. O'DRISCOLL: Right. I'm unsure if the Applicant is taking credit for that system to do that, it seems to me, from reading what they have in 6.2.6, that they're considering the buildings surrounding the ensemble of buildings, annulus plus the safeguards plus the fuel building as a secondary containment.

In that case, we have to do some more review on all those other buildings.

MEMBER STETKAR: Plus those ventilation systems.

MR. O'DRISCOLL: Right.

MEMBER STETKAR: Zero is a pretty small number.

MR. O'DRISCOLL: Yes.

MEMBER STETKAR: Thanks.

MR. O'DRISCOLL: Next slide, please. Okay, we can make the following conclusions. The staff, the existence of guard pipes and the high energy lines protect against the dynamic effects that may result on pipe failures in the reactor shield building.

However, if they are to credited as secondary containment structures, the staff must come to the same findings for the fuel building and the safeguards building, as it applies to the role of a secondary containment structure.

A ventilation system that serves the AVS, that serves the secondary containment space, the annulus, meets the guidance for an ESF filtration system and will be periodically tested.

However, the staff has yet to make this finding for the systems that serve the fuel building and safeguards buildings. If the Applicant clarifies these spaces also serve a secondary containment function, the staff will review the capability of the fuel building and safeguards building ventilation systems for this function.

The analysis of secondary containment, appears to follow the SRP guidance, with the exception of the items noted previously. And the scope of various, to be credited as secondary containment is unclear, however the Applicant should be able to clarify these issues in future RAI responses. Okay, that's all I have.

MR. CARNEAL: That concludes the presentation on section 6.2.3. Do the members have any additional questions on this section before we move to containment isolation?

MEMBER STETKAR: Jim, you said, I didn't know, is there an open item yet on that bypass?

MR. O'DRISCOLL: Yes, there is.

MEMBER STETKAR: There is, okay, fine. I just didn't make a note of it, thanks.

MR. CARNEAL: Okay, with that we'll move on to section 6.2.4 and 6.2.5. And Anne-Marie Grady will be leading these presentations. Anne-Marie.

MS. GRADY: I'm Anne-Marie Grady, I have a bachelor's degree in Nuclear Engineering from Lowell Tech in Massachusetts, and a masters degree in Nuclear Engineering from Columbia University in New York.

Can I have the next slide, please.

CHAIRMAN POWERS: So you can understand, right?

MEMBER RYAN: Absolutely.

(Laughter.)

CHAIRMAN POWERS: He says you're the first person to get up here who didn't have an accent.

(Laughter.)

MS. GRADY: Okay, the containment isolation valve. The FSAR T-2, section 6.2.4, commits to the general design criteria requirement from 55, 56 and 57, that isolation valves outside the containment are located as close to the containment as possible.

That's the requirement and that's the guidance for meeting the requirement, as well. We have an open item because those distances from the containment to the out board isolation valves, have not yet been provided in the FSAR, which means we can't make a finding on it, which means, we can't verify it when it's built. Hence, it's an open item.

CHAIRMAN POWERS: By definition, an open item.

MS. GRADY: It is. The next one is more, it's an open item but it's more nearly a confirmatory item. AREVA has met the requirement with 10 CFR 50.34, that there be a dedicated penetration.

They have identified in the RAI response that there would be a 36 inch dedicated penetration, essentially, a spare penetration. They have added it to table 6.2.4, which are the penetrations and containment.

And this open item is simply asking them to put in that table, the fact that it's 36 inches. It's the only open issue here, so it's more nearly confirmatory.

MEMBER STETKAR: Anne-Marie, do you have any comments on a question that I raised about isolation of the IRWST suction lines to prevent draining the IRWST into the safeguards building?

MS. GRADY: Could you repeat the question?

MEMBER STETKAR: Okay. Maybe you weren't here this morning.

MS. GRADY: No, I was, but I --

MEMBER STETKAR: Oh, were you, okay. The only isolation valve on the IRWST suction lines to each of the four safeguards drains is in fact a three-way common suction isolation valve.

So the question I raised is suppose you have a break in that suction line, out in the safeguards building, and the valve, the single valve does not close.

Thereby having an open pathway from the IRWST to drain into the safeguards building, thereby draining the entire contents of the IRWST and leaving open a, I think it's a 16 inch pathway that communicates directly from the containment atmosphere to the safeguards building.

I don't know. I, it just doesn't, I'd feel a lot more comfortable if there was another valve in that line someplace.

CHAIRMAN POWERS: Gosh, I can't imagine why?

(Laughter.)

MS. GRADY: I believe --

MEMBER STETKAR: But I didn't see any question. You know, I see references to the line, I see references to GDC. I see references to review criteria. But, I'm not sure that we've looked at a similar configuration in other plants.

I don't know if we have. You know, some configure differently. Refueling water storage tanks are configured differently in different plant designs.

This one is a little bit different, in the sense that a single pipe break with a failure of a single valve can be completely disabling your core cooling function and, at the same time, cause a direct, large hole in the containment.

MS. GRADY: Okay, I believe that that single, that failure could lead to draining down of the IRWST, but I think that would involve multiple failures and I think that would get us into severe accident models.

Where we would be modeling that in the TRA rather than here.

MEMBER STETKAR: I don't know, I'm just raising the question now because, as I said, I tend not to be limiting in my questions by design basis, licensing type questions.

MS. GRADY: Well, we could have a failure between the two valves, couldn't we.

MEMBER STETKAR: There aren't two valves, there's only one valve.

MS. GRADY: No, no, if a second valve, it doesn't seem to me that it would be any safer to add a second valve because then you could still postulate a failure between the two of them and you'd be in the same situation.

MEMBER STETKAR: That's true.

CHAIRMAN POWERS: What he's postulating is a failure based on single failure.

MEMBER STETKAR: And I'd even be happy, I have to be careful about what I'd be happy about.

CHAIRMAN POWERS: You're a very unhappy person.

MEMBER STETKAR: I'm a very unhappy, professionally I'm happy and proud of it. Even, for example, redundant isolation capability within reasonably close proximity to containment penetrations, albeit, both are from outside containment.

And, in deed, there might be some evidence with P&IDs of partial thought along those lines, although I don't know distances, because they're only cartoons.

But certainly not in the MHSI suction line. The MHSI suction only has a manual isolation valve and I'm not going to go into that, the IRWST draining into it and close that valve.

The next motor-operated valve that's not on the discharge line probably would be close to the annulus penetration. So there could be a reasonably long length of essentially un-insoluble piping.

And I don't know the distances on the others. It just, I'll raise the question. I mean I've heard your response.

MR. JACKSON: It's a good question. Based on your question this morning, I tried to figure out if it was modeled in PRA, but we would see an accident plus a valve failure. I'm sorry, my name is Chris Jackson, I work in the Containment Branch with Anne-Marie.

But I tried to figure out if that was modeled in the PRA. It's a good question. It should be.

But an accident plus a value failure plus a pipe failure, would be multiple failures and beyond typical design basis.

MEMBER STETKAR: Unless you actually did a full scope seismic analysis, for example. Which they didn't.

MR. JACKSON: I was unable to confirm at lunch whether that was in there.

MEMBER STETKAR: And you're right. Typically in the PRA, people don't look at non-direct consequential pipe failures, anyway.

MR. JACKSON: In this instance, this is the ECCS flow path, as well. So we're having multiple valves that actually create another failure mode for ECCS, so I think if you look at the traditional PWR, the pipe --

MEMBER STETKAR: There are, though, you

know, you can argue that way, but there are two valves in series in the low pressure injection of the suction line.

The throughway valve plus a motor-operated suction valve. So, in low pressure injection, that already, you know, your concern about spurious operation of a second valve.

MR. JACKSON: Yes, or it already exists.

MEMBER STETKAR: Go on, thanks.

MS. GRADY: Okay, combustible gas control. As I'm sure the ACRS knows, combustible gas control law was rewritten in 2003, to change the emphasis from a design basis analysis to a somewhat small design basis analysis, but essentially severe accident analysis.

And I tried to put my slides, my thoughts together here to separate the two. Combustible gas control does have to control the hydrogen concentrations after both a design basis and now accident, and a severe accident.

It relies on the safety related foils, the safety related dampers, the non-safety related PARs and one safety related sets of hydrogen monitors and one non-safety related sets of hydrogen monitors, comprises the system.

Now, for 50.44 for a design basis accident, the requirements to meet them are that the containment be mixed. That means that the concentration of hydrogen locally, as well as overall, has to be pretty much the same and the local and the global concentration has to remain below four percent for the first 24 hours. Severe accident has no requirements on it.

It has to have a mixed containment, as well, which we knew it has to be relatively uniform concentrations in all of the compartments, let's say, in all of the compartments, let's say, in all of the rooms.

The concentration in each and every one of those has to remain below ten percent for the first 24 hours and maintain at least that low afterwards.

The equipment for severe accident management, whatever the equipment might be, and that's pretty much the one they did in chapter 19 of the FSAR for severe accident, is there's a whole list of equipment.

That equipment must also survive a hydrogen burn in the containment. And the burn has to be burning 100 percent of the hydrogen that would be released if the fuel clad interacted with the coolant.

That's the quantity. There has to be reliable hydrogen monitoring in the containment and there is two sets of monitors. There's one set for normal operating and then there's one for severe accident and the containment structural integrity has to be maintained following this hydrogen burn, which again is based on 100 percent of the fuel clad coolant interaction. And, that's it. Okay, results. For the design basis analysis, we did a confirmatory calculation and AREVA used math for their analysis.

We used MELCOR for ours and we found the concentration of hydrogen, both globally and locally, was less than 24 hours, with no credit having been taken for the PARs.

So we agreed with the results that AREVA has stated in chapter 6.1.2.5. And that's how they got their results. This is design basis only.

CHAIRMAN POWERS: Looking at the design basis calculation, neither one of which actually solved the momentum equation --

MS. GRADY: Solved the what?

CHAIRMAN POWERS: Momentum equation, to get the uniformity, you have to invoke some sort of natural convection, but you have to do it with it nodalization or something like that.

MS. GRADY: Yes, yes.

CHAIRMAN POWERS: Which means you happen to know what the convection pattern is.

MS. GRADY: Yes.

CHAIRMAN POWERS: How do you know what the convection pattern is?

MS. GRADY: AREVA modeled their containment using MAP (phonetic) with 27 nodes.

CHAIRMAN POWERS: But it doesn't solve the equation. So in order to get the mixing, you have to have some, they have to know something about convection.

Because the code doesn't solve the momentum equation. It can't move anything, you have to tell it to move.

MS. GRADY: Okay, I --

MS. SLOAN: Dr. Powers?

CHAIRMAN POWERS: Yes.

MS. SLOAN: Let me just say that the details of the noding, the number of nodes, we're beginning to crossover into certain proprietary details. Just make note of that so we can stay in --

CHAIRMAN POWERS: What I'm asking is nothing to do with -- it's the way you completed the input, you have to know something about convection patterns in the containment in order to use lump node codes to calculate concentrations.

How do you know?

MS. GRADY: Okay, I am not a math practitioner nor a MELCOR practitioner. AREVA did the math analysis. We had a Contractor do our MELCOR analysis.

So I'm going to have ask that I could give you an answer to that at a later time. I don't know the answer.

CHAIRMAN POWERS: Okay, that's fine.

MR. CARNEAL: We'll take it as an action.

CHAIRMAN POWERS: That one I have to understand, because this speaks to the issue of do we get any stratification of pipe turn up in the upper dome.

And you're saying, you're coming back and you're saying, gee, we think you don't. And I want to know is why do you think you don't. And telling me to it with a lump node code, means that you told the code, there was no stratification.

You had to have a reason for telling the code that. Because you don't sell the momentum for this. So you cannot do natural convection with those codes, except by telling what the flow pattern is beforehand.

MS. GRADY: The containment was modeled using, taking credit for the CONVECT system. The fact that the foils would open, the dampers would open.

CHAIRMAN POWERS: That's fine.

MS. GRADY: The safety related doors in the pressurizer area would open.

CHAIRMAN POWERS: But you have no buoyancy model.

MS. GRADY: Okay, you're right, I don't have an answer to your question. I could say one additional thing on the confirmatory calc however. That one of the sensitivity studies that we did using the same, roughly the same noding scheme and MELCOR, was that we allowed all of the hydrogen, forced all of the hydrogen that was produced by radiolysis and corrosion, but not through the fuel clad pool and interaction with just under 15 kilograms anyway.

And we forced it up into the dome, and we still, and we still stayed below four percent, taking no credit for PARs. So, if that's reassuring --

CHAIRMAN POWERS: Yes, I just backed them into a corner.

MS. GRADY: I know.

CHAIRMAN POWERS: For that calculation we got 16 Kilograms, so not too bad. Not bad.

(Laughter.)

MS. GRADY: Not bad at all. But there's 300 of them that don't on that sensitivity calc. That's ours, not theirs.

MEMBER STETKAR: Anne-Marie, it says the, I'm looking at a figure from the FSAR. It says that the concentration remains below four percent for 24 hours. Do you have any idea when it actually reaches four percent?

Did you actually take the calculation out to see when it does get to four percent?

MS. GRADY: No, we took it out to 24 hours.

MEMBER STETKAR: Even in the truth it shows it's about two and a half percent or thereabouts.

C: Well, just to --

MEMBER STETKAR: If you believe the calculation.

CHAIRMAN POWERS: Well, I mean --

MEMBER STETKAR: This is a different issue from Dana. I was just curious about what sort of time schedule --

CHAIRMAN POWERS: Understand this four

percent, which gets flipped around, is the lower flammability when, for hydrogen air mixture at room temperature. Those flammability limits change with temperature. And, in particular, the limit goes down with increasing temperature.

This containment, I think we pulled earlier, went around 131F?

MEMBER STETKAR: Well, post-accident, there are temperatures up to 300 and some F.

CHAIRMAN POWERS: At 550F the deflagration, lower deflagration limit for hydrogen mixtures is epsilon. To give you some idea what the slope can do.

So derive no comfort in four percent, just because it's four percent.

MEMBER STETKAR: Okay, the slope of this curve, it's hard to see, you know, whether it's going to an asymptote. The slope is level enough, I was just curious whether you ruled it out.

MS. GRADY: We didn't and we didn't ask AREVA to do it either. So, that's the design basis analysis. For the severe accident, the Applicant finds in the FSAR the containment well mixed with hydrogen in less than ten percent.

And by saying well mixed, I mean it's used frequently. That most of the compartments have concentrations less than ten percent.

Not all, a couple do not. For example, in the reactor cavity, but very special compartments, not in general. The staff analysis results show it was well mixed with several compartments with hydrogen greater than ten percent, based on 100 percent PAR efficiency.

So that's all the PARs working at 100 percent efficiency in our analysis. The PAR performs, we did several sensitivity studies, we looked at some of the foils openings, some of the dampers opening, etcetera.

And we found that the PAR performance dominants the results. Now there's like small differences, but they don't, they really don't matter.

We have an open RAI right now, which asks in order to understand why we have the differences that we do, between our MELCOR results and the results the Applicant has, and we are asking for them to confirm there will be combination rates for the PARs.

The efficiencies credited. The timing of the hydrogen release, they have a character, a particularly idiosyncratic way of releasing the hydrogen in the containment and the foils and dampers and doors to be addressed in their analysis.

Just so we can understand the difference in the results. I should say that we've had information on the PARs and the FSAR in chapter 6, and all that information in chapter 19, for some time.

And answers to RAIs on how the PARs perform and what the analysis looks like. But AREVA has changed its approach and they no longer want to talk about vendor-specific PARs, which really means we now need to confirm exactly what they're taking credit for in their analysis, so we can obviously do our analysis and confirm or not, the overall results.

So this represents a change in approach. So we're kind of asking for stuff that's been in the FSAR for a while, or in response to RAI.

CHAIRMAN POWERS: I'd have to say that I really like these RAIs.

MS. GRADY: I beg your pardon?

CHAIRMAN POWERS: I like these RAIs. I think they're good questions to ask.

MS. GRADY: Oh, okay.

(Laughter.)

MS. GRADY: Well, then, I do too.

(Laughter.)

MS. GRADY: We also have, an of course

this is the RAI-471, really addresses how these PARs are going to perform, what they're going to do.

Okay, the second one, open item RAI-474, recognizes the fact that these PARs as Dr. Powers has told us an the literature will convince us, have to operate in a hostile environment.

They have to operate under significantly challenging conditions. And now that we're not reviewing test results for PARs that are being identified, but rather it's being left up to the COL Applicants to select their own and come up with this. We need to have test specifications so we can be sure that the COL Applicants will be able to answer these questions and address such things as, oh, you can all read.

But temperature, pressure, steam concentrations, effective sprays, aerosols generated by the molten core. Borated water, nitric acid and hydrochloric acid being procedures, etcetera.

So, these test specifications have to be really thorough, so that we can know that the PARs, due to the fact, are operating in a severe accident environment.

And after deflagration, too, I forgot that. Okay, we have two more open items, two more

RAIs. We have, as I mentioned earlier, equipment survivability is one of the key points in 10 CFR 50.44.

The equipment that's required for managing a severe accident has to be able to survive the hydrogen burn that I've already described. And the curves, the pressure and temperature curves in the containment, for this hydrogen burn are lower than I would have expected.

So I'm asking for more information as to what went into the analysis to produce them. Because in the literature I'm finding higher temperatures and not just momentary spikes, but sustained for at least a half hour or an hour.

So, I'm asking for more information so we can understand the analysis that gave us these basically equipment survivability curves.

CHAIRMAN POWERS: The temperatures and pressures in the TMI burn were effected because the sprays came on, the pressure pulse was enough to initiate sprays. So we had a very short moment.

Nevertheless, there's a rather famous photograph by a telephone that's in containment. In which the plastic on one side of the phone is completely molten and the other side of the phone is completely in tact.

MS. GRADY: Okay.

CHAIRMAN POWERS: And we definitely know that the pump was damaged by the hydrogen combustion TMI. The combustion events due produce, do have an effect on equipment.

CHAIRMAN POWERS: Even though, like I said, the temperatures and pressure spike was very limited, TMI displaced. The safety grade sprays came on.

(Laughter.)

MS. GRADY: We don't have, there's nothing else to talk here, as you know.

CHAIRMAN POWERS: I don't know what non-safety grade sprays would be.

MS. GRADY: Control the pressure. That's what it's for.

CHAIRMAN POWERS: Oh, I'm just giving some people in the room a hard time.

MS. GRADY: Okay, there's another RAI-411. Basically, now there are two sets of hydrogen monitors, as I mentioned earlier. One of the normal operation and those hydrogen monitors are described in tier 1, and it's indicated that they will display an alarm in the main control room.

There are also high range monitors that go up to about 30 percent, 30 percent for hydrogen and also monitor their stay concentration.

And I would like those added to tier 1, because I think they're going to need to manage a severe accident. I think they're safety significant, even though they're not safety related.

And I think it would be a good thing to have an ITAAC to confirm that they were there. And that's what that RAI is all about. And, that's my list of questions.

CHAIRMAN POWERS: Looks like that's an interesting RAI, I would be really interested in the outcome of those.

MR. CARNEAL: Before we move on to section 6.3, I'd also like the mention that Anne-Marie is the Reviewer for containment, the great test in section 66. So if there are any additional discussion, I'd just like to open up the floor before shuffle to another person.

CHAIRMAN POWERS: I bet we have questions, but nothing comes to mind right now.

MR. CARNEAL: Okay. Thank you, Anne-Marie. With that, I'm going to ask John Budzynski and Clint Ashley. For section 6.3 we have Reviewers from the Nuclear Performance Code Review Branch and the Containment and Ventilation Branch. So, with that, I'll turn it over to John Budzynski.

MR. BUDZYNSKI: My name is John Budzynski, I've got a BS degree in Nuclear Engineering from Maryland and masters from Drexel University. And I've worked most of my time down at Peach Bottom on the Reactor Engineering Crew.

Okay, let's start with gas accumulation, first slide. Let me give you just a summary of this. Back in 2009, I submitted an RAI and at that time I referenced generic letter 2008-1, which was created for operating plants at the time.

And, in there, they had actions to take and AREVA addressed all these actions, very well, in their response. However, in 2010, there was a new procedure written with guidance.

It was ISG-019, which took into effect for COLs and DCS. The additional part was the ITAAC was added to that. So, I submitted an additional RAI so that AREVA could address the ITAAC.

And basically what the ITAAC stuff would be is that they would take the P&ID drawings and the isometric drawings, and compare that against the as built condition of the ECCS and to see if they can find any discrepancies or any gas accumulation.

That's about it for that one, that's an open item. Any questions? Okay, the next slide is NPSH assessment and containment action in pressure. We submitted an RAI-6.3-6, which is related to NPSH.

And AREVA's analysis is based on the IRWST temperature of 230 degrees Fahrenheit, instead of what the recommendation is in Regulatory Guide 1.28, which they recommend to use, to have pressure of 212 degrees.

I'm sorry, the temperature at 212 degrees Fahrenheit and not to use any of the containment analysis on pressure. Which AREVA did use, using at 230 degrees, came up with vapor pressure.

So we generated an open item question number 6.3.15 and requested them to justify why they can use the pressure instead of using the pressure at the atmospheric conditions, 212, 14.7. Clint will be elaborating on this.

MR. ASHLEY: Good afternoon, my name is Clint Ashley and I have a bachelor's in Engineering from University of Michigan. I spent some time in the Nuclear Navy and then a lot of time at the Calvert Cliffs. I been with the agency for about two years.

CHAIRMAN POWERS: Were you on a boat or a flat dock?

MR. ASHLEY: It didn't sink.

CHAIRMAN POWERS: What?

MR. ASHLEY: I didn't sink.

(Laughter.)

MR. ASHLEY: So I work in the Containment and Ventilation Branch within DSRA of New Reactors. And what I hope to do today is provide additional information to the committee about U.S. EPRs treatment of containment accident pressure, and I refer to that as CAP, and net positive suction head or NPSH, I'll probably say that often.

And provide an explanation of what the staff is doing. The staff is seeking additional information from AREVA about the containment accident pressure in NPSH. And no conclusions have been reached by the staff.

So we do have open items on this. Well, I'll just give you a little bit more background. This slide establishes what AREVA has communicated to the staff concerning NPSH and CAP.

The U.S. EPR uses containment pressure greater than what is present before the accident, for calculating available NPSH. More specifically, U.S. EPR assumes containment pressure equals the vapor pressure of the IRWST or IRWST liquid temperatures above 212.

CHAIRMAN POWERS: That IRWST liquid is borated?

MR. ASHLEY: I'm sorry?

CHAIRMAN POWERS: Is it borated?

MR. ASHLEY: No, oh, is it borated? Yes, it is borated.

CHAIRMAN POWERS: How do you calculate vapor pressure of borated liquid?

MR. ASHLEY: They're using the vapor pressure of water, pure water.

CHAIRMAN POWERS: If they came up here and said that, you would probably throw heavy objects. Because we know, adding some movement, that dissolution of an ionic solid in the water affects the vapor pressure from the most elemental considerations.

MR. ASHLEY: For IRWST temperatures less than 212, AREVA assumes containment pressure is equal to the atmospheric pressure.

The recent SECY, SECY-110014, notes that any use of pressure greater than what exists before the accident, some or all, is defined as CAP credit.

So we're using that definition as we go forward with this review. This figure is meant for general discussion purposes.

MEMBER SHACK: That may be the only thing we agree on.

(Laughter.)

MR. ASHLEY: It's, you can treat it as a cartoon. It's not based on AREVA's U.S. EPR analysis. It does attempt represent a large dry PWR with an incontainment refueling water storage tank.

And, as you know, with incontainment refueled storage tank, when the ECCS pumps start, they're on recirculation. So you won't see a time for when the pumps come on.

Shown at the top of the slide is the NPSH available equation and two terms are highlighted. And there are the pressure head terms associated with containment atmosphere pressure.

Shown as age containment and the vapor pressure at the pump suction, shown as H vapor. The figure below the equation expresses one relationship between the pressure head terms. The figure depicts three pressures, a pre-accident containment pressure, typically atmospheric shown by the horizontal green line.

And a post LOCA containment pressure shown by the solid black lines, somewhat wavy. And a post

LOCA vapor pressure, a saturation pressure which is a function of the sump water temperature, shown by the blue dashed line.

Containment accent pressure identified in the center of the figure, is the pressure developed in containment during a postulated accident. That elevated sump water temperature as the vapor pressure exceeds the pre-accident pressure.

And use of pressure greater than the pre-accident pressure, is a deviation from the guidance in Reg Guide 1.1 and Reg Guide 102. The occlusion of pressure developed in the containment during an accident in the calculation of available NPSH is referred to as CAP credit.

We talked about that previously. And the CAP credit region is highlighted in red text, and it's the region between the vapor pressure curve and the pre-accident pressure curve for the green line and the blue dashed line.

The staff recognizes for a given sump temperature greater than 212, in order for that water to exist as a liquid, a corresponding pressure must be present in containment, at least equal to the saturation pressure without gaining temperature.

Basically, for U.S. EPR, when the water is hot --

CHAIRMAN POWERS: Well, that statement, a little misleading in the equilibrium sense. You could have a much lower rate of pressure and have liquid there in the dynamic interval between the time it takes you to reach the pool.

MR. ASHLEY: This is based on more of an equilibrium type --

CHAIRMAN POWERS: Yes, I know, your statement is entirely accurate. But the truth is that an almost elementary experiment, probably that everybody has done inadvertently, is to have liquid water present without the pressure being equal to the, I mean just throw water on a hot stove.

There's liquid, the pressure is much less than the vapor pressure of the water, and you still have liquid, in a dynamic sense.

Similarly, your containment accident pressure, you show, well that's as if everything was intact. Suppose I had a hole in the containment, what is the containment accident pressure then?

MR. ASHLEY: Correct. And I think later slides will address your concern about containment. So, in summary, from AREVA's perspective when the IRWST is hot, AREVA will limit their containment pressure to the vapor pressure corresponding to the IRWST water temperature. And when the IRWST --

CHAIRMAN POWERS: Which they will properly.

MR. ASHLEY: That's correct. I'm speaking for AREVA.

(Laughter.)

CHAIRMAN POWERS: Oh, we know that. I will calculate it properly.

MR. ASHLEY: When the IRWST is cool or less than 212, AREVA limits containment pressure to the pre-accident pressure left in the atmospheric pressure.

So, if I was to look at their NPSH calculation, which will be in the future, they're going to follow that green line until it intersects the blue dashed line.

And follow the blue dashed line and you can follow up with the green. Does that make sense?

MEMBER SHACK: That's what they've got to do, at any rate.

MR. ASHLEY: That's what their proposed, I mean, what this really shows is that this issue is really dominated by the sump water temperature calculation.

Because they're taking that NPSH equation and they're equating the containment pressure term to the vapor pressure term. Essentially leaving us with just a static term, as for as NPSH is concerned, minus a loss.

So, that's, they're eliminating that pressure head term.

CHAIRMAN POWERS: Yes and the design basis rule is don't get complicated. Because if you run into a problem with the definition of conservative. Most of the time we're getting that water very hot to get, to jack up the containment pressure to make sure we don't see design pressure.

And that's conservative. Now, to be conservative, you've got to keep the water in the IRWST low to be conservative there. And you're getting into a trap on the definition.

You have to be very careful before you get into a problem with definitions of containment.

MR. ASHLEY: This shows one possible scenario. There's a couple extremes. Extreme could be that your containment total pressure, your black curve could be the same as your vapor pressure point.

CHAIRMAN POWERS: So you would get less.

MR. ASHLEY: Or much less than what's

shown. So those are the --

CHAIRMAN POWERS: If I put a 16 hole in there, it maybe less.

MEMBER STETKAR: I'm not worried at that point?

(Laughter.)

CHAIRMAN POWERS: Oh, yes, all the water is gone, that's right.

MEMBER STETKAR: I got rid of this problem.

(Laughter.)

MR. ASHLEY: The next slide shows the staff has communicated to AREVA that as part of our review, we have some issues with containment accident pressure supporting PSH analysis.

Staff does plan to perform sensitivity and confirmatory type analysis when the information comes in. And, according to the recent SECY on containment accident pressure, many operative PWRs also credit use of vapor pressure for CAP credit.

I think it was 60 out of 69. So when they're on recirculation, the water temperatures are above 212. Next slide.

This slide communicates that we've also asked RAIs, as part of our review, to ask AREVA to include risk information to support their own PSH analysis. Risk information to include PLAC, plan accident conditions where CAP credit is used to demonstrate reliable --

CHAIRMAN POWERS: Can you go back to the previous one. What you say is true. And many of the existing PWRs also has safety grade containment sprays.

(Laughter.)

CHAIRMAN POWERS: That was not directed to you.

(Laughter.)

MR. ASHLEY: So we are asking, the real key in this is we're asking for risk information. And I think that gets to your question about, excuse me, design basis assumes containment integrity.

What do you do if you have, are beyond design basis event? That challenge is containment integrity.

CHAIRMAN POWERS: That's good strategy, I like that. That's a good question.

MR. ASHLEY: And we feel that we have the regulatory basis in part 52, to ask for that information.

CHAIRMAN POWERS: And they can answer you in full and complete.

MR. ASHLEY: That really concludes the presentation. More questions? Sure.

MEMBER STETKAR: Not on anything that you covered, but in section 6.3, so I guess it's on the table. There was a discussion, I have a question about the low head safety injection minimum flow recirculation lines to the IRWST.

If I look at the P&ID for those lines, I see motor-operated, I think, check valves in those lines. I don't see motor-operated isolation valves.

I don't know how those check valves. Maybe this is a question, it's probably a question for AREVA, but there were several statements in the SER regarding those minimum flow recirculation lines.

Assumed flows through the, both the injection line and the heat exchangers. Assuming that those lines were isolated, and features of the design that allowed isolation of those lines, if necessary.

I'll ask you and perhaps AREVA needs to answer the question. Are those motor-operated check valves designed to be isolation valves? And, if so, how do they work? Because in many cases motor-operated check valves allow you to use the motor to hold them open for some reason.

But they're not necessarily to drive them closed. Otherwise, why would they be a check valve?

(Laughter.)

MEMBER STETKAR: So, and if they do operate only as check valves, under normal conditions, then I'm curious about the conclusions in the SER regarding flow rates with those lines isolated.

And they're, you know, as a fraction, and I'm not going to quote specific numbers, in case that might be proprietary information. But as a fraction of the discharge line size, those recirc lines are relatively large.

They're not sized, for example, ten percent flow protection, they're large. So do you folks know whether those check valves are designed to operate as isolation valves? And, if so, how they work?

MR. BUDZYNSKI: I would have to get back with you on that, I really don't know.

MEMBER STETKAR: Does AREVA, do you have anybody here?

MS. SLOAN: No, we're not able to answer.

MEMBER STETKAR: Okay, thanks. So that's a question I have about those lines, because I wasn't quite sure how they worked. The other question I had is in your review of overpressure protection of the safety systems, there's a statement in the SER that says that, let me find it here.

ECCS piping is protected from over pressurization events by safety relief valves placed in each pump's injection line.

On the P&IDs, I found those safety relief valves in both cold leg and the hot leg injection flow paths from the low head safety injection pumps. I didn't find any safety relief valves in the medium head safety injection pump, injection lines.

Is the discharge piping from the medium head safety injection system rated at full system pressure? All the way back through, you know, to the pump?

MR. BUDZYNSKI: I believe it is. Does AREVA have any answer to that?

MEMBER STETKAR: It's unusual, I found a statement saying it was rated full system pressure back to the, I don't know whether the first or second check valve, you know, out into the loops.

MR. BUDZYNSKI: I'll check on it.

MEMBER STETKAR: Okay. But I didn't see any safety relief valves so, in case there would be some sort of over pressurization. It would have to be some sort of reverse leaking or something. That's all I have.

MR. CARNEAL: Okay, I think that concludes our presentation for section 6.3. Now we'll move to section 6.4, Habitability Systems and Jim O'Driscoll is back to finish the last two sections of our presentation.

MR. O'DRISCOLL: Yes, I'm Jim O'Driscoll, I'm here to discuss the remaining issues related to 6.4, Habitability Systems. Next slide.

There are four open items. The first one requests the Applicant to more clearly document compliance with the guidance on TSC, Technical Support Center, habitability and size, in section 6.4 of the FSAR.

The second open item requests the Applicant clarify purpose and testability of a separate control room envelope, over pressure acceptance criteria for normal lineup, as well as to clarify conflicting information on the FSAR as stated in that RAI. Next slide.

The third request that the Applicant clarify how the control room envelope will respond to a toxic gas event, and clarify what aspects of toxic gas detection and response, will be described in the standard design FSAR.

And lastly, the fourth item requests the Applicant to clarify the design limit for boundary and leakage. Next slide.

The Applicant should describe the critical details of the Technical Support Center, such as TSC --

CHAIRMAN POWERS: Can I ask you a question? We had a description of that earlier today.

MR. O'DRISCOLL: Yes.

CHAIRMAN POWERS: And one of the questions you posed to the applicant was that our history with existing control rooms, that the unfiltered in-leakage tends to grow with periods of time. And had they done anything on the design to mitigate that tendency for the unfiltered in-leakage to grow, and they described several things and it was very interesting? Have you looked at that? I mean, when you look at these things in your safety evaluation report, do you look at just the design that they have now and its unfiltered leakage or do you think about how is this going to degrade with time?

MR. O'DRISCOLL: Right. We look at the design as it's presented in the FSAR. And with this review and with other reviews you'll find that one of the critical questions we seem to always ask is this a standard allotment of a 10 CFM Allocation for CRE, you know, or the control room unfiltered and leakage, due to access egress.

Basically we say, well, you know, whatever you claim as your unfiltered and leakage in your chapter 15 analysis, should include a 10 CFM penalty of, you know, for access and egress.

And then whatever is left as you're tested, you're tested to an unfiltered image. And you have periodic testing which validates that number.

So we rely, you know, on the periodic testing program to make sure that number doesn't move.

CHAIRMAN POWERS: So wait. I mean you basically said, okay, if you guys let it go, we'll catch it in the periodic testing, and don't do that.

MR. O'DRISCOLL: That's right.

CHAIRMAN POWERS: Even though, we know that in fact it grows with time, and that sometimes the testing is not as expeditious as we would like.

Okay I was just curious how you viewed things.

MR. O'DRISCOLL: The, going back to the TSC, we believe that the Applicant should describe the critical details in the TSC such as its size in order to, for the staff to make findings, which are based on design details as they're stated in the FSAR.

So, in addition, the staff has asked the Applicant if they considered a fully manned TSC when they evaluated the, making sure of occupancy and CO2 production.

So, basically going back, since the Applicant has stated in the FSAR that they have a 25-man TSC in the CRE, how does that effect the CO2 assumptions when we did the control room review.

So we would expect, you know, when this RAI is responded, we'll have a basis for that, for that CO2.

MEMBER STETKAR: Yes, what prompted me is there's a discussion about just simple volumetric discussions saying that the volume, I believe the volume of the CRE is sufficient to maintain CO2, you know, within habitability requirements for a complement of ten people for six hours or something like that.

CHAIRMAN POWERS: Which is about, you know, 20 people less than I'm going to have there, perhaps longer.

MR. O'DRISCOLL: And that language is directly related to the basis we were given to do criteria for the control room.

So he says, when we say basically for five people for seven days of 2xx, you know, cubic feet, it should be fine.

And that's fine. But you've got a TSE also, so now how does that affect that item? And, next slide. The Applicant added a very small control room envelope operating over pressure design parameter in FSAR Revision 2, that was basically an added ITAAC.

The staff has asked, what, if anything, this over pressure will be credited for, in the design, and how that small pressure will be tested.

It's on the order of, I think it's .01 inches of water or something like that. Next slide. The Applicant revised the control room envelope design and revision 2, such that the control room envelope would be manually isolated, as opposed to automatically isolated upon detection of toxic gas.

This change has made other sections in the FSAR inconsistent. Therefore, the staff requested the Applicant clarify the episode. Next slide.

The staff noted in tier one and tier two, it's unclear, well we talked about this already. About the control room envelope, design limit for boundary and leakage.

And the ASCME 741 testing substance criteria. NRC guidance states in NUREG 0800, section 6.4, that 10 CFM should be allocated for unfiltered and leakage due to control room envelope access/egress, on top of the control room envelope in leakage design value.

Chapter 15, Dose Analysis includes 50 CFM unfiltered and leakage total, therefore the tested value should be no greater than 40 CFM to allow for 10 CFM reservation for access, egress and leakage.

The next section is on ESF filter systems. Is there any questions on, before I go on? Next slide.

CHAIRMAN POWERS: Charge ahead, you're doing good.

MR. O'DRISCOLL: There are four open items for ESF filter systems. The first item requests specific design details on the ESF filter systems provided in the previous RAI responses to be added to the FSAR.

The second item requests that the Applicant clarify design details of the moisture separator for the various ESF filter systems and to provide details on applicable industry standards used in the design details of the drainage systems from the moisture separators.

The third item requests the Applicant provide details of alarm displays and controls provided for ESF filtration systems. The fourth item requests additional design information to allow the staff to judge if the ESF filtration systems are designed to equivalent standards as those endorsed by Reg Guide 1.5.2. Next slide.

All these items relate to requests for specific additional design and details on ESF filtration systems we documented in the FSAR. And also there are components.

The staff needs this information to provide a more firm basis for the findings that would be supported by information provided in the FSAR.

Basically Reg Guide 1.5.2, endorses a specific year for ANCY AG1 and other industry documents. The EPR is designed to the current version, the more up-to-date versions of these codes.

So we just want to be sure that there's nothing that's missed, between the update and what we've endorsed in the past.

MEMBER STETKAR: Regarding drainage systems, one of the ESF filter systems that you did not list on your slide, is fuel building system. And

I noticed that the design -- that that system was exclusively designed -- the design of that system was not based on boiling and spent fuel pool. Well, so therefore, I'm assuming that if the spent fuel pool were to go to boiling, the moisture removal capability, the drainage capability in that system is not adequate to handle that condition, is that correct? Do you know?

MR. O'DRISCOLL: Well, a couple of things. We did ask questions specific to spent fuel pool and boiling I believe, in the past. But to clarify though, and be consistent dedicated for the ESF, for the fuel building, is actually in Reg Guide 1.1.4.0, you know system.

The normal atmospheric clean up system. IF there was to be an accident, a fuel-handling accident in the fuel building, the fuel building can be manually aligned to an ESF filtration system, safeguards building ventilation system, ESF filtration trains, would take that function.

MEMBER STETKAR: Are those -- is the moisture removal capability in those trains, adequate to handle a boiling condition in the fuel pool? In other words is the capacity of the drain lines and stuff like that adequate?

MR. O'DRISCOLL: I don't know the answer to that question.

MEMBER STETKAR: I mean if that's the argument then let's do away with the fuel building ventilation system and switch it over to this other thing. Okay.

MR. CARNEAL: That concludes this presentation for chapter 6, CR with open items. Are there any additional questions from members?

CHAIRMAN POWERS: I'm good.

MR. TESFAYE: Well, I hope to see you back in May.

CHAIRMAN POWERS: I like the independent analysis you've been doing. That's good.

MR. TESFAYE: Thank you.

CHAIRMAN POWERS: We want to -- whenever we take these forward to the full committee we want to emphasize we've done independent analyses. I like some -- many of your RAIs I think have been spot on. I like them, I like them a lot.

Okay, at this point what I propose is we go ahead and take a break at this point for 15 minutes and then we'll come back and we will move on to Calvert Cliffs.

(Whereupon, the proceedings went

off the record at 2:41 p.m. and
came back on at 2:58 p.m.)

CHAIRMAN POWERS: Let's come back in session. We have now moved into the RCOLA, Calvert Cliffs. Surinder, do you want to start us off here?

MR. ARORA: Yes, sir. Good afternoon, my name is Surinder Arora and I'm the lead PM for Calvert Cliffs combined license application. And I'll start this presentation while giving a brief status of where we are on the project.

And a couple of slides and in interest of time, I'll rush through them. Let's go to the first slide there, Jason. This slide presents a chronology of milestone dates.

The current original, the application, I'm just reading the last two items which are added to the previous slide. Revision 7 was submitted by UniStar towards the end of last year.

And as of January, 2011, we have presented to the subcommittee nine full chapters and one partial chapter. Next slide. This slide describes the phases, six phases of the review schedule.

And we are currently in phase 2, 3 and 4. The chapters which have been presented to the subcommittee, they are being worked under phase 4.

And the ones which are yet to be presented, we are still in phase 2 on those.

And the target dates have been revised to reflect the new dates that we issued to UniStar on March 4th. That was a schedule that was issued to UniStar and these targets dates have been updated to reflect these new dates. Next slide, Jason.

This again summarizes chapters that have been through the subcommittee review. And we still have eight full chapters and one partial chapter which we need to schedule meetings for.

And as they come along and we have a path forward, we'll bring those to the subcommittee in the future meetings. Do subcommittee members have any questions on where we are on the project?

CHAIRMAN POWERS: We're going to do a set of them the day after tomorrow, and move then from page three to page four. That is our intention and that's about all that can be said on that. So today we will start on six.

MR. ARORA: Now, with that, my brief status presentation is over, and I'll hand it over to Mr. Gibson. He'll introduce his team and start UniStar's presentation for chapter 6.

MR. GIBSON: Okay, Dr. Powers, it's good

to be back with you and, again, I'm Greg Gibson.

CHAIRMAN POWERS: Better late than never, right?

(Laughter.)

MR. GIBSON: Sure. We're very pleased to be here to present chapter 6. Before I start I want to thank Surinder for the summary. We're very pleased at UniStar.

We actually, with our last submittal, we made a big submittal on March 31st. We're down to only 15 RAIs that we have not responded to. So we're working off our workload and we're looking forward to completion of the SERs that are remaining.

CHAIRMAN POWERS: So you're throwing this out as a challenge to us?

(Laughter.)

MR. GIBSON: When we worked off over a thousand of these, it's nice to be down toward the end. So I want to just pause for a moment and enjoy the moment.

So, with that, again on our first slide, just to remind you, of course, this is a standard slide we put in every presentation where we usually incorporate by reference.

And so our presentation today is going to focus, go to the next slide, on the COL items, the departures and exemptions and so forth.

We have ten items for chapter 6, to discuss with you. We have one departure, and then we have nine COL items. So we'll be reviewing those.

And as you heard on the AREVA presentation and then again on the last staff presentation, GSI-191 is being exempted from this, in accordance with that other section 6.2.5.

CHAIRMAN POWERS: I think it's important to note the staff told us that they were exempting you not because of anything particular about the proposed plans but because the GSI is still going through the processes it needs to endure in order to get finalized and we can resolve that issue with finality.

MR. GIBSON: Absolutely.

CHAIRMAN POWERS: Which, trust me, I'm going to go, whew, when that's done.

MR. GIBSON: So, with that, what I'd like to do is introduce our team. We also have supporting us, Mary Richmond from Bechtel, Dan Patton from Bechtel, Pedro Perez from AREVA and Ron Conley from AREVA.

But our presentation primarily today will be made by Mark Finley, and he is our Vice President of Engineering. So, with that, Mark.

MR. FINLEY: Good afternoon, it's good to be back.

CHAIRMAN POWERS: Oh, lie to us some more.

(Laughter.)

CHAIRMAN POWERS: We're nice guys, but we're not that nice.

MEMBER SHACK: It could be chapter 2 and he'll be asking about sea slides.

CHAIRMAN POWERS: Yes.

MR. FINLEY: So, as Greg said, my name is Mark Finley, career Constellation UniStar Utility Engineer. Before that, Nuclear Navy and before that Naval Academy, bachelor of science.

Also PE licensing, Maryland. As Gregg said, we're going to talk about COL information items and the one departure/exemption that we have. If you flip to slide 6, the first COL information item relates to fabrication and welding procedures for class 2 and 3 components.

We will make sure that the Reg Guide 1.44, 1.31 guidance and other QA methods, including qualification of subcontractors and suppliers meet the appropriate requirements as required.

Commitment for future procurement of these components. Slide 7, next COL item has to do with the pre-service and in-service inspection program. We will implement an in-service and pre-service inspection program, in accordance with 10 CFR 55A, Paragraph G, and will comply with ASME section 11, 2004 edition.

We'll implement the pre-service inspection program as we say here before the initial plan start up and we'll implement the in-service inspection program prior to commercial service at the site.

On the next slide we talk about slide 8 there. We talk about how we will upgrade our program to meet the current guidance that's incorporated into 10 CFR 50.55, 12 months prior to the initial fuel load for the initial ISI program.

And then for future ten year inspection intervals, we'll incorporate that version of the requirement, 12 months prior to the start of the subsequent ten year ISI intervals. So, we've made those commitments.

The next slide, slide 9. COL information has to do with protective coatings. Specifically, if we can't procure a component with the proper qualified protective coating, we have three options that will follow.

We will either procure the component uncoated and then apply a qualified coating through a qualified process. Or, we will basically take the component that's got this coating on it, remove the coating so that we can then apply a qualified coating.

Or finally, on slide 10, we'll track this quantity of unqualified coatings and assure that we can accommodate the location of the component with that unqualified coating.

Slide 11, with respect to containment leakage testing, we have a committed milestone for implementation of the program and warming the first containment leak rate test, and that will be prior to initial key load.

Slide 12, with respect to habitability. This COL information item relates to implementing procedures and training, to have a proper habitability program at the site.

And we commit to have the appropriate emergency procedures and training in place, prior to loading fuel on site at Calvert Cliffs.

Slide 13, again habitability. This time with respect to radiological analyses. We have performed radiological analysis for the Units 1 and 2 control rooms, resulting from a LOCA at Unit 3.

The result there is two rem, total effective dose for the Unit 1 and 2 control room. And we did a comparative analysis for the dose in the Unit 3 control room due to a LOCA at Unit 1 and 2, and determined that the dose in the Unit 3 control room was bounded by the calculated dose for those in Unit 1 and Unit 2.

And therefore acceptable, less than two, and therefore less than the five rem requirement. And Calvert Cliffs will incorporate by reference the design in the main control room from the UFSAR, U.S. EPR, FSAR, rather, and we will include the safety related monitors for radiation and automatically isolate the main control room ventilation.

And our emergency filtration system is designed and operates in accordance with U.S. EPR FSAR description.

CHAIRMAN POWERS: During the discussion of the control room habitability, I noted that we have a history of the unfiltered in-leakage on these control rooms. It grows as a function at times.

And, in thinking about this new control room, have you thought about how you prevent things from -- the unfiltered in-leakage from going out of bounds. I mean, I don't happen to know about how physical people, in some of the control rooms across the country.

You know the unfiltered in-leakage just started creeping.

Have you thought anything about this control room at all? It's somewhat out of bounds of the FSAR, I admit, but I mean you guys have to work with it.

MR. FINLEY: Yes, in fact I had a thought specifically of the requirements for the in leakage. I know we will have some in leakage requirements that we'll have to meet and we'll have to do periodic testing to assure that we continue to meet those requirements. I think our control and design is robust in terms of assuring that we don't leak grossly.

In my experience I haven't seen difficulty in meeting the criteria for control of in leakage, although I am aware of industry issues where that's been exceeded.

CHAIRMAN POWERS: For some, yes, it happens, you know what I mean. And then all of sudden you get caught up short and it's a heroic job to sort these things out.

You kind of want to avoid that, when you can.

MR. FINLEY: Oh, we intend to periodically monitor leakage and make sure that we meet the assumption for safeguards.

CHAIRMAN POWERS: Just curious.

MR. FINLEY: On to slide 14, this is the one departure and exemption. Exemption because the information is in tier 1 of the U.S. EPR FSAR, it relates to toxic chemicals and habitability systems, to protect from toxic chemicals.

We've done an analysis of the toxic chemicals that are located on site, both Unit 3 site and Unit 1, Unit 2 site. And we've concluded that those chemicals in the quantity that we have them, will not succeed toxicity limits as specified in Regulatory Guide 1.78.

Therefore, we don't need automatic isolation of the control room. We don't need the instrumentation related to defection of this toxic gas.

And, therefore, we need to take the departure and exemption. So this is the one departure and exemption we have.

MEMBER STETKAR: Mark, I didn't get a chance to do all of my homework, but I seem to recall there's an LNG port in a storage facility, I've forgotten how far away. A couple of miles. I'll use the couple.

MR. FINLEY: Two or three miles, I think, south of the plant.

MEMBER STETKAR: And a pipe line that's also a couple of miles. Releases from those facilities don't qualify as potential toxic gas, you need to protect the control room from?

MR. FINLEY: I'm going to have to defer to our Bechtel representative, Mary. Please introduce yourself.

MS. RICHMOND: I am Mary Richmond from Bechtel. We've analyzed both those releases and they were in a credible event. They didn't cause a concentration in the control room that would exceed any asphyxiation level. We've done an analysis for both pipeline and the storage facility.

MEMBER STETKAR: The staff reviewed those analyses as part of chapter 2. Okay.

MR. FINLEY: Okay, and slide 15. Really that concludes my presentation. I'll ask Greg to offer a final conclusion.

MR. GIBSON: Just that, Surinder, I guess you guys are on next, but thank you.

CHAIRMAN POWERS: You sure drug that out, didn't you?

(Laughter.)

CHAIRMAN POWERS: Are there any questions to pose on this, other than the one exception of and we'll know about that in a second, I suspect.

MEMBER STETKAR: I hope so.

CHAIRMAN POWERS: Well, thanks a lot.

MR. GIBSON: Thank you.

MR. FINLEY: Thank you.

MR. ARORA: I would like to reintroduce Jason Carneal. He's the PM. And presenting chapter 6 this morning for EPR.

CHAIRMAN POWERS: What is he paid for all this fun? I mean you've got all the good stuff here.

MR. COLACCINO: Dr. Powers, he does. This Joe Colaccino, the does have all the good stuff. But there's lots of good stuff to go around.

CHAIRMAN POWERS: Too much fun. Welcome back, we missed you all.

MR. CARNEAL: Thank you, Dr. Powers. And this presentation will cover the staff's phase 2 SECY evaluation report open items for Calvert Cliffs, chapter 6.

As stated in the memo that we transmitted to ACRS, this presentation is going to focus on section 6.4, habitability of systems.

We had a review team assembled from several groups within NRC, including Containment and Ventilation Branch, Reactor Siting and Accident and Consequences Branch and the Integrity Branch.

Just an overview. A lot of chapter 6 is incorporated by reference. There are several sections that did have site specific information, including 6.1.1.6.1.2.

Currently there are no open items associated with those sections. UniStar mentioned that we, at this time, we are not completing the review of Calvert Cliffs, section 6.2.1, 6.2.2 and 6.3, as they are related to GSI-191 or the associated section in the EPR has not been delivered at this time.

For section 6.4, habitability of systems, we had six questions and there are two open items remaining and we will discuss that during our presentation.

In total we had asked ten questions, we have two open items remaining. Again, these open items don't include references to other sections or chapters.

And with that, I'll turn the presentation over to Chris Jackson, who is the Lead Technical Reviewer for section 6.4.

MR. JACKSON: My name is Chris Jackson, I've been with the commission close to 19 years. I've got an undergraduate degree in Nuclear Engineering from the University of Maryland and a masters degree in applied mathematics from Johns Hopkins.

I've spent most of my time at the NRC working in Reactor Systems and in the last four years in Containment Systems, but I've been in the Operating Experience Branch and Generic Communications Branch, I worked for the Chairman for a little while. So, it's a pleasure to be here.

CHAIRMAN POWERS: Another person that lies to you.

(Laughter.)

MR. JACKSON: If we get into the review, 6.4, Habitability Systems, we just heard it from Jim, there are four COL information items that need to be addressed. Two of the COL information items are related to toxic gas.

One is related to training and procedures and one is related to impacts from Units 1 and 2, Radiological hazards from Unit 1 and 2. Would you go to the next slide.

There's the third and the fourth open item. If you could go to the four slides. COL information items 6.4.1 and 6.4.3, deal with toxic gas.

Staff's review of COL FSAR Section 2.2.3, which identifies the toxic gas and needs to be considered for the control room.

And we identified, one chemical was identified in revision 2, has required further analysis. This was hydrochloric acid. The Applicant performed an analysis using ALOHA to confirm that the concentrations in the control room were well below the ideal age. So the staff performed independent calculations to confirm that. If you'd go to the next one.

CHAIRMAN POWERS: Now when you say independent calculations, you also used ALOHA?

MR. JACKSON: Well, we used HABIT originally, so we hired a contractor, NUMARK, to do the analysis. NUMARK used HABIT Version 1.1, the special version of EXTRAN to carry out the calculations longer than is typically done.

We followed the guidance in Reg Guide 178. Multiple runs were run using HABIT on various air stability wind speeds to come up with the worst case.

And, in conclusion, both UniStar's and staff analysis showed control room ILDH limits well below the limit.

Based on recent questions from the ACRS on other designs dealing specifically with the dispersion factors, in HABIT we did additional, the staff. When I say the staff I mean somebody smarter than me did additional calculations using both HABIT and ALOHA for confirmatory work.

Using both the Gaussian dispersion factor model and the heavy gas dispersion model to verify that you're still well below the IDLH and they all do.

The IDLH is 50, and none of the calculations showed more than 14 or ppm. With most of them coming in between five and ten.

So, based on that, the staff, additional staff confirmatory analysis was done after we issued the SER to you. So that's not described in the SER.

CHAIRMAN POWERS: The trouble I always have with IDLH values is, and for the control room, it's immediately dangerous to life and health.

And of course I want my Operators to function, and how well does one function with ten, say ten parts per million HCL?

MR. JACKSON: Actually, I don't know. The ideal age is 50 and they base that on ability to continue functioning for 30 minutes or so. So it's not, when you say immediately dangerous, you could see he held the fax, but I mean they do have, there is some margin there.

And given that we're well below the limit, we felt that that was acceptable.

MR. MCKIRGAN: I'm sorry, John McKirgan for the staff. Yes, I believe that analysis also has a number of built in conservatisms you're looking, you're finding the absolute worst case wind speed, absolute worst case stability class.

And see there are some additional conservatisms that are built in. I think you all seem to make assumptions about the absolute worst case release of whatever toxic.

So there are a number of conservatisms that are built in by the time you get to the five or the six ppm. So that, addition to the margin to the IDLH limit, really provides a great deal of confidence. Or a reasonable assurance at least.

MR. JACKSON: Reasonable assurance.

CHAIRMAN POWERS: My objection may be to the accepted standard. What you know is that your eyes are going to tear. Well, that's not to good of a thing if you're looking at a control panel and trying to read dials and things like that.

The more objectionable one is actually ammonia and DLH and, which is acceptance criteria in the one where you are functional are two different numbers.

Now, I don't happen to know what's in, I've never been in ten parts per million HCL, knowingly. I can't tell. I have been in ammonia environment substantially for IDLH and did not want to stay there.

In fact, I would go to great lengths to get away promptly.

You know it's an area when you think about, this application can't do anything about, this is acceptance criteria. This is what people are working, but it's something they need to think about in the future, I think.

Because what you want is, 30 minutes is fine and they should say go do some work and I would really like to keep my Operators there for a little longer, but, like seven or eight days.

MR. JACKSON: Yes, and this does assume if they don't take action to protect themselves --

CHAIRMAN POWERS: Yes.

MR. JACKSON: -- that's just, so no action is required under these circumstances, so they could isolate the control room. There is a mode that they have in the control for that, as well, based on detection and smell, they don't credit that.

CHAIRMAN POWERS: This is something that --

MR. JACKSON: They're also, if there's a large hydrochloric acid accident, we would expect the control room to be notified before they smell and then they could actually --

CHAIRMAN POWERS: Oh, you'll smell HCL really quickly.

MR. JACKSON: Right, but this analysis because of the distance it takes a while. Oh and we would see, I mean I'm much more concerned about the other employees on the site rather than the ones in the control room.

CHAIRMAN POWERS: Yes, I would be --

MR. JACKSON: Or you could actually be killing guards.

CHAIRMAN POWERS: Well, it's pretty hard -- HCL is difficult just because your physiological, your reaction is so strange that you try to get away from it.

MEMBER STETKAR: Yes.

MR. JACKSON: It also tends to cause your throat to go clamp, make it difficult to breathe, you react to the HCL. Really a lot.

MR. JACKSON: Okay, let's go to the next slide. If you look at the COL information items, the Applicant mentioned it earlier. Two information items, 6.4.1, specifically address hardware and the need to test the hardware in tier 1, as a result take tier 1 exemption, tier 2 departure, tier 1 departure, as well, was needed.

We're physically processing that in 9.4.1, which also deals with control room, so we chose to deal with it there. The exemption or the departures are actually described in chapter 1.

So this design chooses to put the design features in the design and in tier one, to whereas other designs make that the COL responsibility as a result of exemptions needed.

You'll note that in the DCD we have an open item on this area, as well, because there's, we want to make sure these line up. Go to the next slide.

COL information item 6.4.2, deals with

training and procedures, the implementation schedules acceptable to staff. A level of detail provided in SAR is not sufficient to establish conformance with Reg Guide 1.1.9.6.

So the Applicant should provide essential elements of the training program and procedures to facilitate our review, since this on just a level of detail on what is required in the FSAR. So we have an open item on an RAI, on that.

If you go to the next one, the Applicant did respond to that RAI last week, I believe, and I haven't gotten to look at the results.

The last COL information item, deals with Unit 1 and 2 impacts and in the application we reviewed. The Applicant stated that the exposure from 1 and 2 was bounded by an accident from Unit 3, and that would make sense, given that 1 and 2 are smaller and they have containment sprays.

But, Unit 1 and 2 don't have a full shield building or an annular building, so it's not immediately straightforward that those are bounding.

So we requested the Applicant provide more detail to ensure that the source term and distance in accident, neither one wouldn't impact, would be bounded by the analysis for Unit 3.

So we've issued an RAI and held an open item for that.

CHAIRMAN POWERS: How do you do the dispersion from Units 1 and 2?

MR. JACKSON: What we have doesn't do anything, it just says it's bounded. So, and once again that assertion is reasonable, but it's not evidently clear given that they don't have the full secondary containment, 99 percent efficient scrubbing of all of those.

So, that's been responded to as well, but I haven't gotten to look at that one, as well. Additionally, the Unit 3 FSAR currently reports doses in the Unit 1 and 2 control room. And I don't think we have a problem with that technically, but we can't make it binding on Units 1 and 2, this isn't their docket. So it we've asked them to remove the results from Unit 1 and 2. They have their own FSAR and there own, I'm sure they can handle that, and they will.

CHAIRMAN POWERS: That would just be part of the manual update?

MR. JACKSON: Yes, semi-annual update and we would expect them to include that. And they, we are actually, there's a program to look at that to make sure that gets done. In know the Applicant has it and they're following that.

So, that doesn't need to occur now, though, there's formal processes for that. So if we can go to the last slide?

In conclusion, we have two open items, one associated with training and procedures, deals with the level of detail. When open item associated with Unit 1 and 2 impacts.

One dealing with the radiological impacts on Unit 3, of an accident on Units 1 and 2. The second one dealing with removing the control room habitability aspects in Unit 1 and 2, which we have no purview of.

We have an exemption and departure in due process under chapter 9. And we're working with the Applicant and the DCD on that, as a matter of fact.

CHAIRMAN POWERS: Amidst proceeding apace and then there's no problem.

MR. JACKSON: No, no, as a matter of fact, we had, in our open public meeting last month, the month before, AREVA has said that they'd update the FSAR to remove the requirement for hardware associated with toxic gas and make that the, a responsibility of the COL.

I'm reviewing AP-1000 and Mitsubishi and that's the way they do it. The COL is responsible for hardware and then you don't need an exemption, you don't need a departure.

So, that's the better approach, they've committed to doing that in an open public meeting, but we haven't seen that yet, I don't think. It could have come in.

The remainder of section 6.4 is acceptable to the staff. And that's all I have.

CHAIRMAN POWERS: Time to press forward. Any questions on this? Bill, once again, you drug that out pretty hard.

MEMBER SHACK: I do what I can.

CHAIRMAN POWERS: Rough slugging here Surinder you're making us go through. Very expeditious. One comment I might make, when presenting this to the full committee, one characteristic in the NRC staff is an unparalleled capability to do multi-disciplinary reviews.

You might think about making it more explicit and you've brought you expertise in from other areas to focus in on a particular chore.

I think the committee deserves to see when you've done that. In a very explicit, it's always been stated and you, but you do a very good job and historically you've done a very good job at multi-disciplinary reviews. You might want to make that more explicit.

MR. MCKIRGAN: I certainly won't disagree with that statement, but is there an example you could give me that might help?

CHAIRMAN POWERS: Let's see, right at the beginning Mr. Jackson presentation, he noted that they had brought in several people from different groups to work the review.

And he stated that, and you might just want to show that visually. I think that's something where the folks may be recognized.

That when you do these reviews, that you have the matrix of aspects of the problem. And to see that graphically rather than just state it, might drive home how much you have to do on each. You don't have to do it every time, but those where there's been a significant organizational effort both the people with many diverse kinds of technical competencies.

Showing me a graphic visually, probably helps me better understand what you think.

MR. COLACCINO: Dr. Powers, if I may, this Joe Colaccino. As long as I understand what your saying is if we have technical area where we have brought many, it has tentacles that reach out to different parts of the organization.

And we have done our job, as we always do, to reach out to those individuals and they are incorporated as part of the greater review document, that's the type of thing you want to see. And you want to see that --

CHAIRMAN POWERS: Yes. The examples where you've done that and similarly examples where you have done an independent analysis, not just reviewed, but done, making those things explicit I think helps the committee as a whole, better understand what's involved.

Better understand and appreciate the magnitude of work.

MR. COLACCINO: Clearly aware of the independent reviews and know that that's something that ACRS asks the staff on a regular basis.

CHAIRMAN POWERS: That's right.

MR. COLACCINO: And we highlight that. And I will take this back to the other organizations, as well.

CHAIRMAN POWERS: I think it's, I, myself have been continuously impressed with the ability that project managers have to coordinate multi-disciplinary reviews. And I, there are some peculiarity about the NRC and its ability to do that.

You're one of the best organizations in America, in government, in doing multi-disciplinary reviews and I think you ought to take some credit. At the same time communicate with the full committee.

MR. JACKSON: Thank you.

CHAIRMAN POWERS: Any other comments you'd like to make? Closing? You guys are happy, we're happy, let's adjourn. We stand adjourned.

(Whereupon, the proceedings in the above-entitled matter were concluded at 3:36 p.m.)

Presentation to ACRS U.S. EPR^{TM} Subcommittee Design Certification Application FSAR Tier 2 Chapter 6

(excluding Section 6.2.2 and GSI-191)

April 5, 2011

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Chapter 6 ACRS Meeting Agenda

▶ Overview of U.S. EPR Engineered Safety Features (6.1, 6.2.1, 6.3, 6.2.5, 6.2.7, 6.6)	Chris Molseed
▶ Reactor Building Containment and Ventilation (6.2.3)	Ronald Conley
▶ Control Room Habitability (6.4)	Ronald Conley
▶ Engineered Safety Features Filtration Systems (6.5.1)	Ronald Conley
▶ Containment Isolation System (6.2.4)	Terry Daugherty
▶ Containment Leakage Testing (6.2.6)	Terry Daugherty
▶ Combustible Gas Control System (6.2.5)	Fred Maass

Proprietary Session

▶ Containment Analysis (6.2.1)	Chris Molseed

Overview of U.S. EPR Engineered Safety Features (6.1, 6.2.1, 6.3, 6.2.5, 6.2.7, 6.6)

Chris Molseed
Supervisory Engineer,
Containment Analysis

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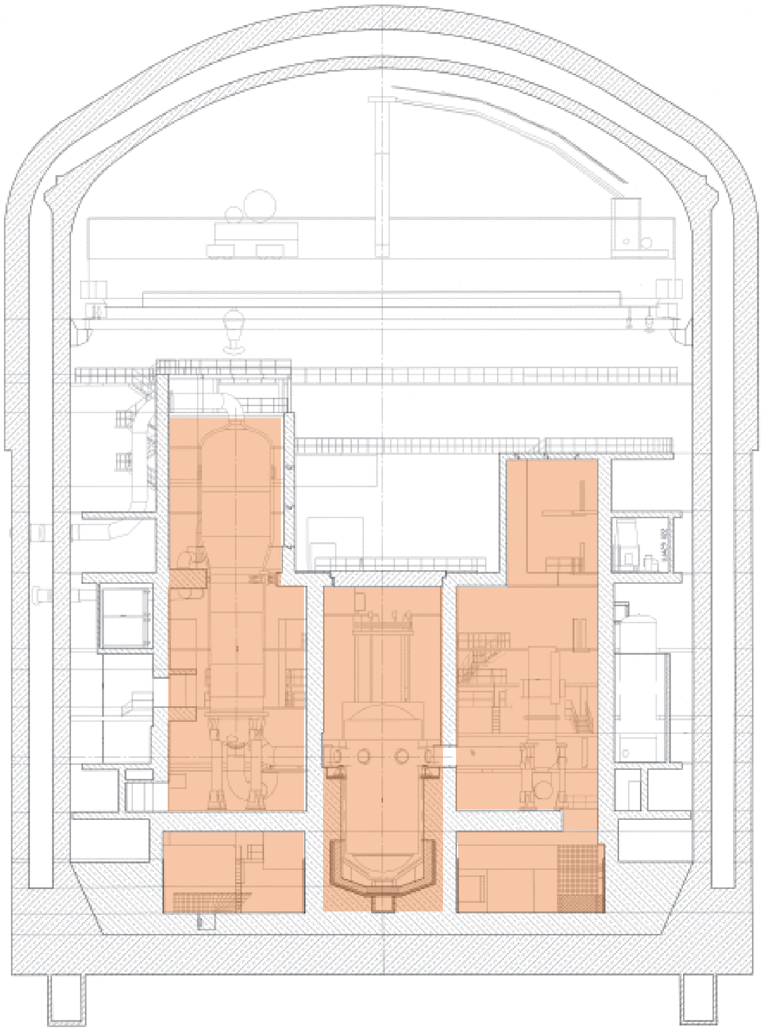
Engineered Safety Features (ESF) Materials (6.1)

- **Metallic Materials**
  - Components used in ESF systems are fabricated to quality standards in conformance to 10 CFR 50.55a
  - ESF components are fabricated of materials recognized by ASME Boiler & Pressure Vessel Code, Section III
  - Process for welding, heat treatment, and nondestructive examination are controlled in accordance with applicable codes and standards
  - Controls for cleaning ESF materials and equipment are in accordance with RG 1.37
- **Organic Materials**
  - Protective coatings carry a Service Level I, II, or III designation
  - Quality Assurance programs provide confidence that safety related coating systems will perform as intended

U.S. EPR Containment Design (6.2.1)



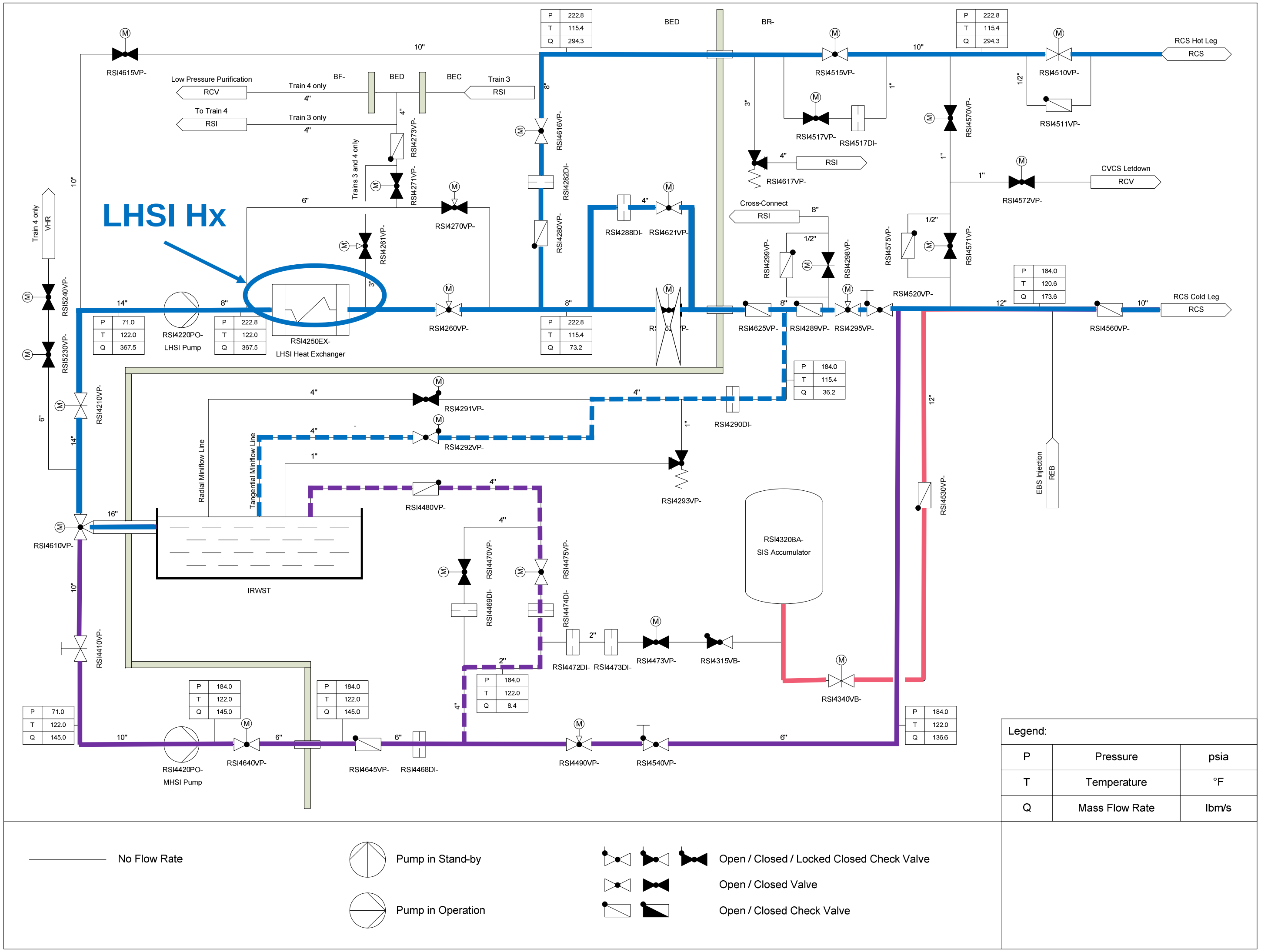
- Post-tensioned concrete containment with steel liner
- Shield Bldg wall reinforced concrete
- Containment Free Volume = 2.8 Mft^3
- Containment Inside Diameter = 153.5 ft.
- Containment Wall Thickness = 4.3 ft.
- Design pressure = 62 psig
- In-Containment Refueling Water Storage Tank (~500,000 gal)
- Two-zone containment
- CONVECT system of rupture and convection foils and dampers connect zones during high energy line breaks (HELBs)
- Passive hydrogen reduction system

U.S. EPR does not rely on safety related fan coolers or containment sprays

ECCS Design Features (6.3)

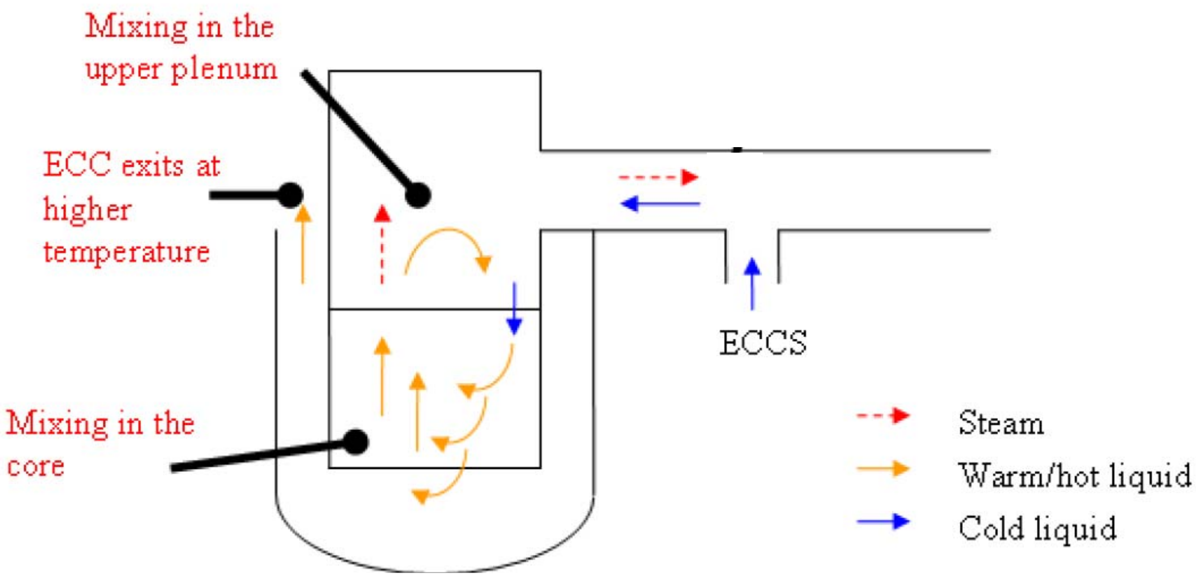
- Four independent front line safety systems
- Automatic partial cooldown of steam generators (SGs) on safety injection system (SIS) actuation signal reduces primary pressure to below discharge head of the medium head safety injection (MHSI) pumps
- In-Containment Refueling Water Storage Tank (IRWST)
  - Single source of emergency core cooling system (ECCS) water
  - Eliminates need to switch to a recirculation injection mode
  - Sufficient static head to the suction of the SIS
  - Sufficient inventory during shutdown to fill reactor cavity, internal storage pool, reactor building transfer pool and the reactor coolant system
  - Sufficient inventory for flooding a core melt during a severe accident
- Manual alignment of low head safety injection (LHSI) to hot leg nozzles

ECCS Design Features (6.3)

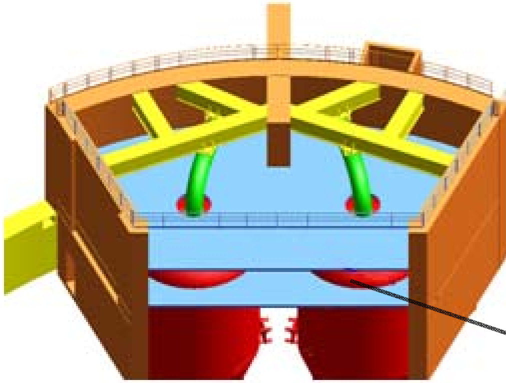


ECCS Design Features (6.3)

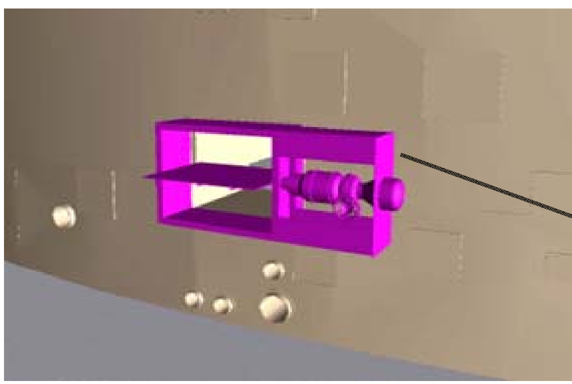
- **Long Term suppression of steaming**
  - **Steam line break: Steam generator feed is manually isolated**
  - **LOCA: manual LHSI switch to hot leg injection at 60 minutes**

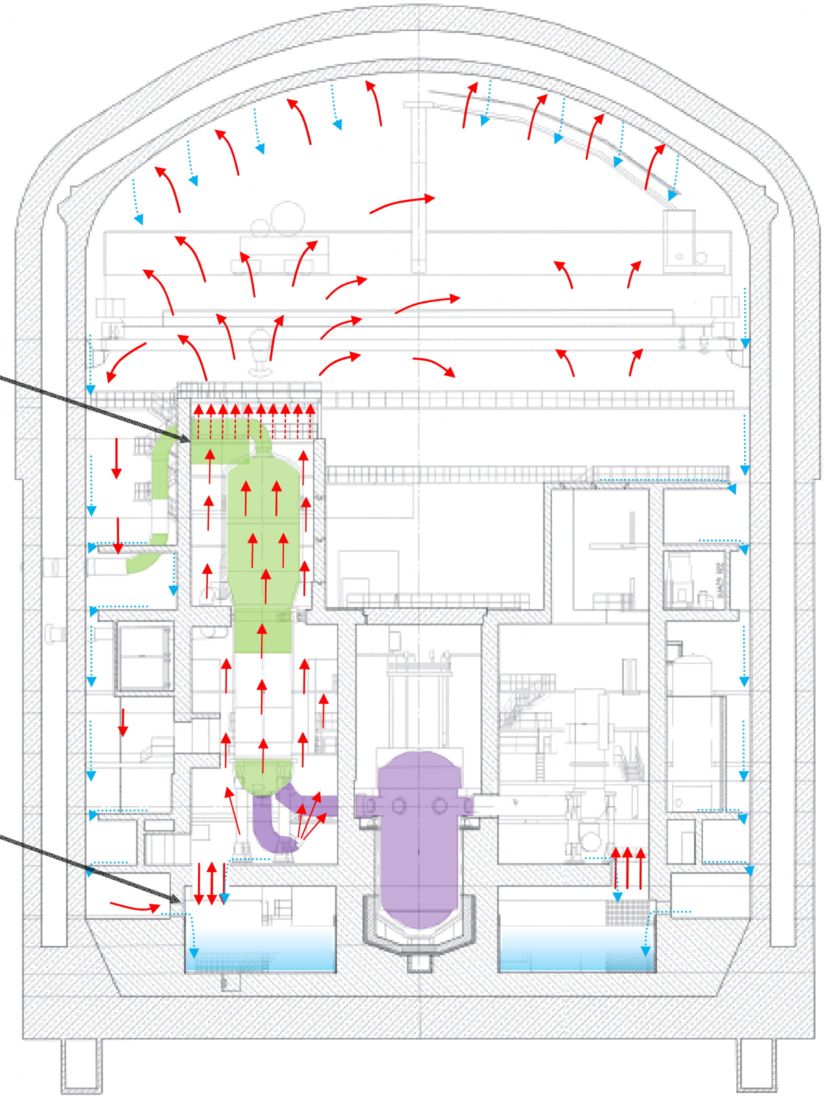


Containment Circulation



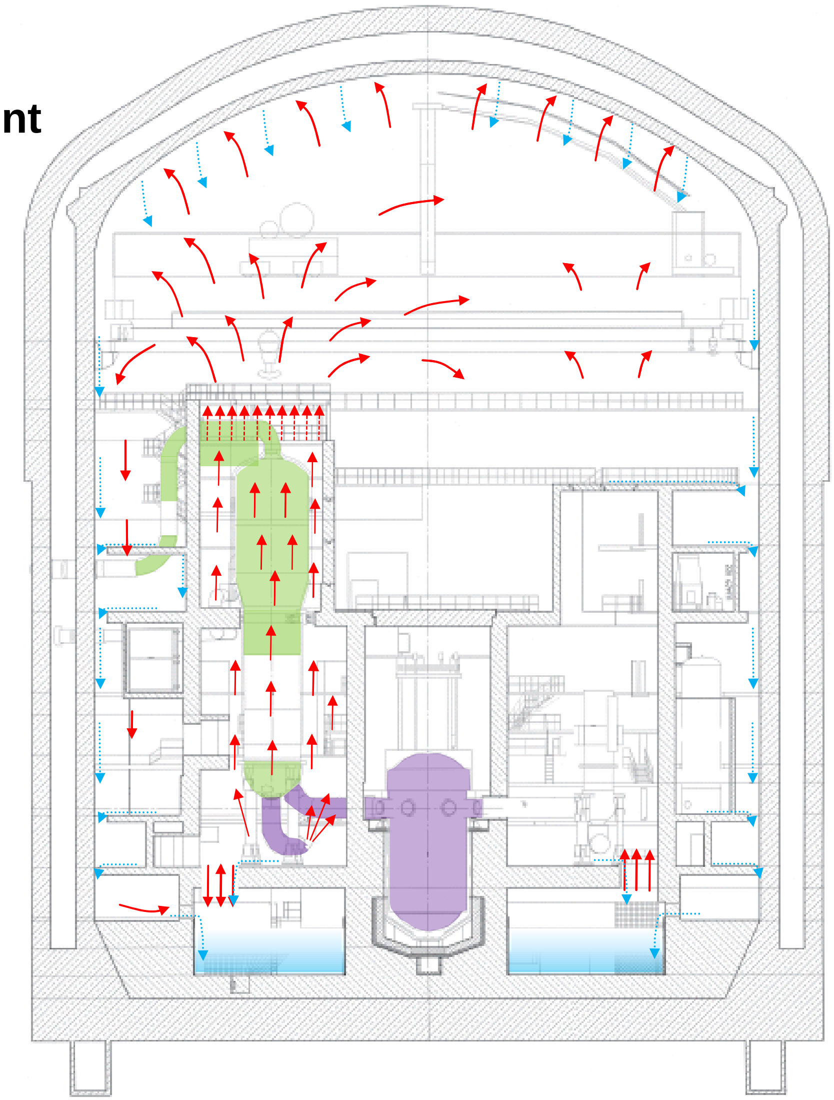
CONVECT System promotes mixing by establishing convection paths inside the reactor building



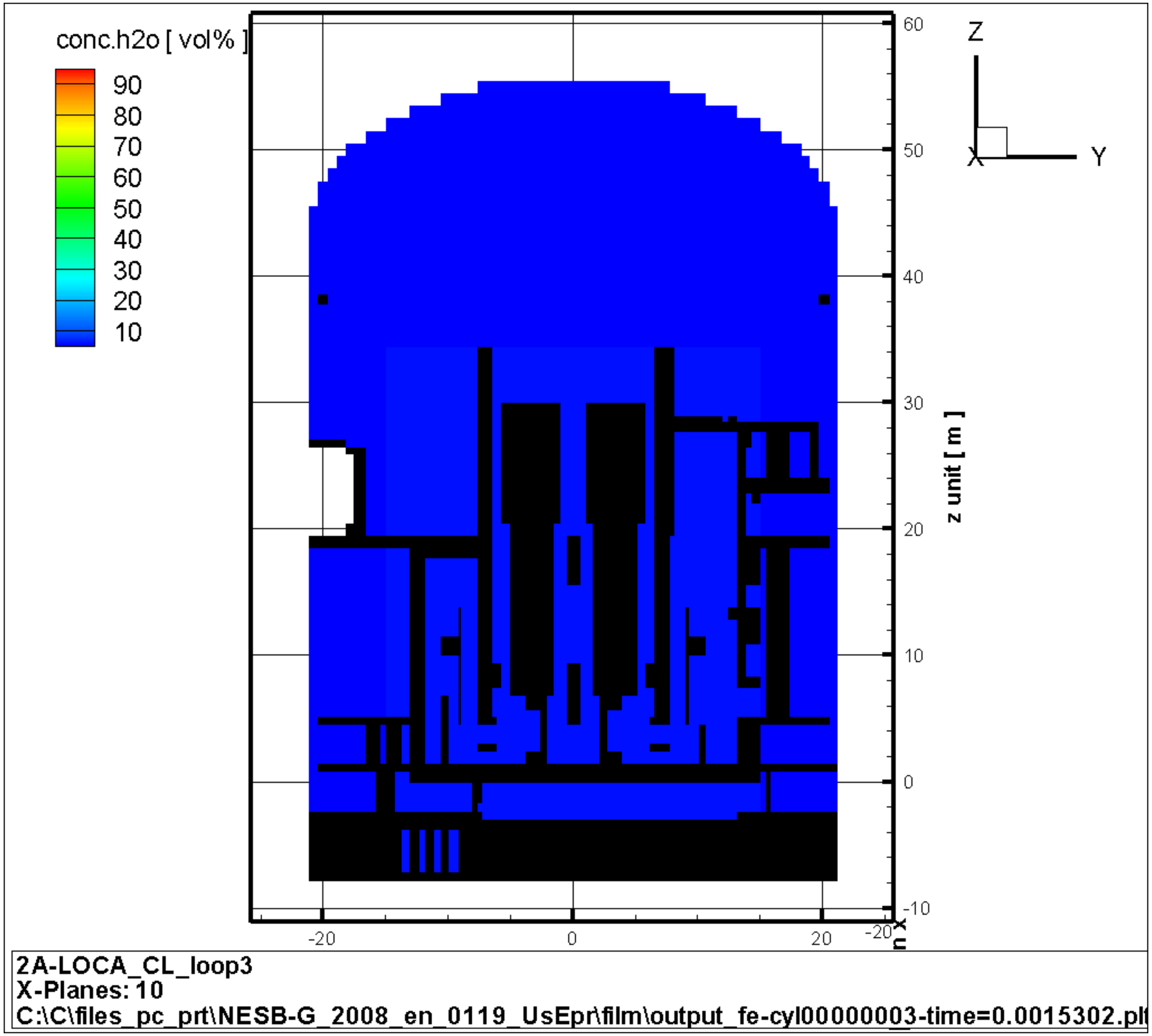


Principles of Circulation

- **Steam release pressurizes containment**
- **Water vapor condenses on cold steel and concrete surfaces**
  - Total surface, incl. concrete and steel is ~725,000 sq. ft.
  - Well distributed
- **Floor grates and drains designed to direct liquid to IRWST**
- **Pressure excursion terminates as**
  - LOCA: Hot Leg Injection
  - Main Steam Line Break (MSLB): SG Inventory depleted



Principles of Circulation



Combustible Gas Control System (6.2.5)

- **Combustible Gas Control System (CGCS)**
  - **Allows for the conversion from a two-zone containment to a mixed homogeneous atmosphere**
  - **Controls the concentration of combustible gases**
  - **Combination of safety and non-safety related equipment**
    - **Rupture and Convection Foils (S)**
    - **Hydrogen Mixing Dampers (S)**
    - **Passive Autocatalytic Recombiners (NS)**

Rupture and Convection Foils
Safety Related Equipment

Hydrogen Mixing Dampers
Safety Related Equipment

Fracture Prevention of Containment Pressure Vessel (6.2.7)

- Materials for the carbon steel liner plate and carbon steel and low alloy steel attachments and appurtenances subject to ASME Section III, Division 2 requirements meet the fracture toughness requirements of Article CC-2520.
- Materials used in ASME Section III, Division 1 attachments and appurtenances meet the fracture toughness requirements of Article NE-2300.

Inservice Inspection of Class 2 and 3 Components (6.6)

- **Components and piping designed to allow required inspections and examinations**
  - **Components designed to permit preservice inspections in accordance with Section XI Edition and addenda applicable to construction of the component.**
  - **High energy fluid system piping is subject to augmented inspections requiring 100% volumetric examination of circumferential and longitudinal pipe welds between containment isolation valves**
- **A COL applicant that references the U.S. EPR design certification will identify the implementation milestones for the site-specific ASME Section XI preservice and inservice inspection program for the Code Class 2 and 3 components consistent with the requirements of 10 CFR 50.55a (g) including:**
  - **Identification of the applicable edition and addenda of ASME Section XI**
  - **Identification of code cases utilized**

U.S. EPR FSAR Reactor Shield Building and Annulus Ventilation System (6.2.3)

Ronald Conley
Advisory Engineer,
Mechanical Engineering

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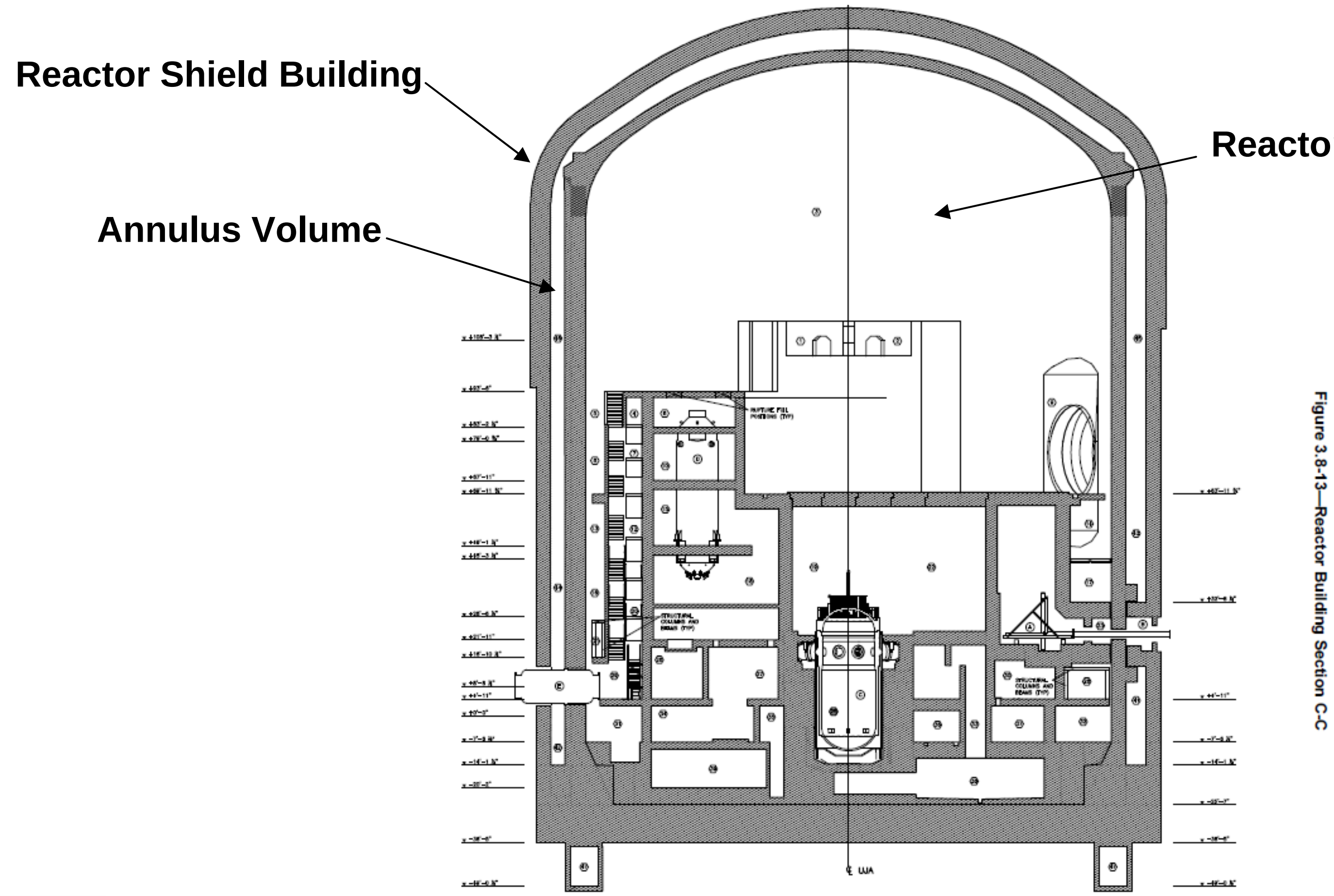
U.S. EPR Reactor Building



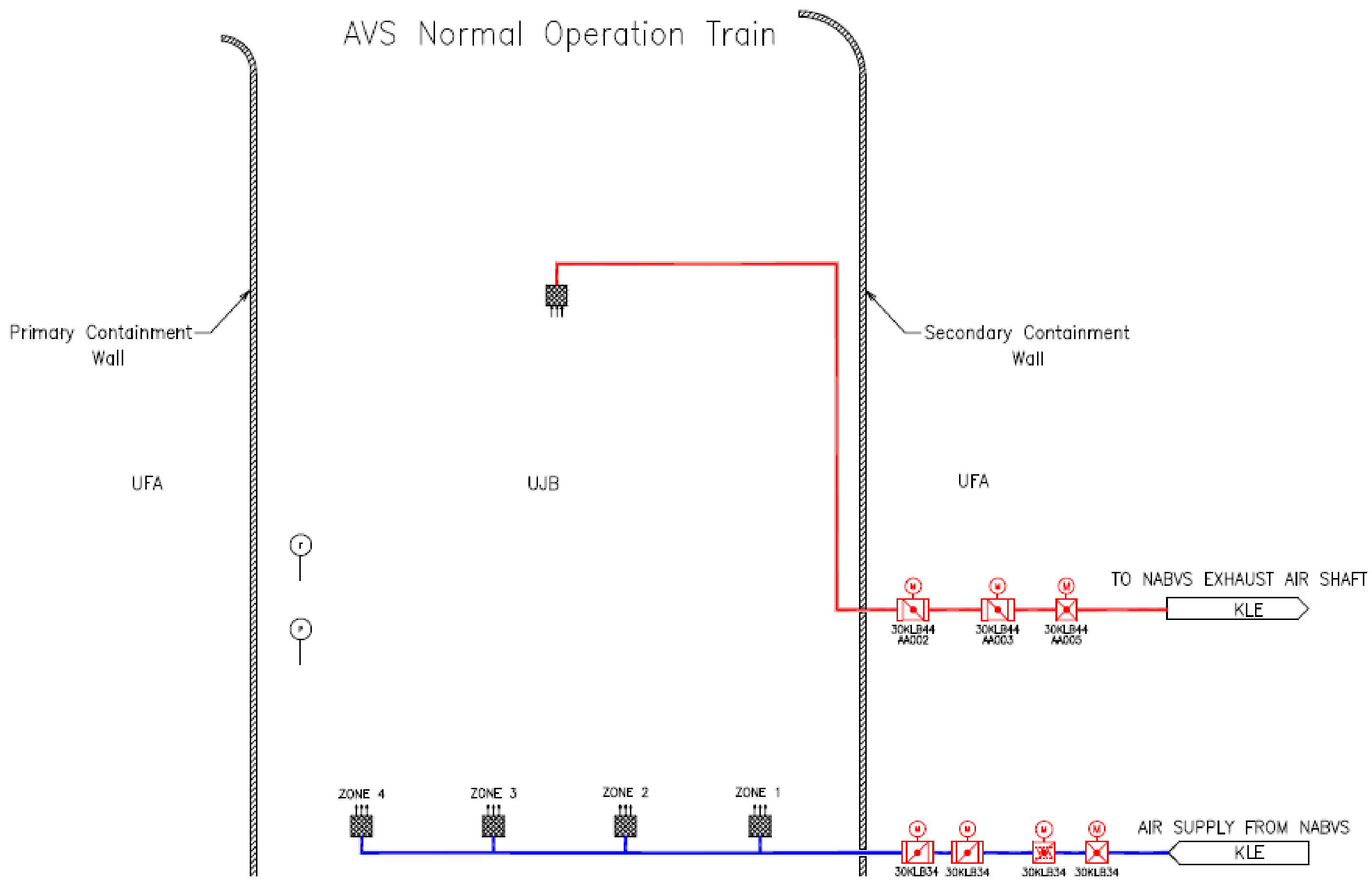
Annulus Ventilation System

- **Design Basis**

  The Reactor Shield Building and the Annulus Ventilation System function as a secondary containment to prevent the uncontrolled release of radioactivity to the environment.

- **Annulus Ventilation System (Normal Operation)**
  - Conditioned air is drawn from the Nuclear Auxiliary Building (NAB) ventilation supply shaft.
  - Supply conditioned air that is distributed in the bottom of the annulus. The pressure in the annulus is maintained at ≤ -0.8 in wg by operation of a pressure control damper located in the supply ducting.
  - Supply conditioned air that is distributed in the bottom of the Exhaust air is drawn from the top of annulus by the NAB ventilation system exhaust fans. The exhaust air is filtered by the NAB filtration trains and exhausted to the unit vent stack.
  - Annulus Ventilation design is not unique to U.S. EPR.

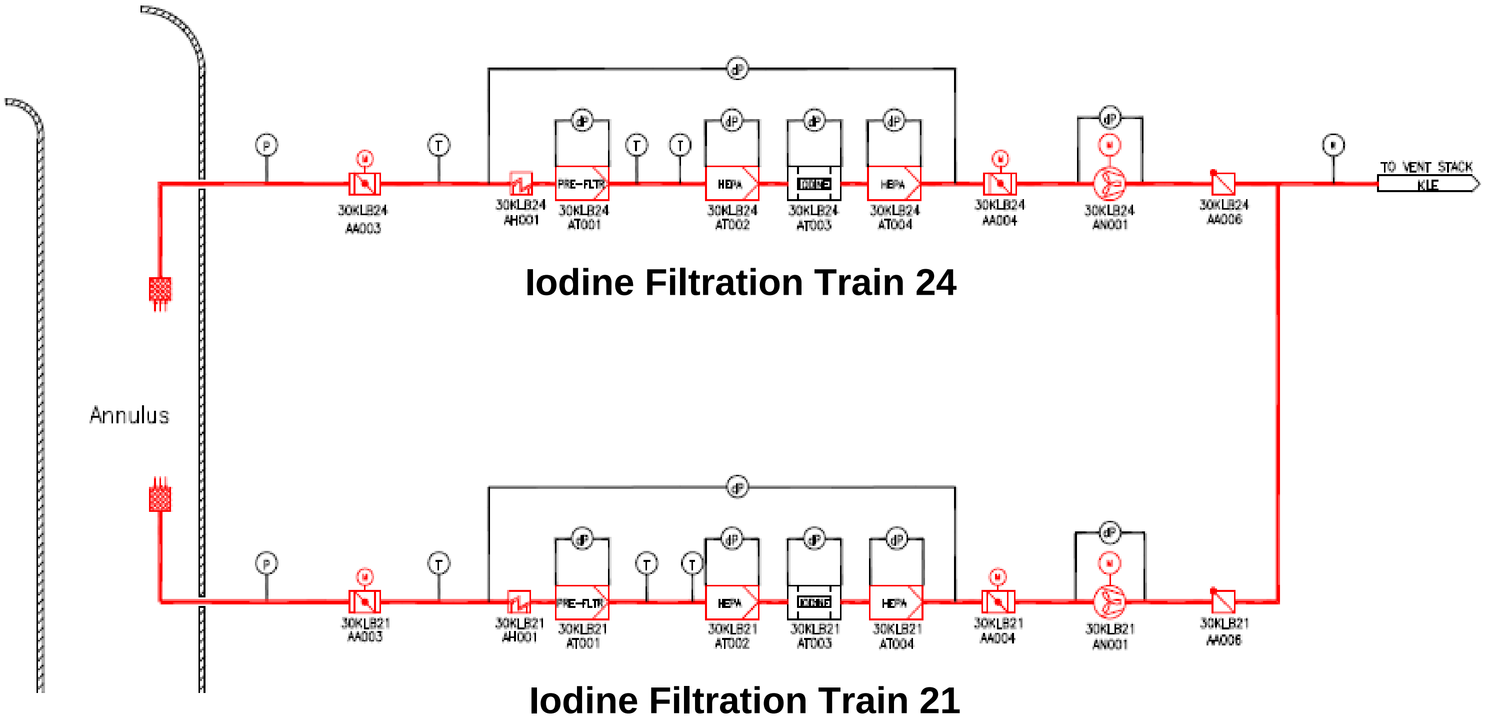
AVS Normal Ventilation



Annulus Ventilation System

- **Annulus Ventilation System (Accident Operation)**
  - Establishing a barrier against uncontrolled release of radioactivity to the environment (GDC 16)
  - Maintains the annulus at a pressure of ≤ -0.25 in wg, the carbon filtration exhaust operates to pull potentially contaminated air from the annulus and filter this air prior to release at the unit vent stack
  - The AVS is designed to permit periodic inspection and functional testing to confirm barrier integrity and operability in accordance with GDC 43 and 10 CFR 50, Appendix J section 6.2.6.
  - Secondary containment in-leakage assumed during postulated accident in primary containment is 0.25% of containment free volume per day.
  - Secondary containment out-leakage assumed during accident in primary containment is zero leakage out of secondary containment.

AVS Accident Exhaust



U.S. EPR FSAR Control Room Habitability (6.4)

Ronald Conley
Advisory Engineer,
Mechanical Engineering

by AREVA

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U.S. EPR Control Room Habitability

General

The U.S. EPR design basis accident (DBA) for Control Room Envelope Habitability is based on meeting the following:

- Regulatory Guide 1.78 (Postulated Hazardous Chemical Release)
- Regulatory Guide 1.196 (MCR Habitability)
- Regulatory Guide 1.197 (Control Room Envelope Integrity)

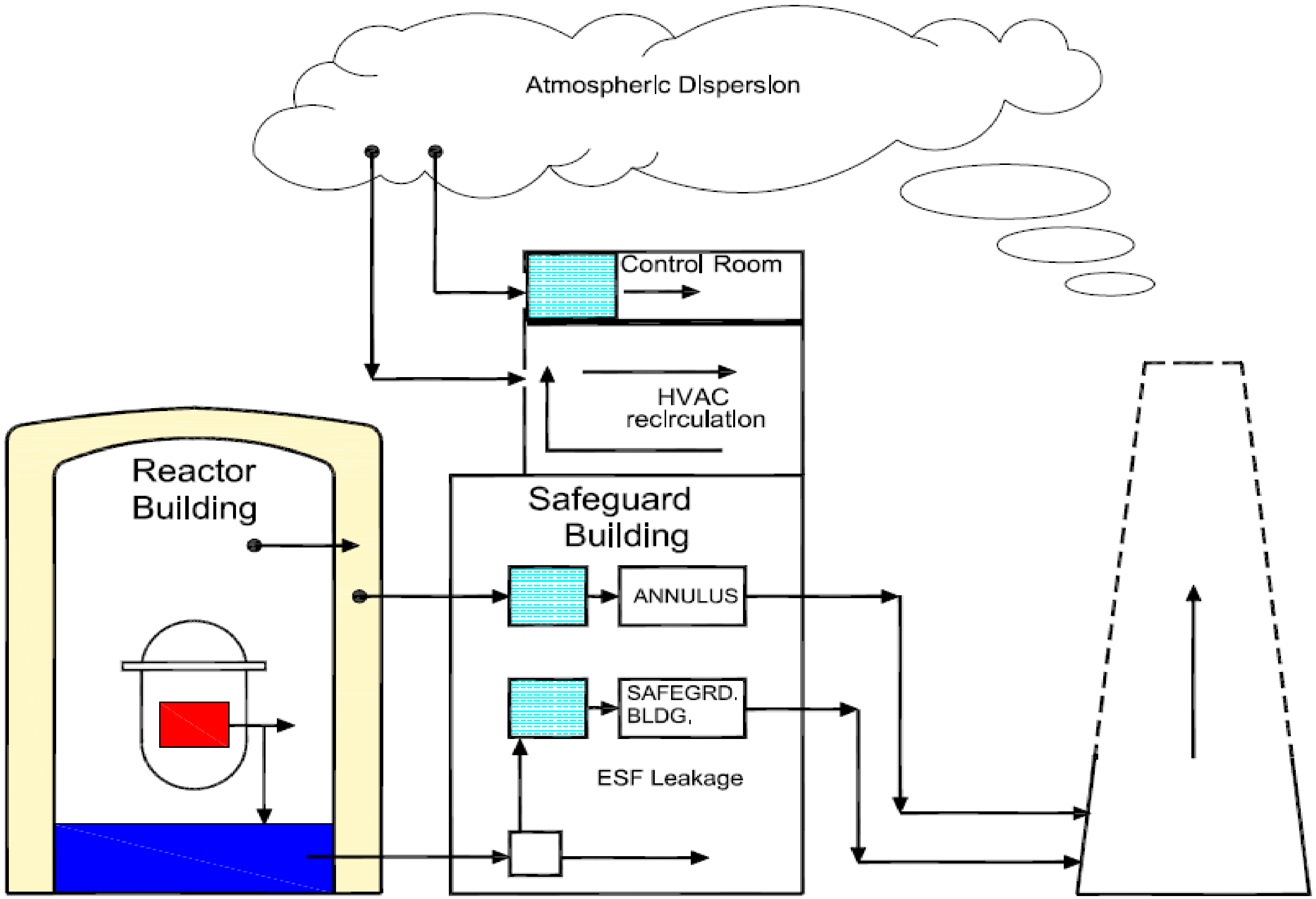
- GDC 4 (Environmental And Dynamic effects bases)
- GDC 5 (Sharing of structures, systems or components)
- GDC 19 (Maintains conditions for Safe Shutdown, personnel will not receive radiation dose in excess of 5 rem TEDE)

U.S. EPR Control Room Habitability

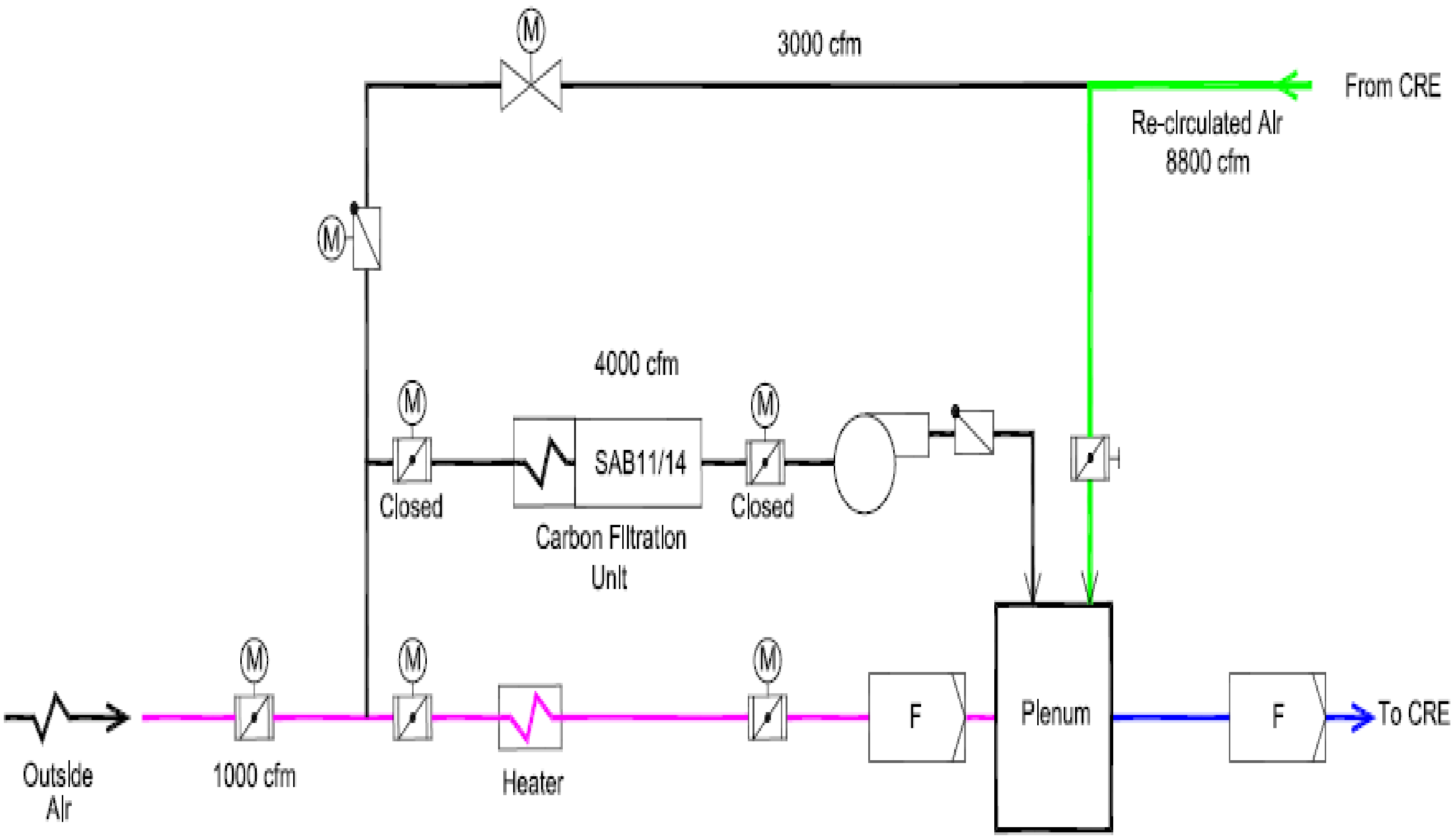
- The Control Room Habitability system design functions:
  - Missile protection (Section 3.8)
  - Control Room Emergency Filtration (Sections 6.5.1 and 9.4.1)
  - Pressurization and Air Conditioning (Section 9.4.1)
  - Radiation Shielding (Section 12.3.4)
  - Protection from toxic gases (Section 9.4.1)
  - Fire protection system (Section 9.5.1)
- A COL applicant that references the U.S. EPR design certification will identify the type(s) of Seismic Category I Class IE toxic gas sensors (i.e., the toxic chemical(s) of concern) necessary for control room operator protection.
- A COL applicant that references the U.S. EPR design certification will confirm that the radiation exposure of main control room occupants resulting from a design basis accident at a nearby unit on a multi-unit site is bounded by the radiation exposure from the postulated design basis accidents analyzed for the U.S. EPR; or confirm that the limits of GDC-19 are met.

Control Room Relative to Surrounding Areas

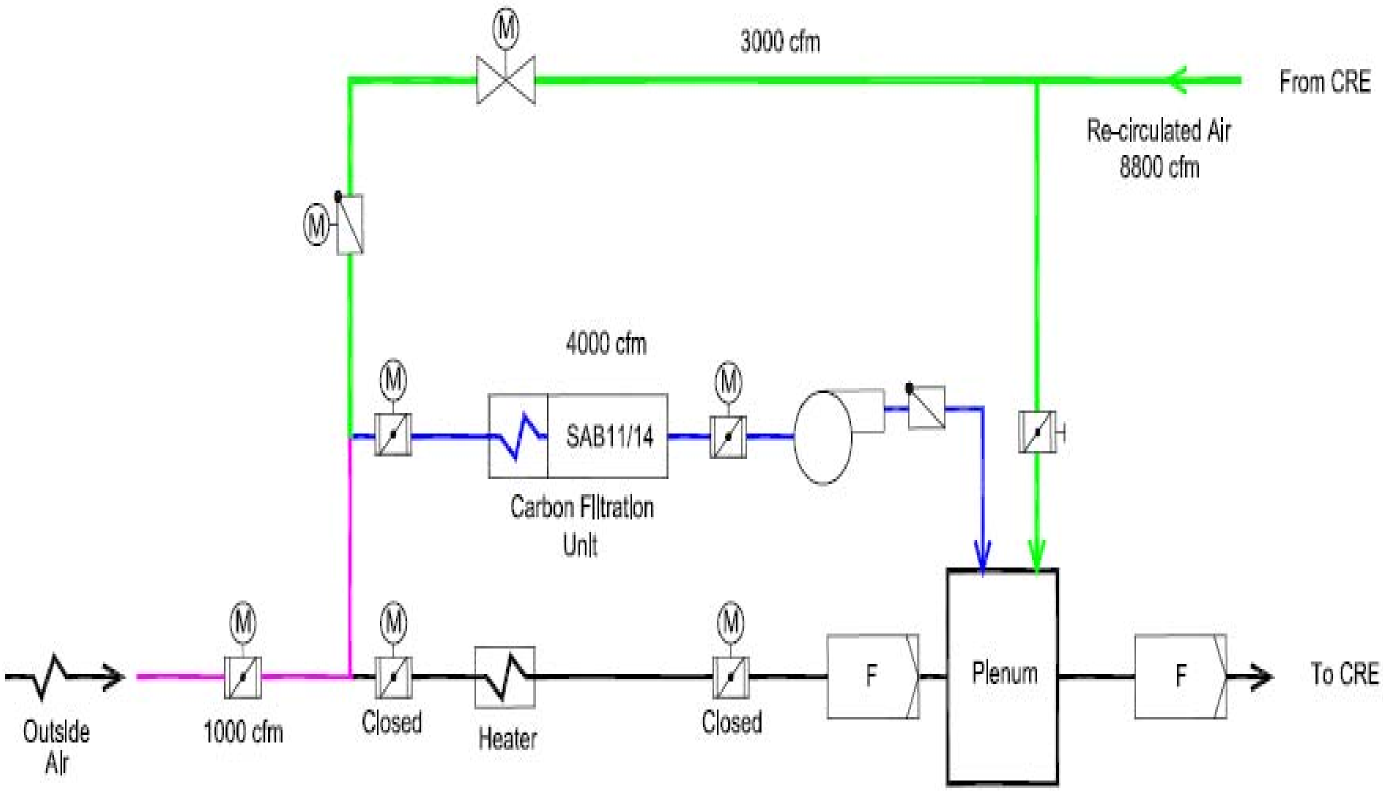
- **Example of DBA model – LOCA (following annulus and safeguard buildings draw down)**



Control Room Ventilation Operating in a Normal Alignment



Control Room Ventilation Operating in Accident Alignment



U.S. EPR Control Room Envelope

- **The CRE has a Total Free Volume of 200,000 ft^3 and includes the following areas:**
  - **Lower Elevation +53 ft (133,000 ft^3)**
    - Main Control Room
    - Technical Support Center (Integrated Operations Center)
    - Restrooms
    - Instrumentation and Controls room
    - Computer rooms
  - **Upper Elevation +69 ft (67,000 ft^3)**
    - HVAC Equipment rooms

U.S. EPR Control Room Envelope

CRACS Design Characteristics	
Filtered air intake flow	1,000 cfm
Air Changes / hour	0.3
CRE Filtered air recirculation air flow	3,000 cfm
Accident Alignment (CRE Unfiltered In-leakage from surrounding areas)	40 cfm boundary leakage plus 10 cfm ingress/egress
Max number of people the CRE will support in Recirculation Alignment	25 (TSC) 5 (MCR) 30 total

U.S. EPR FSAR Engineered Safety Features Filtration (6.5.1)

Ronald Conley
Advisory Engineer,
Mechanical Engineering

U.S. EPR ESF Filtration (6.5.1)

▶ Design

Engineered Safety Features (ESF) Filtration Units are designed to prevent or limit the release of fission products during normal operation and following a design basis accident or fuel handling accident.

U.S. EPR ESF Filtration (6.5.1)

- The following ventilation systems utilize ESF Filtration Units:
  - Control Room Air Conditioning System - Removal of airborne particulate / iodine from the outside air and recirculation air to provide a clean environment within the CRE
  - Annulus Ventilation System – Removal of airborne particulate/iodine exhausted from the Annulus
  - Containment Building Purge System – Removal of airborne particulate/iodine drawn from containment during a low flow purge exhaust
  - Safeguard Building Ventilation System
    - **Removal of airborne particulate/iodine exhausted from the Safeguard Buildings**
    - **Removal of airborne particulate/iodine exhausted from the Fuel Building**

U.S. EPR ESF Filtration Units (6.5.1)

- ESF filter systems designed, constructed and tested to meet RG 1.52 Rev 3, ASME N509-89 and ASME N510-89
- Moisture separators, able to remove 99% by weight of entrained moisture, tested IAW MSAR 71-45 MYQ-3250-6 or equivalent
- Air Heaters, qualified to meet IEEE 323 and 344
- Pre- and post-filters, (tested per ASHRAE 52)
- HEPA filters, shall meet construction and, material and qualification requirements of military specification MIL-F-51068
- Carbon Adsorber, 4 inch carbon thickness (gives carbon efficiency of 99% to support reduction of offsite doses)

U.S. EPR FSAR Containment Isolation System (6.2.4) Containment Leakage Testing (6.2.6)

Terry Daugherty
Advisory Engineer,
Mechanical Engineering

Containment Isolation System (6.2.4)

▶ General System Design

Classification of CI SSCs	Safety, QG B, Seismic I
No. of penetrations / Line sizes	~340 / Min = 1/8 in, Max = 39 in

- **Dedicated penetration per 10 CFR 50.34.**
- **Systems used for accident mitigation or required for safe shutdown are identified as essential systems.**
  - CIVs in these systems do not receive a CI signal; however, they can be closed remotely from the MCR if required for post-accident operation.

▶ Lines Part of the RCPB or Connected to Cont. Atmosphere

- **Valve configurations are in accordance with GDC 55 and 56.**
  - SIS, CVCS, & SAHRS IRWST suction lines and CBVS purge lines.

▶ Lines Part of Closed Systems

- **Valve configurations are in accordance with GDC 57.**
- **CIVs are provided with capability to detect leakage from valve stems and bonnet seals.**

Containment Isolation System (6.2.4)

- **System Actuation**
  - **PS sends CI signals (stage 1 or 2) that automatically isolate non-essential lines.**
  - **Isolation valve closure times are in accordance with ANSI/ANS-56.2.**
    - Low flow CBVS purge valves close within 5 seconds
- **Electrical Power Supplies**
  - **CIVs are supplied from Class 1E power sources**
    - Buses for inner CIVs are backed up by the EDGs and emergency UPS
    - Buses for outer CIVs are backed up by the EDGs
    - Buses supplied by the SBODG during SBO conditions
    - Alternate feeds provide normal and standby power when certain electrical components are out of service (e.g., EDG)
- **Penetrations Overpressure Protection**
  - **Lines have either a bypass check valve or a pressure relief valve.**
  - **Lines that use a check valve as a CIV have inherent protection.**

Containment Leakage Testing (6.2.6)

- Containment Integrated Leakage Rate Test
  - Type A, B and C tests are conducted in accordance with 10 CFR 50, Appendix J Option B with guidance from RG 1.163.
  - Testing intervals are based on NEI 94-01 in accordance with RG 1.163.
  - CLRT program requirements and acceptance criteria are in the Technical Specifications program.
- Acceptance Criteria in Technical Specifications
  - Leakage rate: less than or equal to 1.0*La.
  - During 1st startup and following testing per this program: less than 0.75*La.
  - Type B / Type C testing: less than 0.6*La combined.
  - La = 0.25 w/o containment air mass per day by weight at containment pressure equal to calculated peak internal pressure associated with a DBA LOCA.

U.S. EPR FSAR Combustible Gas Control System (6.2.5)

Fred Maass

Manager,

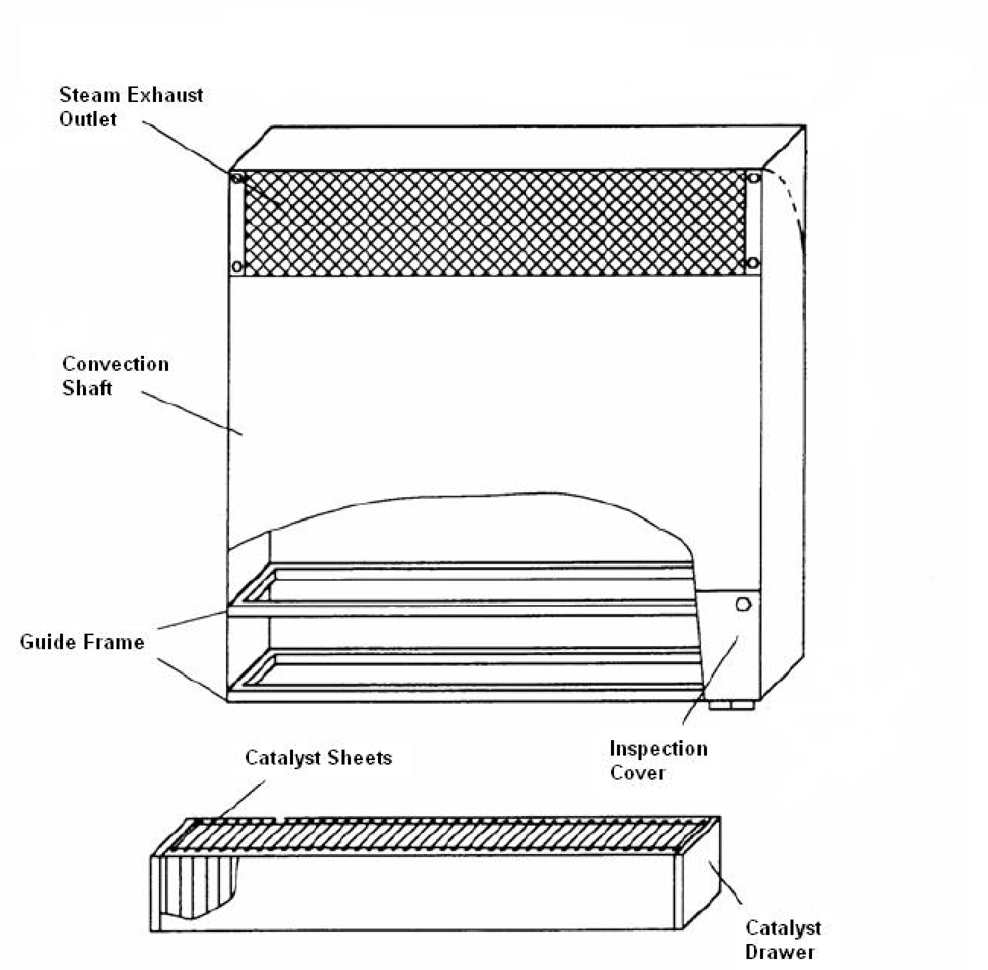
NI System Engineering

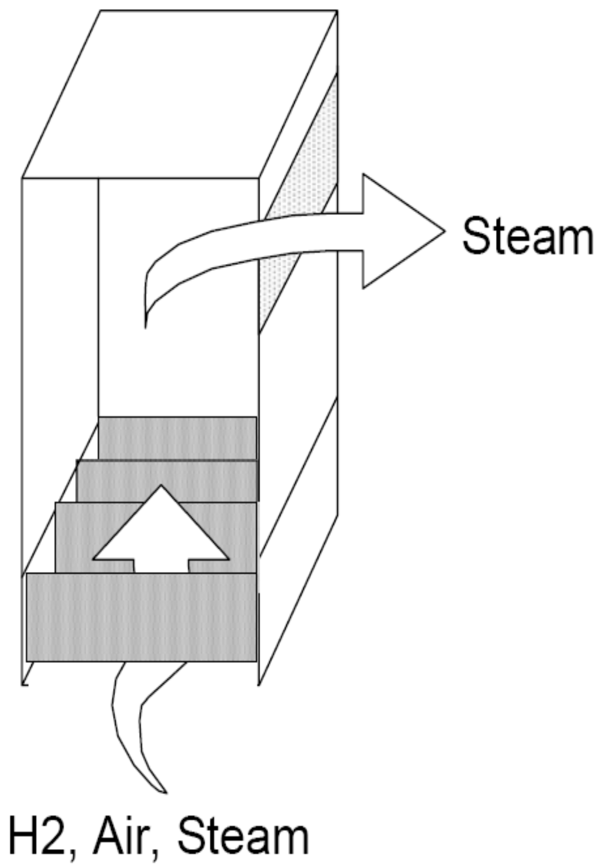
Combustible Gas Control System (CGCS) for Severe Accident (6.2.5)

	Rupture Foils	Convection foils	Mixing Dampers	Passive Autocatalytic Recombiners	Hydrogen Monitoring System
Used for DBA	yes	yes	yes	no	Yes – low range
Used for Severe Accident	yes	yes	yes	yes	Yes – high range

- The CGCS mixes the atmosphere within the containment
- Total hydrogen concentration remains below the threshold for combustion for design basis accidents assuming no PAR hydrogen recombination
- Total hydrogen concentration remains below the threshold for combustion for severe accident assuming PAR hydrogen recombination
- Passive Autocatalytic Recombiners (PAR)
  - 47 PARs distributed throughout containment
  - PARs use plates coated with a catalyst
  - Operates effectively in steam-saturated atmosphere
  - Protected from direct spray

Passive Autocatalytic Recombiner





Closed Session

U.S. EPR FSAR Containment Analysis (6.2.1) Event Evaluation (excluding Section 6.2.1.2)

Chris Molseed
Supervisory Engineer,
Containment Analysis

Containment Response Evaluation Methodology

- **Conservative, deterministic methodology**
- **Conforms to the NUREG-0800 Standard Review Plan (SRP)**
- **In accordance with regulatory guidance**
  - Non-safety related system functionality modeled only when detrimental to outcome
  - Key parameters, such as protection system setpoints and ECCS performance, are biased for conservatism and uncertainty in accordance with Regulatory Guide 1.105
  - Other inputs are nominal
- **Addresses specific General Design Criteria (GDC)**
  - GDC 16 – Requires containment and associated systems being designed to assure that containment design conditions important to safety are not exceeded
  - GDC 38 – Requires a containment heat removal system to rapidly reduce containment pressure and temperature following a LOCA
  - GDC 50 – Requires containment be designed to accommodate the pressure and temperature conditions following a LOCA
- **U.S. EPR Evaluation Methodology described in ANP-10299P**
  - Based on existing AREVA Containment Methodology described in ANP-10252PA for operating plants and modified for the U.S. EPR

Containment Response Evaluation Methodology

- The methodology is presented in Technical Report ANP-10299P:
  - Describes the U.S. EPR containment design, including the CONVECT system and the conversion from a two-zone containment to a single convective volume
  - Applies RG 1.203 framework for Evaluation Model Development and Assessment Process (EMDAP)
  - Assessment of U.S. EPR containment response phenomena
  - Describes the mass and energy (M&E) methodology (RELAP5-BW and GOTHIC)
  - Examination of phenomena relevant to containment analysis using data from separate effects testing and integral effects testing
  - Demonstrates applicability of GOTHIC methodology to U.S. EPR containment design
  - Quantifies margin provided by conservatisms in the evaluation model (EM)

Containment Response Evaluation Methodology

- The applied Evaluation Model Development and Assessment Process (EMDAP) follows the same principles as Code Scaling Applicability Uncertainty (CSAU) process used for statistically based methodologies
- Description of principal phenomena for the LOCA was divided into five phases characterized by distinct phenomena:
  - Blowdown
  - Refill
  - Reflood
  - Post-Reflood
  - Decay Heat

Containment Response Evaluation Methodology

- **Phenomena Identification and Ranking Table (PIRT)**
  - **AREVA sponsored a peer review to develop a PIRT for the U.S. EPR LOCA calculations**
  - **PIRT participants had an average of 20 years experience in the area of LOCA and/or containment phenomena**
  - **U.S. EPR PIRT Identifies, ranks and assesses state of knowledge of the important phenomena for**
    - Mass and Energy release evaluation
    - Containment pressure evaluation

Containment Response Evaluation Methodology

Assessment Database and Scaling

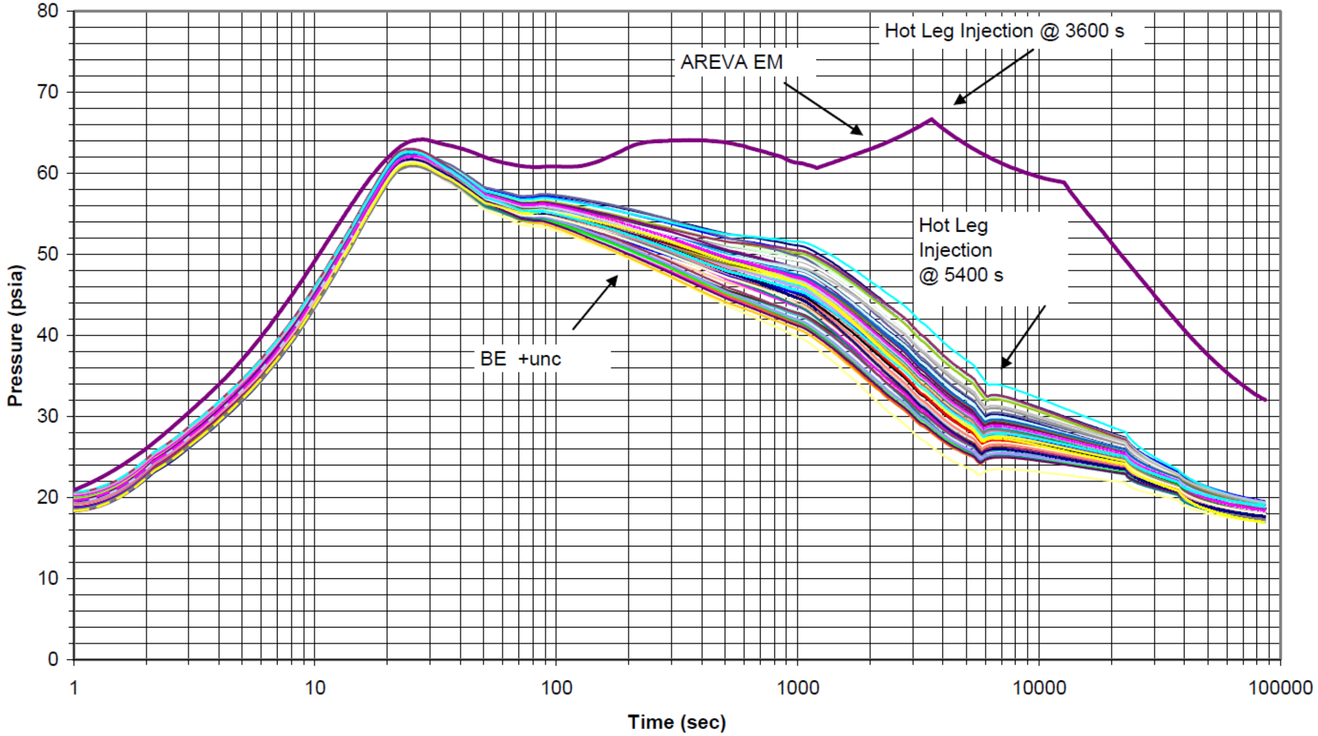
- **Developed a top-down scaling analysis where conservation equations were made non-dimensional with the non-dimensional coefficients defined as various Π groups**
  - Provides validation and reconciliation for the expert panel PIRT
  - The relative magnitude of the Π groups represents the importance for the U.S. EPR containment analysis
  - Blowdown phase identified the most important and distorted Π groups (10 of 38) although the validity of GOTHIC during the phase has been demonstrated repeatedly.
  - Many distortions were already treated non-dimensionally in GOTHIC (e.g. mass and energy analogy)
- **Assessment of RELAP5-BW and GOTHIC show that they predict medium- and high-ranked phenomena except:**
  - Multi-dimensional mixing in reactor vessel during post-reflood, hot leg injection phase
  - Interfacial heat transfer to IRWST liquid
- **Evaluation Methodology was adjusted to compensate for code limitations (conservative biases and analytical treatments)**

Containment Response Evaluation Methodology

- **Uncertainty analysis – follows Code Scaling, Applicability and Uncertainty (CSAU) methodology**
  - **Evaluates through sensitivity studies a range of values bounding the expected value of the parameter**
  - **Confirms the dominant phenomena identified in PIRT. Material thermal properties and condensation are the dominant phenomena for containment pressure.**
- **Modeling and Regulatory Compliance**
  - **Methodology (includes codes, biases and treatments) is compliant with NUREG-0800 SRP and ANSI/ANS-56.4**
  - **Codes used:**
    - LOCA mass and energy release rates
      - Short-term – RELAP5-BW
      - Long-term – GOTHIC
    - GOTHIC with multi-node model predicts containment pressure and temperature response

Containment Response Evaluation Methodology

- Double-ended guillotine cold leg pump suction break sample case



The Evaluation Model is conservative

Chapter 6 Events

- 6.2.1.3 Loss of Coolant Accident
  - Large Break LOCA
  - Small Break LOCA
  - Pressurizer Line Breaks
- 6.2.1.4 Secondary Pipe Ruptures inside Containment
  - MSLB (Equipment Area)
  - MSLB (Service Area)
  - Main Feedwater Line Break (MFWLB) (Equipment Area)
  - MFWLB (Service Area)
- 6.2.1.5 Minimum Containment Pressure Analysis for Performance Capability Studies on Emergency Core Cooling System

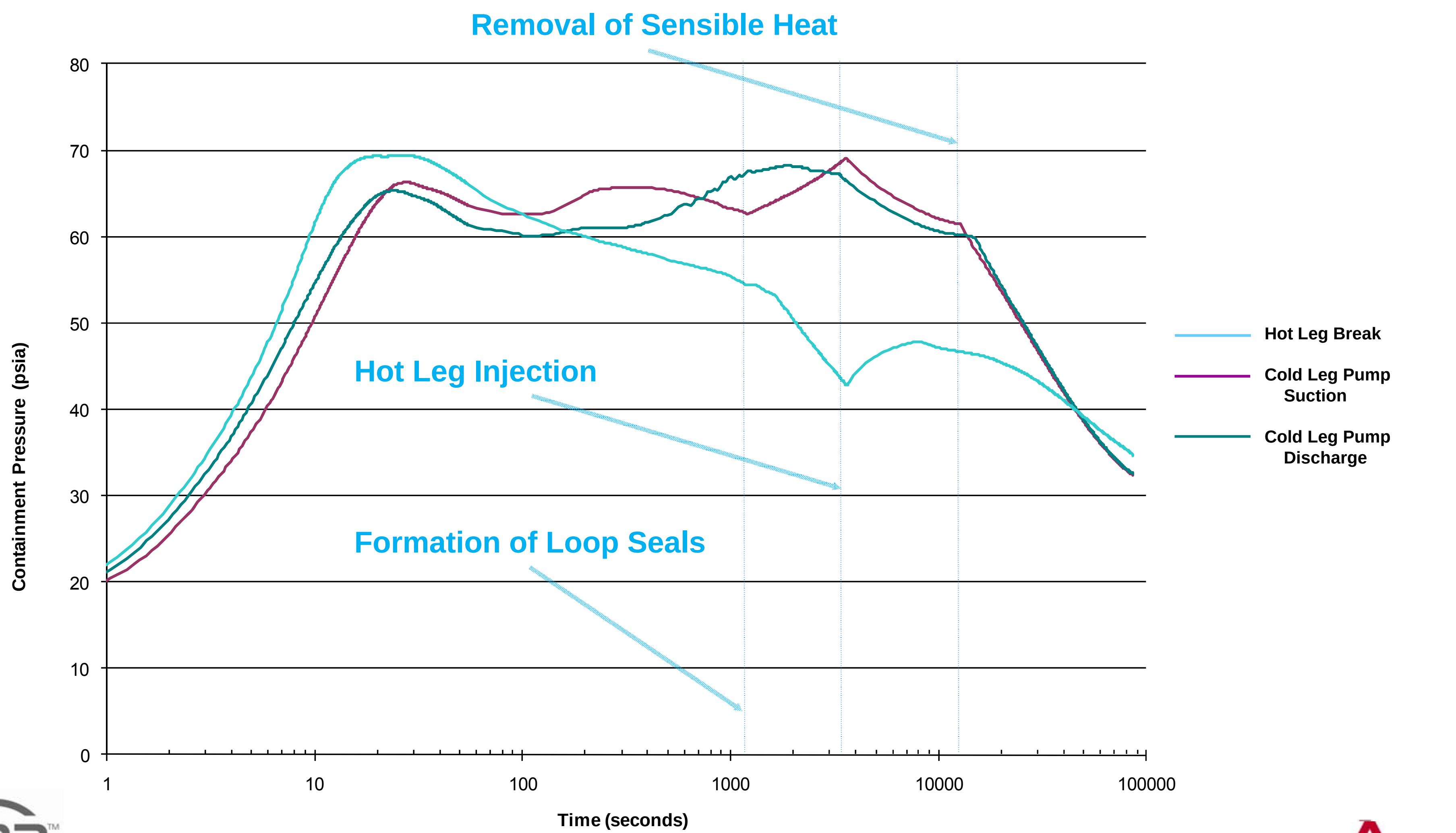
Loss of Coolant Accident (6.2.1.3)

- **Blowdown**
  - **Break opening allows RCS inventory to blow down to containment**
  - **Foils on SG compartments rupture and Hydrogen Mixing Dampers open, creating a "one-zone" containment that fills the building with vapor**
  - **Condensation begins on steel and concrete heat structures**
  - **Liquid begins to pool on the heavy floor and drain to the IRWST**
- **Refill/Reflood**
  - **Core covered by accumulator injection and LHSI flow**
  - **Core sensible heat is transported to containment**
  - **Broken loop LHSI dumps to heavy floor (cold leg (CL) breaks)**
  - **Condensation on heat structures**
- **Post-Reflood**
  - **LHSI delivery to hot legs terminates steaming from the vessel**
  - **Fully developed recirculation path exists from the IRWST to the reactor vessel (RV) (through the RHR heat exchangers)**

Loss of Coolant Accident (6.2.1.3)

- More than fifty LOCA analyses were completed for the U.S. EPR FSAR
- Spectrum of LOCA breaks analyzed included:
  - Cold leg pump discharge,
  - Cold leg pump suction,
  - Hot leg breaks and,
  - Pressurizer line breaks
- Breaks sizes ranged from a three-inch SBLOCA up to the largest postulated double-ended guillotine (DEG) break
- Peak calculated containment pressure
  - Blowdown Peak Pressure = 69.7 psia (Hot Leg Break)
  - Long Term Peak Pressure = 69.3 psia (Cold Leg Pump Suction)
- Acceptance Criteria = 62.3 psig = 77.0 psia
- Containment pressure is less than ½ peak pressure in less than 24 hours

Loss of Coolant Accident (6.2.1.3)



Secondary Pipe Rupture (6.2.1.4)

- More that forty MSLB analyses were completed for the U.S. EPR FSAR
- Spectrum of MSLB breaks analyzed included:
  - Seven Core Power Levels (0%, 20%, 40%, 50%, 60%, 80%, 100%)
  - Single Failure Sensitivity (main steam isolation valve (MSIV) vs. main feedwater isolation control valve (MFICV)
  - Break Sizes from 0.005 ft^2 to full DEG break (4.125 ft^2 limited to 1.4 ft^2)
  - Break Location (Equipment vs. Service Area)
- Peak calculated containment pressure = 66.4 psia (20% Power DEG Break)
- Acceptance Criteria = 62.3 psig = 77.0 psia
- MFWLBs were demonstrated to be bounded by the MSLB in all cases

Minimum Containment Pressure Analysis (6.2.1.5)

- Containment pressure calculations are performed by the ICECON module within the S-RELAP5 code
- ICECON is a variant of CONTEMPT/LT-022
- The mathematical models that calculate the mass and energy releases to the containment are described in Section 15.6 and conform to the realistic ECCS evaluation models of 10 CFR 50.46(a)(1)(i)
- Containment pressure is treated statistically in the RLBLOCA methodology by sampling:
  - Containment volume from the best estimate value to the maximum possible free volume
  - Initial temperature from 100°F to 131°F

Nomenclature

- CRE Control Room Envelope
- CRACS Control Room Air Conditioning System
- EBS Extra Borating System
- ECCS Emergency Core Cooling System
- EFW Emergency Feedwater
- FWLB Feedwater Line Break
- HVAC Heating and Ventilation and Air Conditioning
- IRWST In-containment Reactor Water Storage Tank
- LHSI Low Head Safety Injection
- LOCA Loss of Coolant Accident
- MCR Main Control Room
- MFW Main Feedwater
- MHSI Medium Head Injection System
- MSIV Main Steam Isolation Valve
- MSLB Main Steam Line Break
- MSRT Main Steam Relief Train
- MSSV Main Steam Safety Valve
- RB Reactor Building
- RCS Reactor Coolant System
- RHR Residual Heat Removal [System]
- RV Reactor Vessel
- SIS Safety Injection System
- SG Steam Generator
- SGTR Steam Generator Tube Rupture

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Presentation to ACRS
U.S. EPR™ Subcommittee
Calvert Cliffs Nuclear Power Plant Unit 3
FSAR Chapter 6, Engineered Safety Features
April 5, 2011

Introduction

- RCOLA authored using ‘Incorporate by Reference’ (IBR) methodology.
- To simplify document presentation and review, only supplemental information, site-specific information, or departures/exemptions from the U.S. EPR FSAR are contained in the COLA.
- AREVA U.S. EPR FSAR ACRS Meeting for Chapter 6– Engineered Safety Features occurred on April 5, 2011.

Introduction

- One Departure/Exemption from the U.S. EPR FSAR for Calvert Cliffs Unit 3, Chapter 6
- No ASLB Contentions
- Nine COL Information Items
- Consistent with the AREVA presentation of the U.S. EPR FSAR for Chapter 6, issues associated with GSI-191 are exempted from this discussion and will be addressed in Phase 4.

Introduction

- Today's Presentation was prepared by UniStar and is supported by AREVA (U.S. EPR Supplier) and Bechtel (Architect Engineer).
- Mary Richmond (Bechtel - Senior Environmental Engineer)
- Dan Patton (Bechtel - Nuclear/Environmental Engineer)
- Pedro Perez (AREVA - Supervisory Engineer-Radiological Engineering)
- Ron Conley (AREVA - Advisory Engineer- Mechanical Engineering)
- Today Mark Finley, UniStar Engineering Manager, will present the Calvert Cliffs Unit 3 FSAR Chapter 6.
- The focus of today's presentation will be on site-specific information that supplements the U.S. EPR FSAR.

Chapter 6, Engineered Safety Features Agenda

Engineered Safety Features

- COL Information Items/Site Supplemental Items
- Departures/Exemptions

Conclusions

Engineered Safety Features
COL Information Items

- Engineered Safety Features Materials
  - ➢ Calvert Cliffs Unit 3 will review the fabrication and welding procedures and other QA methods of Engineered Safety Features component vendors to verify conformance with RGs 1.44 and 1.31.

Engineered Safety Features
COL Information Items

- <u>Inservice Inspection of Class 2 and 3 Components</u>
- ➢ The Calvert Cliffs Unit 3 site-specific preservice inspection and inservice inspection (ISI) programs for ASME Class 2 and Class 3 components meet the requirements of 10 CFR 50.55a(g), and comply with ASME Boiler and Pressure Vessel Code, Section XI, 2004 Edition.
- ➢ Preservice inspection will be implemented prior to initial startup.
- ➢ ISI program will be implemented prior to commercial service.
- ➢ Preservice inspection and ISI programs for the ASME Class 2 and Class 3 components meet the requirements of 10 CFR 50.55a(g), and comply with ASME Boiler and Pressure Vessel Code, Section XI, 2004 edition.

Engineered Safety Features COL Information Items

- Inservice Inspection of Class 2 and 3 Components (continued)

➢ The ISI program will incorporate the latest edition and addenda of the ASME Boiler and Pressure Vessel Code Section XI approved in 10 CFR 50.55a(b) on the date 12 months before initial fuel load.

➢ Inservice examination of components and system pressure tests conducted during successive 120-month inspection intervals will comply with the requirements of the latest edition and addenda of the Code approved in 10 CFR 50.55a(b) 12 months before the start of the 120-month inspection interval (or the optional ASME Code cases listed in Regulatory Guide 1.147, that are defined in 10 CFR 50.55a(b), subject to the limitations and modifications listed in 10 CFR 50.55a(b)).

Engineered Safety Features COL Information Items

- Protective Coatings

➢ For components which cannot be procured with DBA-qualified coatings applied by the component manufacturer, Calvert Cliffs Unit 3 will do one of the following:

  - Procure the component as uncoated and apply a DBA-qualified coating system in accordance with 10 CFR 50, Appendix B, Criterion IX. The DBA-qualified (i.e., Service Level 1) coating will be applied in accordance with the applicable standards stated in RG 1.54, Rev. 1, except as modified by U.S. EPR FSAR Section 6.1.2.4.
  - Confirm that the DBA-unqualified coating is removed and that the component is recoated with DBA-qualified coatings in accordance with 10 CFR 50, Appendix B, Criterion IX. The DBA-qualified (i.e., Service Level 1) coating will be applied in accordance with the applicable standards stated in RG 1.54, Rev. 1, except as modified by U.S. EPR FSAR Section 6.1.2.4.

Engineered Safety Features COL Information Items

- Protective Coatings (continued)
  - Add the quantity of DBA-unqualified coatings to a list that documents those DBA-unqualified coatings already existing within containment.

Engineered Safety Features COL Information Items

- Containment Leakage Testing

➢ Calvert Cliffs Unit 3 milestone for containment leak rate testing implementation in accordance with 10 CFR 50, Appendix J is prior to initial fuel load.

Engineered Safety Features
COL Information Items

- <u>Habitability Systems – System Operating Procedures</u>

➢ Calvert Cliffs 3 Nuclear Project, LLC and UniStar Nuclear Operating Services, LLC shall provide written emergency planning and procedures for use in the event of a radiological or hazardous chemical release within or near the plant, and will provide training of control room personnel, prior to receipt of fuel onsite at Calvert Cliffs Unit 3.

Engineered Safety Features
COL Information Items

- Habitability Systems – Main Control Room, Radiation Exposure

➢ The main control room (MCR) dose to Calvert Cliffs Units 1 and 2 from a Calvert Cliffs Unit 3 LOCA is less than 2.0 rem total effective dose equivalent (TEDE). This dose is below the regulatory dose acceptance criterion of 5 rem TEDE (GDC 19).

➢ The Calvert Cliffs Unit 3 MCR dose from a LOCA in Calvert Cliffs Unit 1 or 2 will be less than Calvert Cliffs Units 1 and 2 dose from a Calvert Cliffs Unit 3 LOCA, which also meets the regulatory dose acceptance criterion of 5 rem TEDE (GDC 19).

➢ The Calvert Cliffs Unit 3 MCR is equipped with safety-related radiation monitors in the HVAC intake ducts and would isolate the MCR in a timely manner.

➢ The Calvert Cliffs Unit 3 MCR HVAC emergency filtration system design basis accident configuration is described in U.S. EPR FSAR Section 15.0.3.

Engineered Safety Features Departure and Exemption

- Habitability Systems – Main Control Room, Toxic Chemicals

➢ For Calvert Cliffs Unit 3, the detection of toxic gases and subsequent isolation of the Control Room Envelope (CRE) is not required and is not a part of the site-specific design.

  - The evaluation of the Calvert Cliffs Unit 3 toxic chemicals in Calvert Cliffs Unit 3 FSAR Section 2.2.3 did not identify any credible toxic chemical accidents that exceeded the limits established in Regulatory Guide 1.78.
  - No specific provisions are required to protect the operators from an event involving a release of a toxic gas.
  - Therefore, Seismic Category 1/Class 1E toxic gas detectors and isolation are not required and will not be provided at Calvert Cliffs Unit 3.

Chapter 6, Engineered Safety Features Agenda

Engineered Safety Features

- COL Information Items/Site Supplemental Items
- Departures/Exemptions

Conclusions

Conclusions

- COL Information Items, as specified by U.S.EPR FSAR, are addressed in Calvert Cliffs Unit 3 FSAR Chapter 6
- One Departure/Exemption from U.S. EPR FSAR
- No ASLB Contentions
- There are two (2) SER Open Items and responses have been submitted (March 25, 2011).
- There are three (3) Confirmatory Items and they have been incorporated into the COLA.

Acronyms

- ACRS – Advisory Committee on Reactor Safeguards
- ASLB – Atomic Safety & Licensing Board
- ASME – American Society For Mechanical Engineers
- CFR – Code of Federal Regulations
- COL – Combined License
- COLA – COL Application
- CRE – Control Room Envelope
- DBA – Design Basis Accident
- FSAR – Final Safety Analysis Report
- GDC – General Design Criteria
- GSI – Generic Safety Issue
- HVAC – Heating Ventilation and Air Conditioning
- IBR – Incorporate by Reference
- ISI – Inservice Inspection
- MCR – Main Control Room
- QA – Quality Assurance
- RCOLA – Reference COL Application
- RG – Regulatory Guide
- SER – Safety Evaluation Report
- TEDE – Total Effective Dose Equivalent

Presentation to the ACRS Subcommittee

AREVA U.S. EPR Design Certification Application Review

Safety Evaluation Report with Open Items

Chapter 6: Engineered Safety Features

April 5, 2011

Technical Staff Review Team

Containment and Ventilation Branch

- **Walton Jensen**
- **James O'Driscoll**
- **Clinton Ashley**
- **Ann-Marie Grady**
- **Christopher Jackson**

Project Managers:

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- **Jason Carneal**

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- **Michelle Hart**

Component Integrity Branch

- **Eduardo Sastre**
- **Robert Davis**
- **Joel Jenkins**
- **Timothy Steingass**

Reactor Systems, Nuclear Performance, and Code Review Branch

- **John Budzynski**
- **Shanlai Lu**

Overview of DCA

SRP Section/Application Section		No. of Questions	Number of OI
6.1.1	Metallic Materials	21	0
6.1.2	Organic Materials	11	2
6.2.1	Containment Functional Design (with exception of 6.2.1.2)	114	12
6.2.1.2	Subcompartment Analysis*	Not delivered in Phase 2	Not delivered in Phase 2
6.2.2	Containment Heat Removal*	Not delivered in Phase 2	Not delivered in Phase 2
6.2.3	Secondary Containment Functional Design	8	3
6.2.4	Containment Isolation System	12	2

*The safety evaluation for these Sections was not delivered in the Phase 2 SE for Chapter 6.

Overview of DCA (continued)

SRP Section/Application Section		No. of Questions	Number of OI
6.2.5	Combustible Gas Control in Containment	25	6
6.2.6	Containment Leakage Testing	4	0
6.2.7	Fracture Prevention of Containment Pressure Vessel	0	0
6.3	Emergency Core Cooling System	17	2
6.4	Habitability Systems	8	4
6.5	Fission Product Removal and Control Systems	6	4
6.6	Inservice Inspection of ASME Class 2 and 3 Components	2	0
Totals**		**228**	**35**

**Total numbers do not include references to open items in other Sections or Chapters.

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United States Nuclear Regulatory Commission
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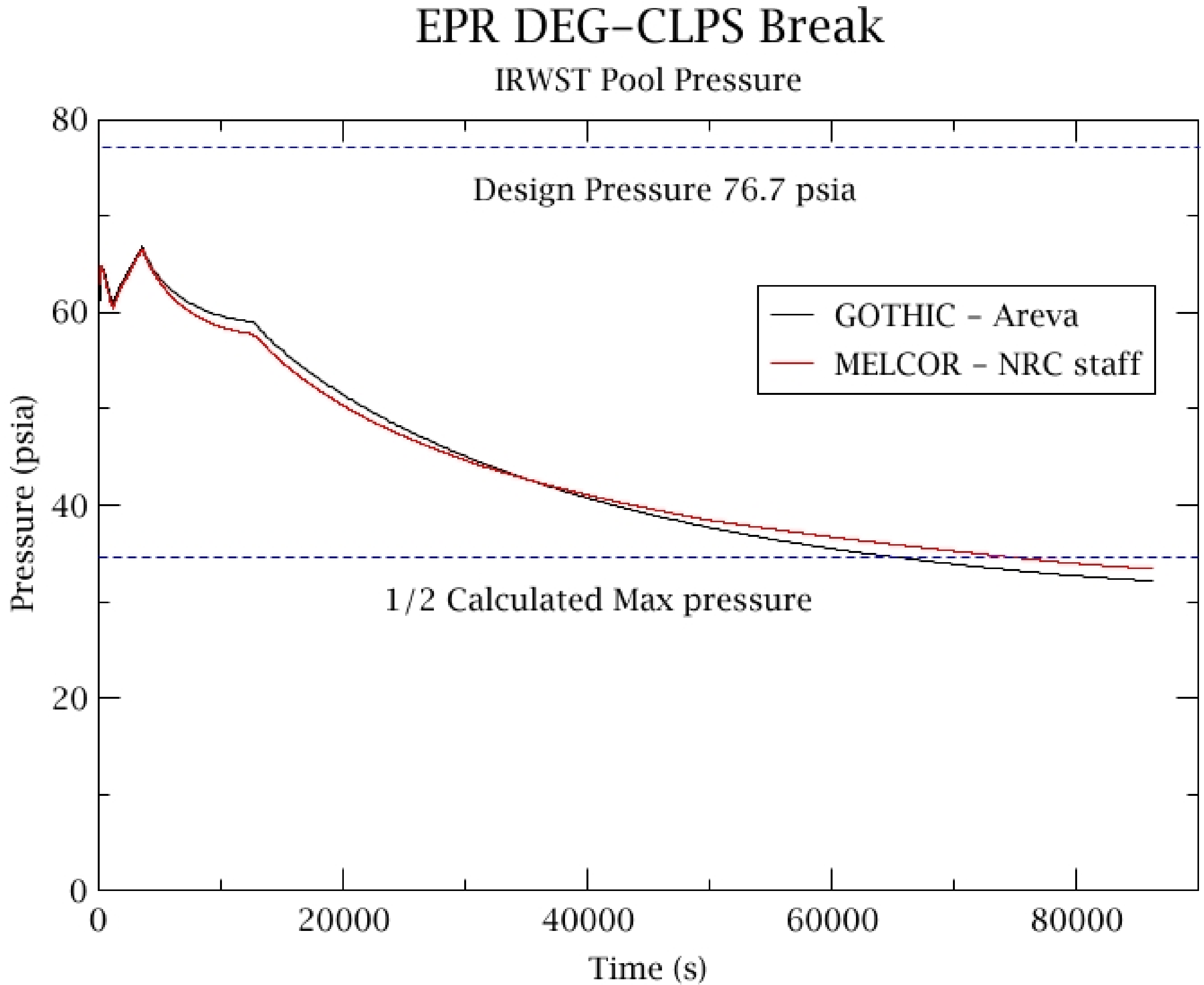
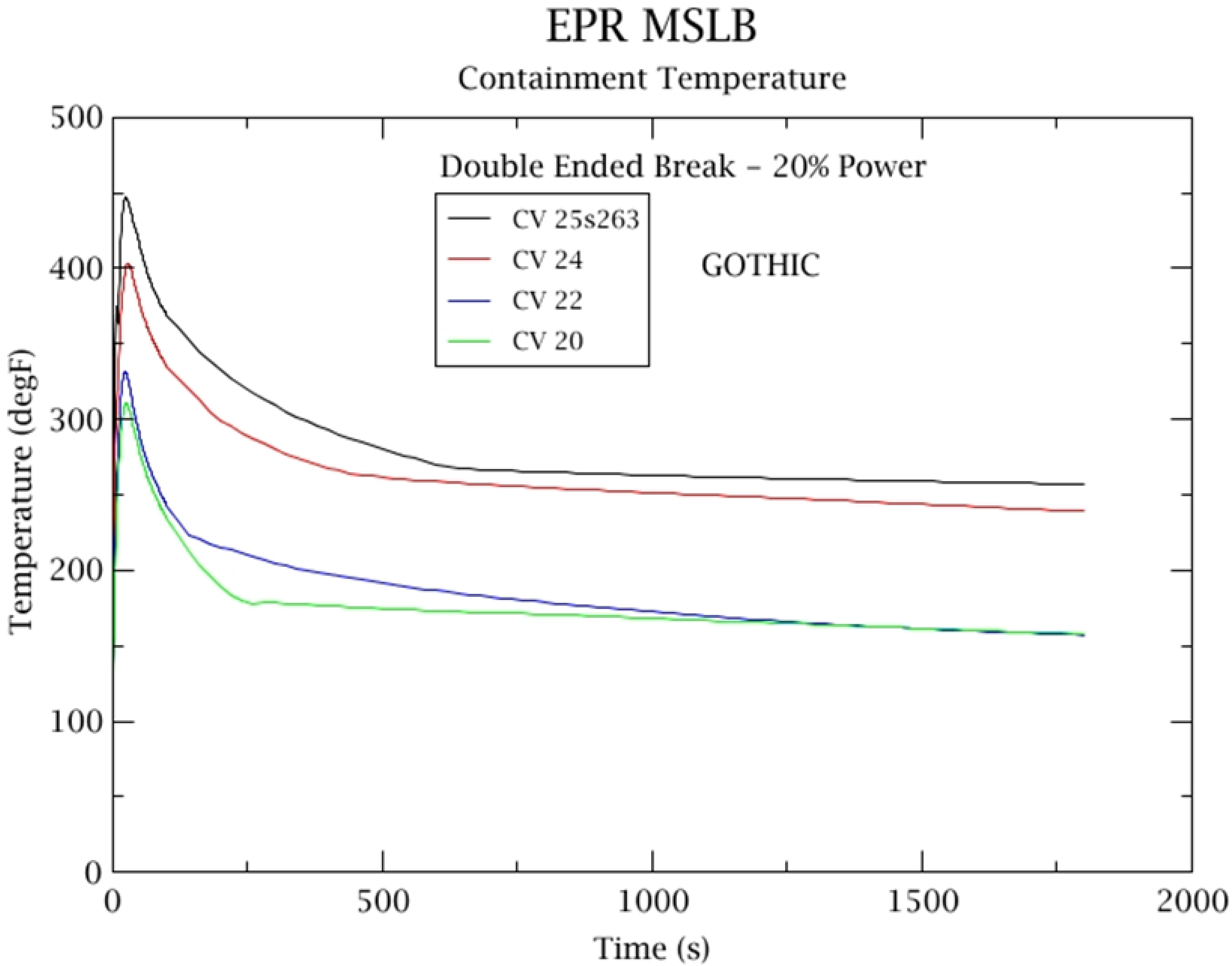
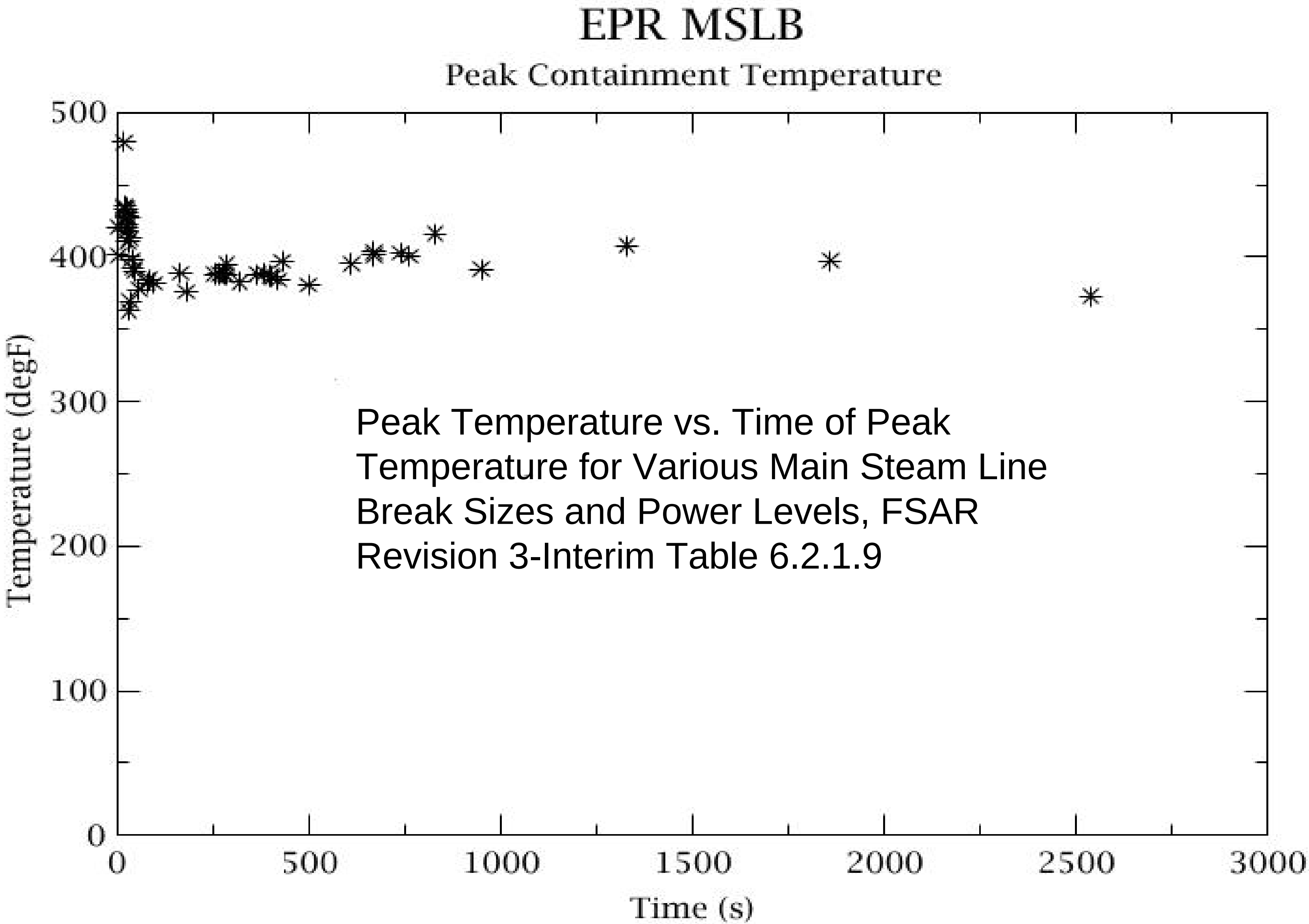
U.S. EPR Containment Evaluation

Containment Functional Design
SRP Section 6.2.1.1, 6.2.1.3 and 6.2.1.4

Walton Jensen
NRO/DSRA/SPCV


EPR DEG–CLPS Break
IRWST Pool Pressure
Design Pressure 76.7 psia
GOTHIC – Areva
MELCOR – NRC staff
1/2 Calculated Max pressure
Pressure (psia)
Time (s)
0
20
40
60
80
0
20000
40000
60000
80000


EPR MSLB
Containment Temperature
Double Ended Break – 20% Power
CV 25s263
CV 24
CV 22
CV 20
GOTHIC
Temperature (degF)
Time (s)
500
400
300
200
100
0
0
500
1000
1500
2000


EPR MSLB
Peak Containment Temperature
Temperature (degF)
Time (s)
0
100
200
300
400
500
0
500
1000
1500
2000
2500
3000
Peak Temperature vs. Time of Peak Temperature for Various Main Steam Line Break Sizes and Power Levels, FSAR Revision 3-Interim Table 6.2.1.9

Containment Modeling Remaining Issues

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- AREVA needs to address NRC requirements for safety related containment doors, foils and dampers in the FSAR. (RAI 368, Questions 06.02.01-70 and 06.02.01-71, RAI 389, Question 06.02.02-49 and RAI 468, Question 6.02.02-83)

- There remain outstanding RAIs concerning input for the 30 Node GOTHIC model as compared with plant dimensional data. (RAI 437, Questions 06.02.01-99 and 06.02.01-100)

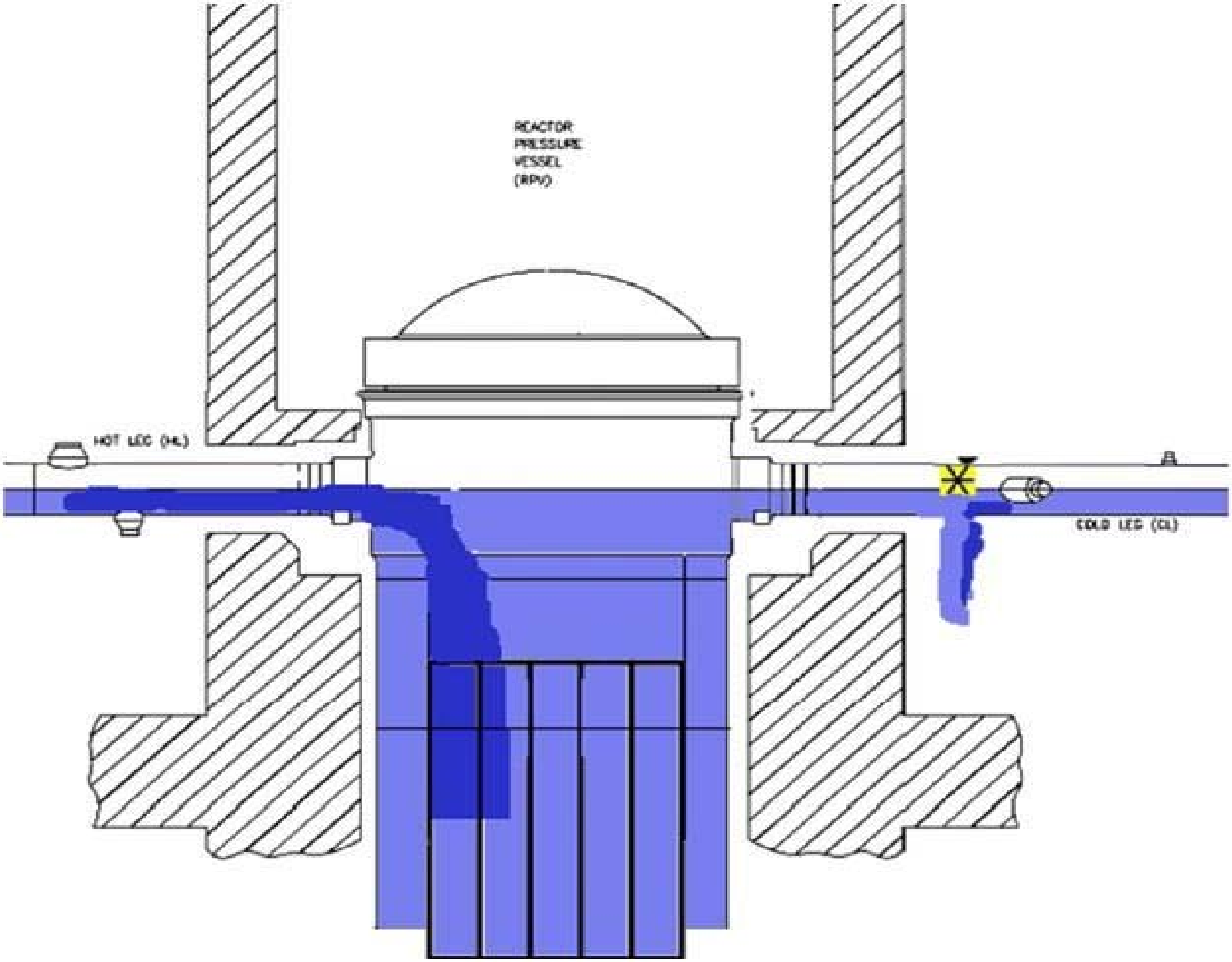
- Additional LOCA scoping calculations need to be provided using the multi-node mode to determine the limiting set of conditions. (RAI 378, Question 06.02.01-93)

- AREVA needs to complete the equipment qualification curve of maximum calculated containment temperatures. (RAI 368, Question 06.02.01-80, and RAI 437, Question 06.02.01-98b)

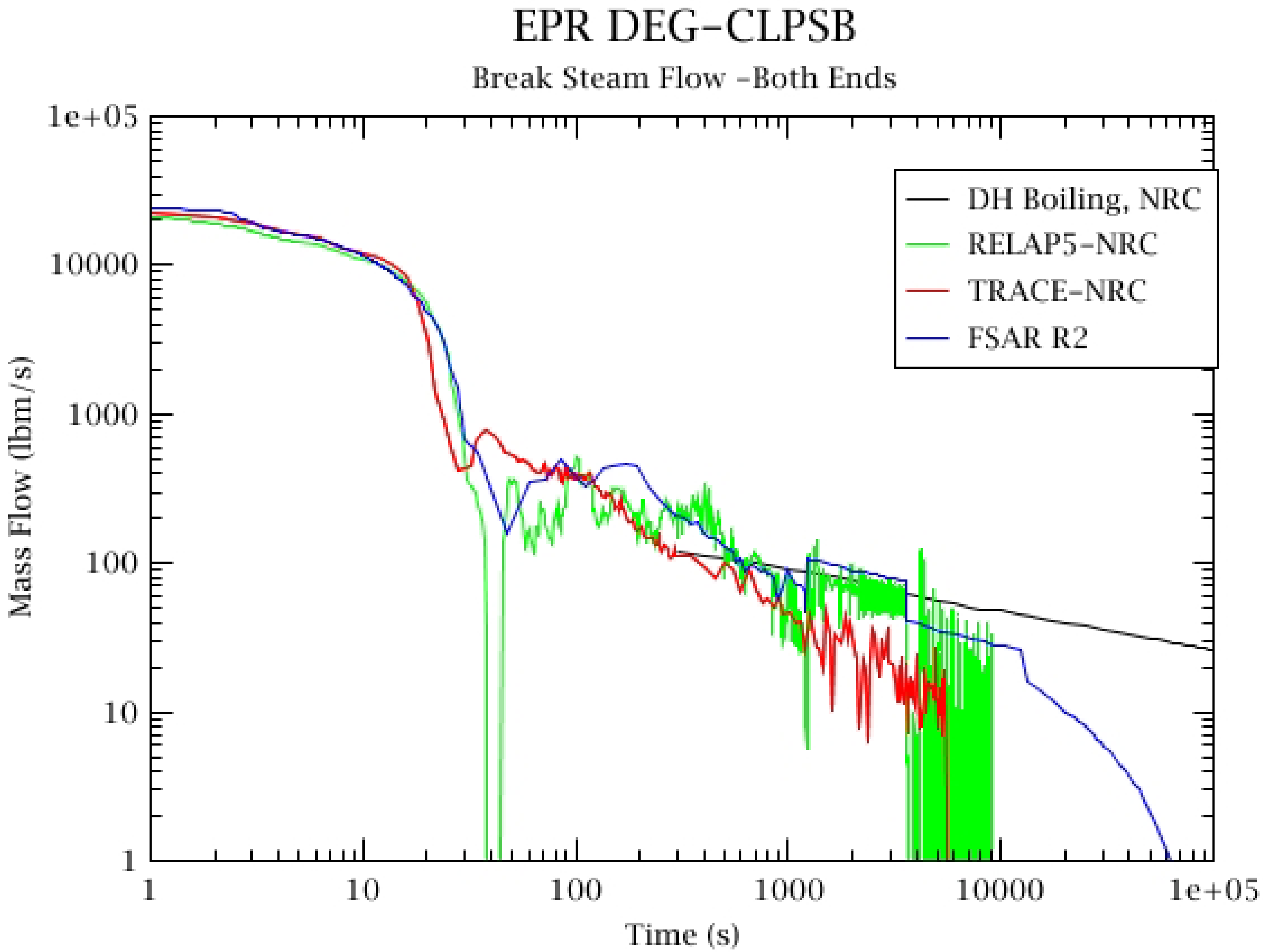
Hot Leg Injection

- Initiated 60 minutes post-LOCA for core boric acid control and steam quenching
- Steam condensation assumed only in upper plenum
- Condensation efficiency shown to be conservative using UPTF data, CCTF data, wall plume calculations, STAR-CD and CATHARE 3D code analyses
- Staff performed analyses using RELAP5 Mod. 3.3 and TRACE which showed AREVA's condensation efficiency to be conservative.

Hot Leg Injection



U.S. EPR DEG - CLPSB



LOCA M&E Remaining Issues

- AREVA needs to investigate the potential for reverse break flow to reduce steam condensation within the reactor system.
(RAI 437, Question 06.02.01-97)

- AREVA needs to investigate two-phase level swell into the steam generators during post reflood to show analytical assumptions conservative. (RAI 389, Question 06.02.02-47)

- AREVA needs to investigate the flow split of liquid from the core into the broken and intact loops during post reflood to show analytical assumptions conservative. (RAI 389, Question 06.02.02-47)

MSLB M&E Remaining Issues

- Validation of SG inventories (RAI 451, Question 06.02.01.04-8)

- Clarify if the containment temperatures in the FSAR Tier 2, Chapter 15.1 assumptions within the EQ curve.
(RAI 437, Question 06.02.01-98b)

- A high containment pressure SG isolation signal was added. Chapter 7.3 needs to be updated accordingly.
(RAI 389, Question 06.02.02-51)

Conclusions

- With exception to the unresolved issues captured as OPEN ITEMS the AREVA U.S. EPR containment analyses appear to follow the SRP guidance.

- The issues remaining to be resolved do not appear to present insurmountable obstacles.

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U.S. EPR Secondary Containment Functional Design Evaluation

SRP Section 6.2.3

James O’Driscoll
NRO/DSRA/SPCV

Description of Open Items

- RAI 378, Question 06.02.03-6: Requests that the applicant provide a more substantive justification that heat will not transfer into the secondary containment from the primary containment, or alternatively, include the heat transferred into the design basis for the sizing of ventilation systems that serve secondary containment spaces.

- RAI 462, Question 06.02.03-7: Requests that the applicant provide the GOTHIC input deck used in the analysis of the pressure and temperature response of the secondary containment to a LOCA in the primary containment. Requests the applicant to clarify if any credit was taken for secondary containment out leakage.

- RAI 462, Question 06.02.03-8: Requests the applicant include the details of the Containment Leak-off system, that was provided in the response to RAI 89 Question 06.02.03-5, in section 6.2.3.2.3 of the FSAR.

Scope of areas and components considered in secondary Containment analysis

NUREG-0800 SRP Acceptance Criterion 1A through E. provides guidance to the staff for evaluation of GDC 16: An analysis of the pressure and temperature response of the secondary containment to a LOCA in the primary containment should be reviewed. This analysis should include all structures that function as secondary containment. Conductive and radiant heat transfer to the secondary containment from the primary containment should be considered.

Staff Evaluation

- The applicant's analysis and RAI responses are focused on heat transfer to the Annulus space surrounding primary containment. Consequently, the applicant considers radiant and conductive heat transfer insignificant due to the large mass of concrete in the RB and the time period considered.
- Open Item
  - RAI 378, Question 06.02.03-6: Requests the applicant justify that heat will not transfer into the secondary containment from the primary containment. RAI 462, Question 06.02.03-7: Requests that the applicant provide the GOTHIC input deck used in the analysis.

Secondary containment out-leakage and bypass leakage

NUREG-0800 SRP Acceptance Criterion 1 A through E. provides guidance to the staff for evaluation of GDC 16: This analysis should not credit secondary containment out-leakage.

Staff Evaluation

- The staff is unclear if credit was taken for secondary containment out-leakage. In addition, the staff needs to verify that the applicant's assertion in the special testing requirements section 6.2.6 of the FSAR, that there is zero bypass leakage from secondary containment, agrees with the definition of secondary containment put forth in 6.2.3 of the FSAR.

- Open Item
    - RAI 462, Question 06.02.03-7: Requests that the applicant provide the GOTHIC input deck used in the analysis. RAI 462, Question 06.02.03-8 requests the applicant include the details of the Containment Leak-off system, that was provided in the response to RAI 89 Question 06.02.03-5, in section 6.2.3.2.3 of the FSAR.

Conclusions

- Guard pipes placed on high energy lines protect against dynamic effects that may result in pipe failures in the RSB.
- A Ventilation system that serves a secondary containment space (AVS) meets the guidance for ESF filter systems and will be periodically tested.
- The analysis of secondary containment appear to follow the SRP guidance, with the exception of the open items noted above.
- The scope of areas credited as secondary containment is unclear, however issues remaining to be resolved do not appear to present insurmountable obstacles.

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U.S. EPR Containment Isolation System and Combustible Gas Control in Containment

SRP Sections 6.2.4 and 6.2.5

Anne-Marie Grady
NRO/DSRA/SPCV

April 5, 2011

Containment Isolation Valves (CIVs)

FSAR Tier 2, Section 6.2.4 commits to GDC 55, GDC 56, and GDC 57 require that isolation valves outside containment be located as close to the containment as practical.

Open Item

- RAI 479, Question 06.02.04-11 requests that the applicant provide the distance from each CIV outside containment to the containment, add this information to the FSAR Tier 2, Table 6.2.4-1, “Containment Isolation Valve and Actuator,” and provide an ITAAC for each outboard CIV for this distance in the respective sections in FSAR Tier 1.

3-foot diameter opening

The containment design must include one or more dedicated containment penetrations that are equivalent in size to a single 3-foot diameter opening as specified by 10 CFR 50.34(f)(3)(iv). FSAR Tier 2, Section 19.2.3.3.8, "Containment Venting," states that an existing containment penetration will be used to meet this requirement. In a May 13, 2009, response to RAI 181, Question 19-271, the applicant stated that the dedicated penetration will have a diameter of 91.44 cm (36 in.).

Staff Evaluation

- The staff finds that the proposed 91.44 cm (36 in.) diameter dedicated penetration meets the regulatory requirement as specified by 10 CFR 50.34(f)(3)(iv). However, the required size of the penetration is not included in FSAR Tier 2, Table 6.2.4 1 and needs to be specified.

Open Item

- RAI 479, Question 06.02.04-12 requests that the applicant add this information to the FSAR Tier 2, Table 6.2.4-1.

U.S. EPR DCA – Section 6.2.5

Combustible Gas Control in Containment

- CGCS controls H_2 concentrations in containment after a DBA or an SA

- CGCS relies on SR foils and dampers, and non-SR passive autocatalytic recombiners (PARs), and H_2 monitors

- 10 CFR 50.44(c) requires:
- DBA – mixed containment atmosphere – H_2 concentration LT 4% - 24 hrs
- SA – mixed containment atmosphere – H_2 concentration LT 10% - 24 hrs - Equipment for SAM must survive H_2 burning - reliable H_2 monitoring - containment structural integrity following H_2 burn - based on H_2 release from 100% fuel clad-coolant interaction

- For DBA analysis – containment well mixed, H_2 concentration LT 4% for 24 hrs, no credit taken for PARs. Staff confirmatory calculation agrees.

U.S. EPR DCA – Section 6.2.5

- For SA analysis - applicant find well mixed containment with H_2 LT 10%
- Staff analysis results less well mixed, several compartments with H_2 GT 10%, based on 100% PAR efficiency.
- PAR performance dominates results.
- Open Item RAI 471, Questions 06.02.05-20 through 06.02.05-24 addresses MAAP4 input including: PAR recombination rates and efficiencies credited; timing of H_2 release; number of open foils, dampers and doors.
- Open Item RAI 474, Question 06.02.05-25 addresses test specification for PAR performance in a SA environment, including : temperature; pressure; steam concentration; effects of spray and line break; aerosols generated by a molten core, such as iodine, tellurium, cesium and antimony; borated water; HNO_3 and HCl from radiolysis; coking; effects of radiation, operational vibrations, welding and solvent fumes; and, functionality of PARs after H_2 ignition and deflagration.

U.S. EPR DCA Section 6.2.5

- Open Item RAI 473, Question 06.02.05-24 addresses pressure, temperature in containment during a H_2 burn for equipment survivability
- Open Item RAI 411, Question 14.03.11-4 addresses addition of high range H_2 monitors to FSAR Tier 1, for SAM
- ITAAC confirms existence, location of PARs, foils, dampers, low range H_2 monitors

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U.S. EPR Emergency Core Cooling System

SRP Section 6.3

Clinton Ashley
NRO/DSRA/SPCV

John Budzynski
NRO/DSRA/SRSB

April 5, 2011

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Gas Accumulation in the ECCS

Generic Letter (GL) 2008-01

- **Discussed gas accumulation events & pathways (operating plants)**
- **Action: Licensee to evaluate safety systems to adequately address gas accumulation/intrusion:**

  Licensing basis, design, testing, and corrective actions

Interim Staff Guidance (ISG)-019

- **Address Gas Accumulation Issues in Safety Related Systems**
  1. **Potential Gas Accumulation Locations & Intrusion Mechanisms**
  2. **P&ID and Isometric Drawing Confirmation (Part of ITAAC)**
  3. **Surveillance and Venting Procedures**
- **RAI 310 Questions 06.03-12 and 06.03-13**
  1. **Applicant identified potential pathways & corrective actions**

     - High point vents in the SIS/RHRS lines

     - TS SR 3.5.2.2, (all modes of plant operations)

Open Item (RAI 480, Question 06.03-17)

- **Applicant to provide ITAAC that satisfies the guidance in ISG-019**

NPSH assessment and Containment Accident Pressure

AREVA responded to a RAI 212, Question 6.03-6 – related to NPSH and stated the following: AREVA NP elected to use the saturation pressure corresponding to the peak calculated IRWST temperature, instead of the containment pressure prior to the postulated accident as recommended by RG 1.82. This is justified since the containment pressure prior to the postulated accident (atmospheric) is not realistic for the peak calculated IRWST temperature of 230ºF. The realistic pressure above the IRWST is the saturation pressure corresponding to the peak IRWST temperature.

Staff Evaluation

- The calculations cited by the applicant do not follow the recommendations of RG 1.82. The applicant has not yet provided a complete evaluation of NPSH using appropriate assumptions, including the use of containment accident pressure (CAP).

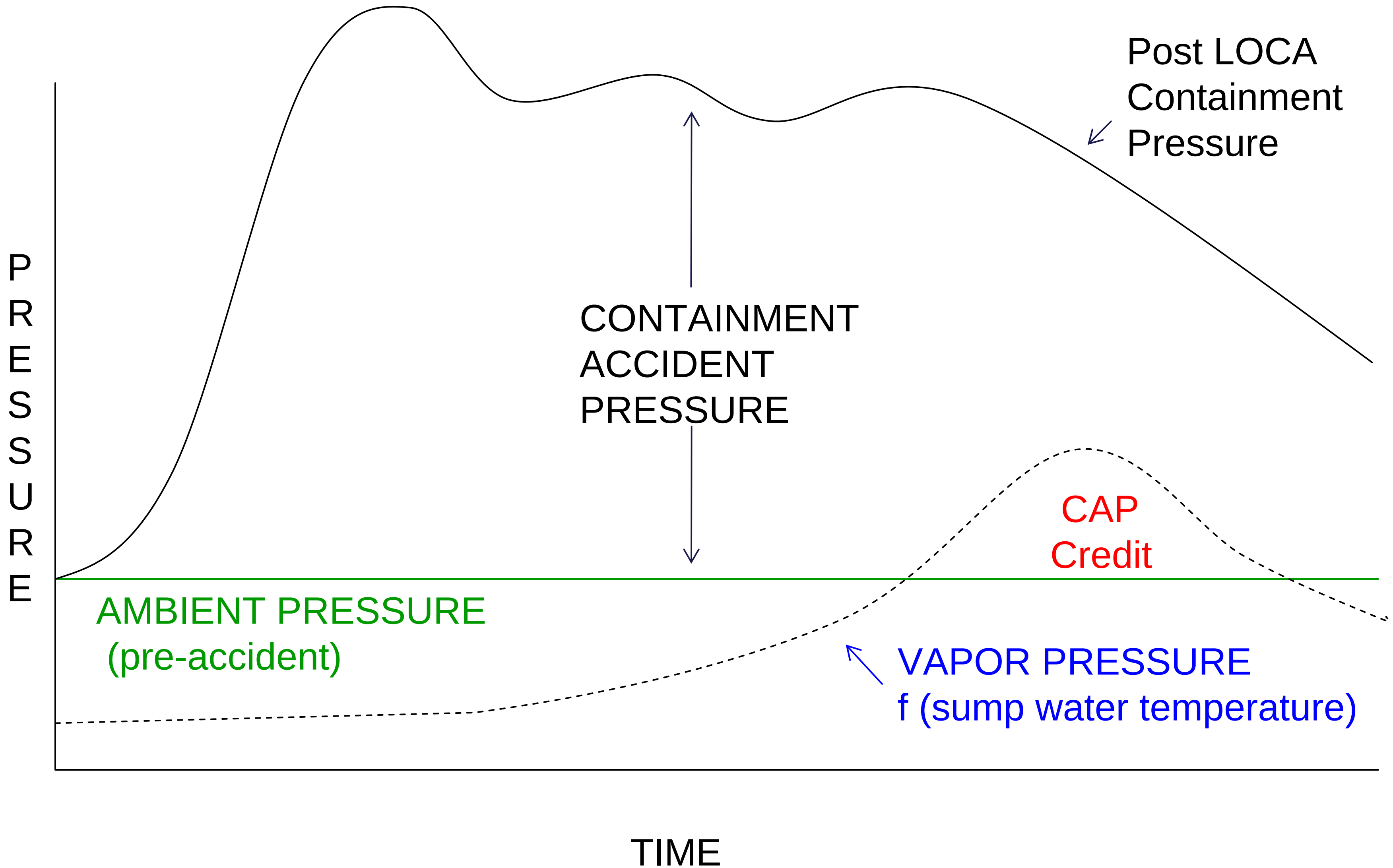
Open Item

- RAI 416, Questions 06.03-15 requests that the applicant justify why the selected approach, use of CAP to support ECCS NPSH analysis, is acceptable.

CAP and NPSHa

- U.S. EPR uses containment pressure greater than what is present before the accident for calculating NPSH available (NPSHa).
- U.S. EPR assumes containment pressure equals the vapor pressure of the IRWST liquid for IRWST temperatures above 212°F.

$NPSH_a = H_{containment} + H_{static} - H_{loss} - H_{vapor}$



Staff Review

- Staff issued RAIs on the U.S. EPR deviation from regulatory guidance (RAI 416, question 06.03-15; RAI 468, question 06.02.02-82).
  - Staff plans to perform confirmatory analysis to assess use of CAP credit.
  - Staff recognizes that for a given IRWST temperature, in order for the water to exist as a liquid, a corresponding pressure must be present at least equal to the vapor pressure for the given water temperature.
- According to SECY 11-0014, many operating PWRs use vapor pressure as CAP credit.

Staff Review

- Staff issued an RAI requesting AREVA perform a risk assessment of NPSH CAP credit. (RAI 457 question 06.02.02-81).
  - Risk information to address:
    - Plant accident conditions where CAP credit is used to demonstrate reliable operation of the ECCS (SIS) pumps.
    - Operator actions (if any).
    - Impaired containment integrity.

Summary

- Staff is requesting additional information concerning AREVAs use of CAP credit
  - includes risk information.

- Limiting NPSH CAP credit to the vapor pressure of the IRWST fluid for IRWST temperatures above 212°F is a mechanistic assumption and consistent with many operating PWRs.

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U.S. EPR Habitability Systems

SRP Section 6.4

James O'Driscoll
NRO/DSRA/SPCV

Description of Open Items

- RAI 462, Question 06.04-5: Requests that the applicant add design details of the proposed TSC, provided in RAI 24, Question 13.03-3, to FSAR Tier 2 Section 6.4, along with more explicit statements of compliance with NUREG-0696 as it applies to guidance for TSC habitability and TSC size.

- RAI 462, Question 06.04-6: Requests that the applicant clarify the purpose of a separate CRE overpressure acceptance criterion for normal lineup added in FSAR revision 2. The RAI also requests the applicant justify the practicality of periodic tests to verify this criterion. The RAI also requests the applicant clarify conflicting information in other sections of the FSAR due to this change.

Description of Open Items (continued)

- RAI 462, Question 06.04-7: Requests that the applicant clarify and make consistent several sections of FSAR that describe how the CRE will respond to a toxic gas event. The RAI also asks the applicant to clarify what aspects of toxic gas detection and response is addressed and is to be in the standard design FSAR.

- RAI 462, Question 06.04-8: Requests that the applicant to clarify the FSAR to clearly state either the CRE design limit for boundary inleakage, or the CRE unfiltered ASTM E-741 test acceptance criteria.

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TSC Design Details

Because the standard design includes a proposed TSC located within the CRE, the staff has included a review of the proposed TSC against guidance criteria on TSC size and habitability contained in NUREG-0696, "Function Criteria for Emergency Response Facilities" sections 2.4 and 2.5.

Staff Evaluation

- The FSAR should state the TSC design details such a size, provided in earlier RAI responses such that it will be apparent that the TSC size will be sufficient to accommodate staffing levels stated in the guidance. In addition, statements in the FSAR regarding CRE habitability as it applies to Occupancy and CO_2 production should address conditions where both the TSC as well as the MCR are manned at staffing levels recommended by the guidance.

- Open Item
  - RAI 462, Question 06.04-5: Requests that the applicant add design details of the proposed TSC, provided in RAI 24, Question 13.03-3, to FSAR Tier 2 Section 6.4, along with more explicit statements of compliance with NUREG-0696 as it applies to guidance for TSC habitability and TSC size.

New CRE Normal Operating Overpressure Acceptance Criterion

FSAR Revision 2 Tier 1 modifies the Acceptance criterion of ITAAC Table 2.6.1-3 item 6.1 to include a normal operating positive pressure of 0.01 inches of water gauge. NEI 99-03, cited by RG 1.197 provides the technical basis for 0.125 inches of water as the minimum positive pressure that must be demonstrated in order to assure control room envelope integrity.

Staff Evaluation

- The changes that were made in FSAR Revision 2 makes it unclear to what degree a positive pressure will be maintained in the MCR during normal operation. The staff is also unclear on what guidance will be used to develop and justify periodic tests to verify this parameter, and assure MCR integrity.

- Open Item
  - RAI 462, Question 06.04-6: Requests that the applicant clarify the purpose of a separate CRE overpressure acceptance criterion for normal lineup added in FSAR revision 2. The RAI also requests the applicant justify the practicality of periodic tests to verify this criterion. The RAI also requests the applicant clarify conflicting information in other sections of the FSAR due to this change.

Section 6.4 – CRE Toxic Gas Equipment

Clarify Toxic Gas Equipment an related CRE features to be reviewed in the EPR standard design

FSAR Revision 2 Tier 2 section 6.4.2.4 includes changes that prescribe manual as opposed to automatic isolation of the CRE upon detection of toxic gas. This change is inconsistent with other section of the FSAR that indicate automatic CRE isolation upon detection. Manual isolation of the CRE appears to be inconstant with RG 1.78 section 4.2.

Staff Evaluation

- The Changes that were made in FSAR Revision 2 makes it unclear how the CRE will respond to a toxic gas event.
- Open Item
  - RAI 462, Question 06.04-7: Requests that the applicant clarify and make consistent several sections of FSAR that describe how the CRE will respond to a toxic gas event. The RAI also asks the applicant to clarify what aspects of toxic gas detection and response is addressed and is to be in the standard design FSAR.

Section 6.4 – CRE design Inleakage

Clarify The design basis CRE inleakage value

FSAR Revision 2 Tier 2 section 6.4.2.3, "Leak-tightness" states that the CRE boundary limits leakage from adjacent environmental zones to a maximum of 50 cfm unfiltered-inleakage.

Staff Evaluation

- The FSAR in section 6.4 should clearly state either the CRE design limit for boundary inleakage or 2) the CRE unfiltered inleakage ASTM E-741 test acceptance criteria.
- Open Item
  - RAI 462, Question 06.04-8: Question 06.04-8: Requests that the applicant to clarify the FSAR to clearly state either the CRE design limit for boundary inleakage, or the CRE unfiltered ASTM E-741 test acceptance criteria. The RAI also requests that Tier 1 Table 2.6.1-3 Main Control Room Air Conditioning System ITAAC item 6.4 Acceptance Criteria be clarified to state that the test confirms that the unfiltered air in-leakage inside the CRE area boundary is less than or equal to 50 cfm total, which includes 10 cfm allocated for unfiltered in-leakage due to CRE access/egress.

U.S. EPR Engineered Safety Feature Filter Systems

SRP Section 6.5.1

James O'Driscoll
NRO/DSRA/SPCV

Description of Open Items

- RAI 462, Question 06.05.01-2: Requests that the applicant add details of the design, inspection and testing of ESF filters systems to the FSAR. This design information was described in response to RAI 233 Question 06.05.01-1

- RAI 462, Question 06.05.01-3: Requests that the applicant clarify the FSAR description of the moisture separator for the AVS, CRACS and Containment Building Low Flow Purge Exhaust filtration trains. It also requests the applicant provide details of applicable industry codes and standards used in design and details of provisions for drainage from demister sections.

- RAI 462, Question 06.05.01-4: Requests that the applicant clarify the FSAR minimum inventory of alarms displays and controls for each ESF filter system.

- RAI 462, Question 06.05.01-5: Requests that the applicant provide additional design information in the FSAR in order for the staff to evaluate compliance with codes and standards endorsed in Regulatory Guide 1.52

Section 6.5.1 – ESF Filter Systems

Clarify the design details of ESF filter systems

The EPR ESF filter systems are designed to meet ASME AG-1-2003 “Code on Nuclear Air and Gas Treatment Systems ASME N509 “Nuclear Power Plant Air-Cleaning Units and Components” standards. The 1997 and the 1989 versions of these codes, respectively, are endorsed by the current regulatory guidance.

Staff Evaluation

- The staff requires additional design information in order determine the equivalency of these codes as they apply to the EPR design. Additional design information is also needed in order to evaluate specific design features, such as alarms and controls against specific SRP review criteria.

- Open Item
  - RAI 462, Questions 06.05.01-2,3,4,5 request that the applicant provide and document specific design information in the FSAR.

Acronyms

- AVS- Annulus Ventilation System
- CAP – Containment Accident Pressure
- CFR – Code of Federal Regulations
- CIV – Containment Isolation Valve
- COL – combined license
- CLPSB – cold leg pump suction break
- CRE- Control Room Envelope
- DEG – double-ended guillotine
- ECCS – Emergency Core Cooling System
- EQ – equipment qualification
- ESF- Engineered Safety Feature
- FSAR – Final Safety Analysis Report
- GDC – General Design Criteria
- IRWST – in-containment refueling water storage tank
- ITAAC – inspections, test, analyses, and acceptance criteria
- LOCA – loss of coolant accident
- MCR- Main Control Room
- MSLB – main steam line break
- NPSH – net positive suction head
- PAR – passive autocatalytic recombiner
- RAI – request for additional information
- RB – Reactor Building
- RG – Regulatory Guide
- RSB- Reactor Shield Building
- SA – severe accident
- SER – Safety Evaluation Report
- SG – steam generator
- SR – surveillance requirement
- SRP – standard review plan
- TS – Technical Specification
- TSC- Technical Support Center

Presentation to the ACRS Subcommittee

UniStar Calvert Cliffs Nuclear Power Plant (CCNPP) Unit 3
COL Application Review

Safety Evaluation Report

CHAPTER 6: ENGINEERED SAFETY FEATURES

April 5, 2011

Order of Presentation

- **Surinder Arora** – Calvert Cliffs COLA Lead PM
- **UniStar** – RCOL Applicant
- **Jason Carneal** – Chapter 6 PM
- **Technical Staff**

Major Milestones Chronology

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07/13/2007	Part 1 of the COL Application (Partial) submitted
12/14/2007	Part 1, Rev. 1, submitted
03/14/2008	Part 1, Rev. 2, & Part 2 of the Application submitted
06/03/2008	Part 2 of the Application accepted for review (Docketed)
08/01/2008	Revision 3 submitted
03/09/2009	Revision 4 submitted
06/30/2009	Revision 5 submitted
07/14/2009	Initial Review schedule milestones published
09/30/2009	Revision 6 submitted
04/12/2010	Phase 1 review completion milestone
12/20/2010	Revision 7 submitted
January 2011	ACRS Sub Committee review complete on Chapters 2 part 1, 4, 5, 8,10, 11,12, 16, 17 & 19

Review Schedule
(Public Milestones)

Phase - Activity	Target Date
Phase 1 - Preliminary Safety Evaluation Report (SER) and Request for Additional Information (RAI)	April 2010 (Actual)
Phase 2 - SER with Open Items	November 2011
Phase 3 – Advisory Committee on Reactor Safeguards (ACRS) Review of SER with Open Items	February 2012
Phase 4 - Advanced SER with No Open Items	June 2012
Phase 5 - ACRS Review of Advanced SER with No Open Items	October 2012
Phase 6 – Final SER with No Open Items	January 2013

NOTE: The target dates shown above are currently published milestones. The target dates are periodically reviewed and are subject to revision.

ACRS Phase 3 Review Plan

U.S.NRC
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FSAR CHAPTERS BY COMPLETION DATES

Chapter(s)	Completion Date	Subcommittee Meeting
8	1/6/2010	2/18/2010
4 5 12 17 19	3/24/2010 3/22/2010 3/19/2010 3/12/2010 4/19/2010	4/20/2010 4/20/2010 4/20/2010 4/20/2010 5/21/2010
10 11 16	6/11/2010 10/30/2010 10/11/2010	11/30/2010
2 (Group 1)	10/29/2010	1/12/2011
6	4/1/2011	4/5/2011
1, 2 (Group 2), 3, 7, 9, 13, 14, 15, 18	Various	Meeting dates not yet finalized

Technical Staff Review Team

- **Christopher Jackson**
  Containment and Ventilation Branch
- **Ann-Marie Grady**
  Containment and Ventilation Branch
- **Michelle Hart**
  Reactor Siting and Accident Consequence Branch
- **Eduardo Sastre**
  Component Integrity Branch
- **Robert Davis**
  Component Integrity Branch
- **Timothy Steingass**
  Component Integrity Branch

Project Managers:

- **Surinder Arora**
- **Jason Carneal**

Overview of COLA Review

SRP Section/Application Section		No. of Questions	Number of OI
6.1.1	Metallic Materials	1	0
6.1.2	Organic Materials	3	0
6.2.1*	Containment Functional Design*	Review not complete	Review not complete
6.2.2*	Containment Heat Removal*	Review not complete	Review not complete
6.2.3	Secondary Containment Functional Design	IBR	IBR
6.2.4	Containment Isolation System	IBR	IBR
6.2.5	Combustible Gas Control in Containment	IBR	IBR

*The safety evaluation for these Sections was not delivered in the Phase 2 SE for Chapter 6.

Overview of COLA Review (continued)

SRP Section/Application Section		No. of Questions	Number of OI
6.2.6	Containment Leakage Testing	0	0
6.2.7	Fracture Prevention of Containment Pressure Vessel	IBR	IBR
6.3*	Emergency Core Cooling System*	Review not complete	Review not complete
6.4	Habitability Systems	6	2
6.5	Fission Product Removal and Control Systems	IBR	IBR
6.6	Inservice Inspection of ASME Class 2 and 3 Components	0	0
Totals**		**10**	**2**

*The safety evaluation for these Sections was not delivered in the Phase 2 SE for Chapter 6.

**Total numbers do not include references to open items in other Sections or Chapters.

COL Information Items

- COL Information Item No. 6.4-1

  A COL applicant that references the U.S. EPR design certification will identify the type(s) of Seismic Category I Class IE toxic gas sensors (i.e., the toxic chemical(s) of concern) necessary for control room operator protection.

- COL Information Item No. 6.4-2

  A COL applicant that references the U.S. EPR design certification will provide written emergency planning and procedures in the event of a radiological or a hazardous chemical release within or near the plant, and will provide training of control room personnel.

COL Information Items (cont)

- <u>COL Information Item No. 6.4-3</u>

  A COL applicant that references the U.S. EPR design certification will evaluate the results of the toxic chemical accidents from Section 2.2.3 and address their impact on control room habitability in accordance with RG 1.78.

- <u>COL Information Item No. 6.4-4</u>

  A COL applicant that references the U.S. EPR design certification will confirm that the radiation exposure of main control room occupants resulting from a design basis accident at a nearby unit on a multi-unit site is bounded by the radiation exposure from the postulated design basis accidents analyzed for the U.S. EPR or confirm that the limits of GDC 19 are met.

Toxic Gas

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- COL Information Items 6.4-1 and 6.4-3 deal with toxic gas.
- The staff's review of COL FSAR Section 2.2.3 confirmed that there are no hazardous chemicals or toxic gas accidents that need to be considered.
- One chemical, hydrochloric acid, was identified as having the potential for challenging the control room habitability.
- The staff performed independent calculations for this chemical and confirmed the COL applicant's assertion that no design-basis toxic gas threat exists.

Toxic Gas (cont) Staff Confirmatory Analyses

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- Confirmatory analyses performed for staff by NUMARK (ML101050259).
- The analysis was completed using the NRC HABIT code (Version 1.1) with a special version of EXTRAN.
- The analysis was performed consistent with the guidance in RG 1.78 “Evaluating the Habitability of a Nuclear Power Plant Control Room During a Postulated Hazardous Chemical Release.”
- Multiple runs were performed with HABIT using various air stability and wind speeds to match the sensitivity analysis performed by Unistar.
- Both Unistar and staff analysis showed control room concentrations well below IDLH.

Toxic Gas (cont)

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- COL Information Item 6.4-1 specifically addresses hardware – as such, a Tier 1 and Tier 2 departure as well as an exemption are necessary.
- Exemption is being processed in Chapter 9.4.1 of the staff’s safety evaluation.

Procedures and Training

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- COL Information Item 6.4-2 deals with procedures and training.
- The implementation schedule is acceptable to the staff.
- Level of detail not sufficient to establish conformance with RG 1.196.
- The COL applicant should provide in the COL FSAR the essential elements of the training program and procedures to facilitate staff review and show compliance with applicable regulatory requirements and conformance to the guidance in RG 1.196.
- This item is being tracked as an Open Item in RAI 296, Question 06.04-5.

Units 1 and 2 Impacts

- The applicant stated that the U.S. EPR radiation exposure analysis bounds exposure from Unit 1 and Unit 2. However, insufficient details were provided to demonstrate this.
- The staff requested the applicant justify that the U.S. EPR radiological evaluation bounds radiation exposure from postulated DBAs at Unit 1 or 2.
- Additionally, the Unit 3 FSAR should not discuss doses in the Unit 1 and 2 control room. The staff has requested that the applicant revise the COL FSAR.
- These items are tracked as an Open Item in RAI 296, Question 06.04-6.

Conclusion

- Two Open Items remain
  - Open item associated with training and procedures.
  - Open Item associated with Unit 1 and 2 impacts
- Exemption and departure need to be processed under Chapter 9 review.
- Remainder of the Section 6.4 application is acceptable to the staff.

Acronyms

- COL – combined license
- COLA – combined license application
- DBA – design basis accident
- FSAR – Final Safety Analysis Report
- GDC – General Design Criteria
- IBR – incorporated by reference
- IDLH – immediately dangerous to life or health
- SER – Safety Evaluation Report
- RAI – request for additional information
- RCOL – reference combined license