Official Transcript of Proceedings

NUCLEAR REGULATORY COMMISSION

Title: Advisory Committee on Reactor Safeguards
ESBWR Subcommittee: Open Session

Docket Number: (n/a)

Location: Rockville, Maryland

Date: Wednesday, May 19, 2010

Work Order No.: NRC-266 Pages 1-89

NEAL R. GROSS AND CO., INC.
Court Reporters and Transcribers
1323 Rhode Island Avenue, N.W.
Washington, D.C. 20005
(202) 234-4433

DISCLAIMER

UNITED STATES NUCLEAR REGULATORY COMMISSION'S
ADVISORY COMMITTEE ON REACTOR SAFEGUARDS

The contents of this transcript of the proceeding of the United States Nuclear Regulatory Commission Advisory Committee on Reactor Safeguards, as reported herein, is a record of the discussions recorded at the meeting.

This transcript has not been reviewed, corrected, and edited, and it may contain inaccuracies.

UNITED STATES OF AMERICA

NUCLEAR REGULATORY COMMISSION

+ + + + +

ADVISORY COMMITTEE ON REACTOR SAFEGUARDS

(ACRS)

+ + + + +

SUBCOMMITTEE ON ESBWR

OPEN SESSION

+ + + + +

WEDNESDAY, MAY 19, 2010

+ + + + +

ROCKVILLE, MARYLAND

The Subcommittee convened at the Nuclear Regulatory Commission, Two White Flint North, Room T2B1, 11545 Rockville Pike, Rockville, Maryland at 8:30 a.m., Dr. Michael Corradini, Chairman, presiding.

SUBCOMMITTEE MEMBERS PRESENT:

MICHAEL CORRADINI, Chair

SAID ABDEL-KHALIK

J. SAM ARMIJO

MARIO V. BONACA

MICHAEL T. RYAN

WILLIAM J. SHACK

JOHN D. SIEBER

JOHN W. STETKAR

CONSULTANTS TO THE SUBCOMMITTEE PRESENT:

THOMAS S. KRESS

GRAHAM WALLIS

NRC STAFF PRESENT:

CHRISTOPHER L. BROWN, Designated Federal Official

DENNIS GALVIN

JAMES O'DRISCOLL

JOHN McKIRGAN

ED FORREST

SYED HAIDER

ALSO PRESENT:

ANTONIO BARRETT

PETER YANDOW

LLOYD HECKLE (via teleconference)

T-A-B-L-E O-F C-O-N-T-E-N-T-S

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

8:28 a.m.

CHAIR CORRADINI: Okay. Why don't we get started? This meeting will come to order.

This is the second day of our Advisory Committee or Subcommittee meeting of the Advisory Committee on Reactor Safeguards on the ESBWR.

My name is Mike Corradini, Chair of the Subcommittee. In attendance today is a massive group of Subcommittee Members: Jack Sieber, John Stetkar, Sam Armijo, Said Abdel-Khalik, Mike Ryan eventually, Bill Shack and Mario Bonaca, as well as our consultants, Tom Kress and Graham Wallis.

Just to review to everybody, this is the second day of a meeting to discuss final SERs on license topical reports relating to fuel design.

Yesterday and today on the 72 hour safety-related battery qualification and resolution of issues for control room habitability for the ESBWR.

The Subcommittee will hear presentations and hold discussions with representative of the NRC staff, as well as the ESBWR applicant, GEH, regarding these matters.

Let me point out that Chris Brown is again our Designated Federal Official for this meeting.

And as usual, the Rules of Participation for today's meeting were announced as part of the notice of this meeting published in the Federal Register on May 7^{th}. Portions of the meeting will be closed to protect information that is proprietary to GEH and its contractors pursuant to 5 USC 552(B)(c)(4). I guess parenthetically, I'll ask GEH or the staff to alert us when that is going to occur, so we properly check the room to make sure that it has satisfied the closed portion of the meeting.

A transcript of the meeting is being kept and will be available as stated in the Federal Register and it is requested, as usual, that speakers identify themselves, first, and speak with sufficient clarity and volume, so that we can hear you.

Please, silence all cell phones and Blackberrys.

And we have not received any requests from member of the public to make oral statements. And my understanding is the bridge-line is open and we have folks from Wilmington representing GEH on the line and will come in as needed for their help in answering questions during our discussion.

I'll simply point out to our current present Members of the Committee, compared to yesterday, we completed our look at the fuel design, associated neutronics, gammathermometry, as well as control design yesterday.

And our focus today is on the safety-related battery qualification and new information in terms of resolution of issues for control room habitability.

Let's proceed. I'll turn to Amy Cubbage, Branch Chief, Acting Branch Chief and lead PM, to get us going.

UNIDENTIFIED SPEAKER: We're closed. We're going to be in closed.

CHAIR CORRADINI: And were closed from the beginning?

MS. CUBBAGE: We will be closed from the beginning, yes.

(Whereupon, at 8:31 a.m. a recess until 10:06 a.m.)

CHAIR CORRADINI: Okay. And we are in open session. So we guessed right. All right. Let's get started. Dennis, do you want to --

MR. GAVIN: I'll give a brief introduction. Again, we briefed you on the control room habitability, I guess, the temperate and humidity issues last fall. Since then, we have seen a bunch of

RAIs. We have now gotten applicants' response and we resolved all the issues and Jim is going to talk to that.

MR. O'DRISCOLL: Okay. Hello, everybody. My name is Jim O'Driscoll. And I'm here, as Dennis said, to brief the Subcommittee on the status review of the design, the ESBWR Chapter 9.4, HVAC and Control Room Habitability.

The previous meeting was in November and we're also here to answer questions.

Next slide. The ISO Team, Dennis and Ilka for project managers on 6.4-94. I'm the lead reviewer for 6.4 and those chapters. And I am helped by Ed Forrest, Syed Haider and Peng.

Okay. The staff's focus on this was to determine the expected performance of the passive cooling of the control room habitability area. Its ability to maintain habitability and operability of equipment in the 72 hour period after a postulated accident.

And these issues center around the EFU operation, the quantity of air supply, air distribution, mixing, flow paths and temperature and carbon dioxide levels and power supply.

Next slide. This is a summary of all the

RAIs we asked on these sections throughout the time we had the documentary review.

Next slide. I just want to talk -- you know, I should be back to the next slide, the last slide. Since the last briefing, there were several RAIs issued and responded to. So I just wanted to briefly recap those RAIs just to bring everybody back.

MR. McKIRGAN: Jim, I'm sorry, if I could interrupt you?

MR. O'DRISCOLL: Sure.

MR. McKIRGAN: John McKirgan for the staff. Thank you. Jim is proceeding fairly quickly through these first few slides, because much of this information the Committee has seen before.

When we come to the new information, Jim is going to slow down and we will take that a little bit more deliberately. So if you will bear with us.

MEMBER STETKAR: Jim, can I ask one quick question?

MR. O'DRISCOLL: Sure.

MEMBER STETKAR: I was trying to leaf ahead in your presentation and it will help me on your focus questions later or be quiet.

CHAIR CORRADINI: This is your chance.

MEMBER STETKAR: In the SER, I think it

was in the SER, there was a reference to a topical report that GE prepared that shows the actual room heat-up analysis.

MR. O'DRISCOLL: Yes.

MEMBER STETKAR: Has the staff reviewed that topical report?

MR. O'DRISCOLL: Yes.

MEMBER STETKAR: Have you issued a draft SER or NCR on it?

MR. O'DRISCOLL: Yes. That topical report, based on these RAIs that we have issued since November, is now Tier 2* information and in DCD. That is what we are counting an applicant to perform, to do that, to do a reexamination of their as-built control room design with the as-built information to verify that the design assumptions are, you know, maintained in the as-built design. So that topical report is a part of Tier 2.

MR. GAVIN: If I could verify?

MS. CUBBAGE: Yes.

MR. GAVIN: It's going to be addressed as part of Chapter 6 and Chapter 9. There won't be a stand-alone SER.

MEMBER STETKAR: Okay.

MS. CUBBAGE: It is supporting information to the DCD in this case.

MEMBER STETKAR: In Chapter 6 and Chapter -- or, yes, for the --

MS. CUBBAGE: Right.

MEMBER STETKAR: Okay.

MS. CUBBAGE: Right.

MEMBER STETKAR: So there will not be a separate SER on that, this topical report?

MS. CUBBAGE: No.

MR. O'DRISCOLL: That's correct.

MEMBER STETKAR: Okay. Thanks.

MS. CUBBAGE: But those chapters will be coming to the Subcommittee this summer for review.

MEMBER STETKAR: Right. And this -- what we are having today is simply a briefing on where you are in that process. Is that right?

MS. CUBBAGE: I'm sorry. This is a briefing to --

MEMBER STETKAR: Thank you.

MS. CUBBAGE: -- discuss this topic and the closure --

MEMBER STETKAR: Thank you.

MS. CUBBAGE: -- of the associated RAIs.

MEMBER STETKAR: Thank you. Thanks.

MR. O'DRISCOLL: Okay. Sure. Okay. The

RAIs that were issued since November, we asked 9.4-29, Supplement 4, where we asked the applicant to better define the definition of a control room occupied zone and also to include design features of the control room habitability area to illustrating mixing.

9.4-55 was issued to add that calculation that we just talked about as Tier 2* information to the DC.

9.4-56 was asked to -- just requesting clarification and some information in the contained input deck.

9.4-57 was asked about the -- for the applicant to clarify what controls would be used to maintain the assumptions for the life of the plant, for the heat sinks.

9.4-58 was also asked to include the reactor building heat-up calculation as to Tier 2* information as well.

In 6.4 we asked, 6.4-25, for the applicant to justify the 27 degree diurnal swing that they used in that heat-up analysis.

6.4-24 was issued for the applicant to better clarify their heat stress acceptance criteria.

And 6.4-24 was asked for a better description of the design details of the variable orifice device and include that in the DC.

And 3.11-28 was asked for a better understand, you know, for the applicant to provide us a better understanding of the term habitability area, equipment qualification process and how that equipment is going to be qualified.

So I'm going to talk about all of those as I go through that, but all of those RAIs have been received and reviewed and are closed. And so we'll go on to the next slide.

The first thing we're going to talk about is temperature and control for the reactor building and control room habitability area. The question we asked, we have to ask ourselves, is can passive cooling of the control room in the reactor building maintain habitability and operability of equipment for 72 hours following an accident?

What we have to do for this is determine the reasonable habitability area, habitability acceptance criteria for the control room in regards to temperature and humidity, review the applicant's acceptance criteria and their method of demonstration, determine the required level of detail for the supporting heat-up analysis and then also determine the important assumptions and the appropriate level of configuration control to maintain those assumptions.

Next slide. Okay. So we have to -- first, the control room habitability temperature and humidity, we also, first, reviewed the proposed performance acceptance criteria for the reactor building control room, review the input assumptions to the design basis calc.

We need to review the verification methodologies, analyses and identify sensitivities, review the results of the analyses, documentation of insights of the analysis and review the proposed ITAAC.

What we are trying to say here, and we'll make this short, is this is the process we did to review that stuff that they provided.

Next slide. What the applicant has done is provided us with the CONTAIN 2.0 analysis as their design basis calculation for the control room habitability area.

CHAIR CORRADINI: May I just ask, when you say has completed, these are new things since we got together last or these are updated? So can you kind of, if it's new or old, help us out there?

MR. O'DRISCOLL: Sure. The submittal of the CONTAIN 2.0 analysis is not new. However, it was

-- we haven't -- in November, we hadn't completed our review of that. But just to let you know here, that analysis still is the design basis analysis for the reactor building control room building heat-up.

They also provided us a GOTHIC analysis, this is again not new information, to demonstrate mixing. What we had to do on the staff is to determine what we needed to review, you know, on that analysis to either support CONTAIN or to refute CONTAIN.

So in other words, we provided, essentially, two or actually three analyses, CONTAIN 2.0, GOTHIC and a first principles analysis to evaluate this room. Only one of which is the design basis analysis. The other two are supporting analyses. So we have to -- since we review all of them in some detail to come to our findings here.

MEMBER STETKAR: Jim, when are we going to get into or when are we going to see some details of that review? Because you talk about this as a room, but it's actually a dozen or so rooms that are somehow linked through a fairly complex geometry. And the part of that volume that, I think, we are most concerned about is the place where the people live and the digital electronic equipment live and the displays live.

MR. O'DRISCOLL: Sure.

MEMBER STETKAR: I'm assuming that is a fairly complex analysis.

MR. O'DRISCOLL: Right.

MEMBER STETKAR: So --

MR. O'DRISCOLL: Right. Just to get the gist of the presentation on that, is that we had these three analyses submitted to us. And we had to determine what's the best way of evaluating this. And we decided the best way is to look at the problem from first principles point of view.

If we were to -- we asked ourselves what would we expect as an adequate demonstration of this room, if this was the -- you know, as proposed by the applicant? So we developed a calculation. It's a single-node calculation. It is similar to CONTAIN.

CHAIR CORRADINI: That you guys did?

MR. O'DRISCOLL: We did.

CHAIR CORRADINI: Okay.

MR. O'DRISCOLL: We did to see, you know, what the results would be for that, how close they would be to the applicant's submitted analyses.

CHAIR CORRADINI: Okay.

MR. O'DRISCOLL: In order to determine if there is any insights to be gathered from that, if there are some things that were missed.

CHAIR CORRADINI: Okay.

MEMBER STETKAR: I'm not a code modeler, so I have to defer to some of my other colleagues --

MR. O'DRISCOLL: Right.

MEMBER STETKAR: -- who understand this.

MR. O'DRISCOLL: But just to make --

MEMBER STETKAR: Is a single-node calculation reasonable to try to develop the actual convective heat flows through this --

MR. O'DRISCOLL: Right.

MEMBER STETKAR: -- multi-cell problem?

MR. O'DRISCOLL: That's precisely the question we had to determine for ourselves in order to come up with how important were those flows? In other words, a multi-node code, you can model the flow. You can quantify the flows. What you have to do also is to have the design details sufficient to provide assurance that those would support those flows when built.

A single-node code assumes that the heat is instantaneously transferred uniformly in the space. So it is simpler, but, you know --

MEMBER STETKAR: But not very realistic.

MR. O'DRISCOLL: -- is it -- the question is -- well, that's --

CONSULTANT KRESS: But it isn't very realistic for something like a control room.

MR. O'DRISCOLL: Right.

CONSULTANT KRESS: And the assumption is that the current is well-mixed. But it's pretty good.

MEMBER STETKAR: But remember, Tom, that this -- if I characterize the room that we are sitting in right now as the control room, we are removing heat from this volume by convective air flow up above the ceiling out through the rest of the building that has cool air out there.

CONSULTANT KRESS: Yes, but you can see this particular room is well-mixed. And the heat transfer to the various walls --

MR. O'DRISCOLL: And it also comes down to acceptance criteria. I mean, if your acceptance criteria and your -- you know, what you are trying to evaluate that for are pretty -- you know, there is a wide margin there, then you don't necessarily have to have to quantify all of the things that you can possibly quantify in order to come to a conclusion.

MEMBER STETKAR: That is eventually I'm going to get is the acceptance criteria.

MR. O'DRISCOLL: Right.

MEMBER STETKAR: Because I'm interested in my ability, as a human being, to work reasonably well in this environment for 72 hours.

MR. O'DRISCOLL: Yes.

MEMBER STETKAR: And I'm interested in my little laptop computer's ability to give me information, because I'm really concerned about the temperature inside that laptop computer and not the bulk air temperature in the room.

MR. O'DRISCOLL: Right.

MEMBER STETKAR: And that depends on how easily it transfers heat through the bulk fluid,

MR. O'DRISCOLL: That's right. And how confident you are that that detail will be carried forward, so that we can prove something and be confident that it is going to do what it is --

MEMBER STETKAR: Anyway, that's probably more detail, I'm sure, than you wanted to get into. My basic question was when are we going to be able to really --

MR. O'DRISCOLL: That's going to be -- I'm going to -- I think, that's part of the -- as we go forward through this presentation, it will become clearer.

I would like to talk about acceptance criteria first and then talk about each of these analyses.

CHAIR CORRADINI: That's fine.

MEMBER SHACK: Well, just one last.

MR. O'DRISCOLL: Sure.

MEMBER SHACK: On the applicant's GOTHIC analysis, was that a multi-node calculation?

MR. O'DRISCOLL: That was a multi-node calculation. It was submitted --

MEMBER SHACK: Good point.

MR. O'DRISCOLL: -- for a very narrow purpose to demonstrate that there would be conductive current mixing in the control room.

CHAIR CORRADINI: So let me just repeat what you said to us, so I understand. So did staff do the analysis and what did they do in the -- an analysis with?

MR. O'DRISCOLL: Our analysis, our safety analysis is solely based on the applicant's submitted CONTAIN 2.0 analysis.

CHAIR CORRADINI: Yes, but you indicated you did some sort of audit calculation.

MR. O'DRISCOLL: Sure.

CHAIR CORRADINI: And so what was that

calculation?

MR. O'DRISCOLL: I think Syed might be able to go into detail on the exact --

CHAIR CORRADINI: If you are going to do that later, that's fine. I just wanted to make sure.

MR. O'DRISCOLL: Right. I mean, yes.

MR. McKIRGAN: If I could, I think Jim is going to cover some of those things and we do have --

CHAIR CORRADINI: Okay.

MR. McKIRGAN: -- Syed, our author of the first principles of the staff's first principle population.

CHAIR CORRADINI: Understood.

MR. McKIRGAN: Not to be confused with the one provided by the applicant.

CHAIR CORRADINI: I understand. Right.

MR. McKIRGAN: And we will come to all that. But I think some of these things will be made a little bit clearer as Jim proceeds.

CHAIR CORRADINI: Okay.

MR. McKIRGAN: But we do what to save time. As we saw in November, the review was still under way. The Committee had a number of questions. I was encouraged that the staff was asking, essentially, the same questions and I think we have come to resolution on many of those.

CHAIR CORRADINI: Well, we have.

MR. McKIRGAN: So let's save all those.

CHAIR CORRADINI: Okay. Go ahead.

MR. O'DRISCOLL: Okay.

CHAIR CORRADINI: Thank you.

MR. O'DRISCOLL: Yes. The next slide. Discussing acceptance criteria first, the applicant provided us with an acceptance criteria of no greater than a 73 degree temperature, degree fahrenheit, not a good temperature for the control room.

This was based on guidance from the EPRI URD, which allows a 15 degree rise in the main control room that is maintained at 78 degrees. So this particular control room is maintained by tech spec at 74 degrees. However, they are maintaining a 93 degree number as you could infer that the URD supports. So on that basis, we find that that's consistent with the URD guidance, 93 degrees.

So they also had to pin down outside air temperature input assumptions. In other words, this particular design has active safety-related EFUs that take in air from the outside and distribute it to the control room. The outside air temperature we found in our sensitivity analysis that we will talk about later is significant in regards to the assumed humidity and temperature on what you get in the control room at the end of 72 hours.

So what they have done as input assumption is two cases. One is a dry case, a dry day of 117 degrees fahrenheit coincident with 80 degree wet bulb. That is the site envelope, zero percent exceedance value and that's per the EPRI guidance for what you should select for this.

However, as came up in November and as we have confirmed in our sensitivity analysis, is that humidity is important and so -- well, let me first talk about the daily swing. The applicant also imposed a 27 degree diurnal swing on that temperature. In other words, the hottest part of the day it's 117, but it's allowed to drop to 90 degrees and then go back up.

The moisture is maintained constant, so your relative humidity goes from about 20, you know, during the hottest part of the day to about 40, I think, in the middle of the night. Okay.

CHAIR CORRADINI: Can you repeat that, please? I'm sorry.

MR. O'DRISCOLL: Sure. So this is --

MEMBER STETKAR: This was justified by

data from Nellis Air Force Base, right?

MR. O'DRISCOLL: That's right.

MEMBER STETKAR: Just think Nevada.

MR. O'DRISCOLL: Yes.

MEMBER STETKAR: In the summertime.

MR. O'DRISCOLL: Right. That's why we accepted that value, because the applicant clarified there is a rationale basis for that number, 27 is based on a review of meteorological data. So we allowed that.

MEMBER STETKAR: But in a climate where it is known to be (a) dry and have large diurnal swings.

MR. O'DRISCOLL: Right. And they need to validate that. A COL applicant needs to validate that swing for their particular site. They have to -- this is one of the input assumptions they must update when, you know, they complete their ITAAC.

CHAIR CORRADINI: But if I might just -- so now, I understand. But what you are saying though is that if I pick a different climate, they are going to have to redo this analysis?

MR. O'DRISCOLL: They have to check it.

CHAIR CORRADINI: Okay. Check it.

MR. O'DRISCOLL: Right, yes, make sure it's balanced.

CHAIR CORRADINI: So if I might ask the GEH, at this point, is the picking of these values, I can't remember from the Subcommittee, I'm sure we talked about this, but I just don't remember the response. Did we ask and did you conclude that these, at least from your estimates, were limiting if I went from the beauties of Nevada to the beauties of Florida?

UNIDENTIFIED SPEAKER: Or South Carolina.

CHAIR CORRADINI: I'm asking GEH about that. Because what I remember from the Subcommittee meeting was that the concern was high temperature/low humidity might not be limiting compared to lower temperature/higher humidity.

MS. CUBBAGE: You will on the next slide.

(Multiple people speaking at once.)

CHAIR CORRADINI: Yes, sorry.

MR. O'DRISCOLL: Right, low temperature/ high humidity.

CHAIR CORRADINI: You go, you're in charge.

MR. O'DRISCOLL: Okay. Moving on. Next slide. Okay. All right. Now, we also noticed that, like we said, humidity is a factor. And what the applicant has done for -- it affects people primarily.

And it just impacts heat stress.

So the applicant provided acceptance criteria for heat stress for the main control room for passive design plans using Wet Bulb Globe Temperature Index as a measure of the heat stress. Does everybody know what -- Wet Bulb Globe Temperature Index is a calculation using the wet bulb and the dry bulb temperatures. It is .7 times web bulb plus .3 times dry bulb will give you a temperature that is indicative of a heat stress condition.

And basically, there is industry guidance that recommends stay times or compensatory actions based on that measured value. So the applicant provided the NIOSH Standard has a value of 86 degrees or less for unlimited stay time.

NUREG 700 recommends stay times to be implemented when your Web Bulb Globe Temperature Index gets above 90 degrees. So, yes, it's not -- we're not here to say this is going to be a comfortable place to be. The question is habitability.

CHAIR CORRADINI: Okay. Thank you.

MR. O'DRISCOLL: So I'll put that out there.

MEMBER SIEBER: Great.

MEMBER ARMIJO: This 86 degrees is this

WBGT Index, right? It's not an actual temperature?

MR. O'DRISCOLL: It's not an actual temperature.

MEMBER ARMIJO: Got it.

MR. O'DRISCOLL: It's not like every day in Tennessee. Okay. So the applicant chose a Wet Bulb Globe Temperature Index of 90 degrees. And they are going to evaluate that on the limiting case in Chapter 2, which is the 88 degree non-coincident wet bulb temperature.

Okay. Now, the factor is that that's a non-coincident temperature, so your associated dry bulb, theoretically, could be anything from 88 degrees, which you would get 100 percent humidity, all the way to 116.99, because 117 you have the coincident criteria.

So what the applicant did to determine the diurnal swing associated with that and the dry bulb temperatures is they, again, used site-specific data. They, basically, looked back and found the hottest wet bulb days and took the associated dry bulb swings from those days and determined an eight degree diurnal swing for the design certification calculation. John?

MR. McKIRGAN: These data from three weather stations, Corpus Christi, Baton Rouge and

Pensacola, and they found a three day period in July 1980 for Pensacola that they used to characterize this swing, do you know what period of time they went back and mined the data for?

I mean, I went back. I can find daily temperature data and humidity data for Pensacola back to 1949. So did they only look at a five year period or --

CHAIR CORRADINI: You mean you didn't check it to make sure that this was -- it's just a question.

MEMBER SIEBER: It was done.

MEMBER STETKAR: I didn't have the time to download it. It's easy to download.

MR. O'DRISCOLL: I don't recall off --

MEMBER STETKAR: I was just curious what sort of sample in terms of time they looked at.

MR. BARRETT: This is Antonio Barrett from GEH. And while we looked at a really large year range, but what we did was if we went back and looked at some other documentation, which documented when, basically, different heat waves were coming through and different high web bulb globe temperatures were affecting the U.S. and what we found is documentation that said that during the 1980s or during 1980, we had like, basically, a heat wave, but we had very high and very humid conditions. And that's where we focused our searches around 1980, based off of that information.

And then we also looked at where in the U.S. the highest wet bulb temperatures and wet bulb globe temperatures exist in the U.S. and that's how we zeroed in on the Pensacola data which bounds all the other different locations for high humidity.

MR. O'DRISCOLL: I guess that --

MEMBER STETKAR: I guess, you didn't quite answer. You said you looked at a large range. Can you give me a feel? Is it like 20 years?

MR. BARRETT: I think it was more like 40.

MEMBER STETKAR: Yes, that helps.

MR. O'DRISCOLL: Yes. Just to summarize here, the idea is that on the dry humid case, you're going to have a larger swing as would be expected in a dry environment. And in the wet case, you would be expecting less of a swing as is normal for --

MEMBER STETKAR: Okay.

MR. O'DRISCOLL: -- those types of environments. And there is two --

CONSULTANT WALLIS: Can you just clarify something?

MR. O'DRISCOLL: Sure.

CONSULTANT WALLIS: When you accepted this 117, this Arizona thing, and did you ask them to do this as a supplementary thing for Florida?

MR. O'DRISCOLL: They must satisfy --

CONSULTANT WALLIS: Do both?

MR. O'DRISCOLL: -- both.

CONSULTANT WALLIS: They must do both. This is the new part is the Florida part?

MR. O'DRISCOLL: That's correct.

CONSULTANT WALLIS: Just to clarify.

MR. O'DRISCOLL: That's correct.

CONSULTANT WALLIS: Thank you.

CHAIR CORRADINI: I think this was after we had asked --

CONSULTANT WALLIS: Yes, we had asked about that.

MR. O'DRISCOLL: Yes.

CONSULTANT WALLIS: So I just wanted to be clear, because you seem to be accepting both things.

MR. O'DRISCOLL: They have to.

CONSULTANT WALLIS: And I'm just wondering which one you are --

MR. O'DRISCOLL: Right.

CONSULTANT WALLIS: -- talking about.

MR. O'DRISCOLL: They have the challenge of citing this in a huge --

CONSULTANT WALLIS: But it doesn't replace the Arizona?

MR. O'DRISCOLL: No.

CONSULTANT WALLIS: It just adds to it?

MR. O'DRISCOLL: Yes.

CHAIR CORRADINI: Nevada.

CONSULTANT WALLIS: Nevada. Wherever, somewhere out there.

MR. O'DRISCOLL: Okay. I'm going to go to talk about specifically what we have done and what these analyses were all about. Again, the design basis: CONTAIN single-node model. It was provided to demonstrate both room temperature and the heat stress conditions, meet the proposed acceptance criteria.

CONSULTANT WALLIS: What do you do about the other rooms now? The other rooms presumably connect to this control room, the kitchen and the bathroom and so on.

MR. O'DRISCOLL: Well, the applicant's design favors a zone called the control room habitability area. And that's, essentially, the central area where all the panels are. And they have actually qualified that to be the start of the raised floor all the way to about six points --

CONSULTANT WALLIS: Did you consider mixing from other rooms as well or what do they do about the other rooms?

MR. O'DRISCOLL: It's just in the -- there is a false -- no. They are focused on the mixing in that area.

CONSULTANT WALLIS: Well, there is no connection with the other rooms?

MR. O'DRISCOLL: There are connections. There is a false floor and there is a false ceiling and air is allowed to circulate around --

CONSULTANT WALLIS: Does it go from the kitchen into the control room and back or what happens at that interface?

MR. O'DRISCOLL: Well, I think, again, the kitchen has got a false ceiling and a false floor. And the air is allowed to rise and to --

CONSULTANT WALLIS: But this one node, does it consist of the control room and the kitchen?

MR. McKIRGAN: Jim? I'm sorry, this is John McKirgan again for the staff. Perhaps it would help if you could differentiate between the CONTAIN analysis and the GOTHIC analysis, which was the multi-node analysis that the applicant provided.

MR. O'DRISCOLL: Well, okay. The CONTAIN analysis has a single-node that includes all the rooms in the control room.

CONSULTANT WALLIS: All the rooms?

MR. O'DRISCOLL: That's correct.

CONSULTANT WALLIS: Okay. That explains that.

MR. O'DRISCOLL: But now, GOTHIC has actually done a more detailed examination of that.

CONSULTANT WALLIS: Well, you answered the question.

MEMBER STETKAR: Jim, let me ask what I asked earlier, because we're probably not going to get to it today. Are we going to have a presentation from GEH on the GOTHIC analysis that they performed? And when are we going to hear about that?

CHAIR CORRADINI: Well, not today for sure.

MS. CUBBAGE: I believe that happened in November.

CHAIR CORRADINI: We had this.

MEMBER STETKAR: And that's all we are going to hear? Okay.

CHAIR CORRADINI: But I am pretty sure we saw this in November.

MEMBER STETKAR: We did and we had a lot of questions about it. Okay.

MR. O'DRISCOLL: And I'll talk about how we treated that and dealt with that analysis in our review.

MEMBER STETKAR: Okay.

MR. O'DRISCOLL: The supplementary models was GOTHIC and was provided to demonstrate that convective mixing is expected in the control room. And the first principles calculation was provided to support CONTAIN as the design basis method for the check.

All right. So for the CONTAIN review, we looked at that and this is what we have done. We checked, of course, the values that were in the model and they don't conflict with what is in Tier 2. We did some sensitivity models/studies on their input deck that they provided us.

What we did is we varied the concrete physical properties. We changed the heat transfer area. We changed the EFU fan flow rate. Moisture generation rate, basically, the sweating rate, the perspiration we changed. The outside air temperature, we modulated, we changed as well as the humidity outside.

CONSULTANT KRESS: I don't see the concrete thermal conductivity there. Did you vary it?

MR. O'DRISCOLL: Yes, we varied. We did it as a -- we changed both density and thermal conductivity properties at the same time.

CHAIR CORRADINI: Okay. You said specific heat.

MR. O'DRISCOLL: Yes.

CHAIR CORRADINI: But you meant thermal conductivity? I guess that's what I think, Tom.

CONSULTANT KRESS: Yes. Of course, that's only if you are looking at the transient.

CHAIR CORRADINI: Yes, right.

CONSULTANT KRESS: Well, I think in this case, the whole thing is a transient, because you are storing it mostly in the concrete as well as transferring it in the concrete, it's so thick.

CHAIR CORRADINI: We need the thermal conductivity. So let's get back to Tom's question. Was thermal conductivity one of your sensitivity --

MR. O'DRISCOLL: Yes, yes. But we didn't do it as a separate effect. What I'm trying to say is when we changed the concrete properties, we changed -- we went from 120 pound concrete to properties associated with 140 pound concrete. And we changed both thermal density conductivity and specific heat.

CONSULTANT KRESS: So you did it by concrete type?

MR. O'DRISCOLL: That's right.

CONSULTANT KRESS: Or density, excuse me.

MR. O'DRISCOLL: That's right.

CONSULTANT KRESS: Okay. Thank you.

CONSULTANT WALLIS: What did you do about the number of people in there?

MR. O'DRISCOLL: The applicant assumes 11 people in the control room for heat-up.

CONSULTANT WALLIS: All the time?

MR. O'DRISCOLL: All the time.

CONSULTANT WALLIS: All right. But then you said that shift changes and so on, that things happen?

MR. O'DRISCOLL: Right. That -- yes, I mean, basically, that assumes -- that number assumes the normal compliment in the control room plus augment because of the TSC. And I think that's a reasonable assumption, because, of course, the TSC has non-safety power to it and you can expect the TSC folks to relocate.

CONSULTANT WALLIS: And this perspiration assumes a certain level of activity. We presume it depends upon the level of --

MR. O'DRISCOLL: Yes.

CONSULTANT WALLIS: -- let's say --

MR. O'DRISCOLL: Sweating.

CONSULTANT WALLIS: -- the level of concern or something?

MR. O'DRISCOLL: Right. What we have done is this. The applicant provided a number, a moisture reduction rate and a number in GOTHIC. And that equates to -- you know, we looked at a NIOSH Standard, I think it is 86, for what would be a moisture reduction rate and they provided us -- they provided a band of values for us for sedentary activities all the way to chopping wood.

So the value that they provided, and I'll give you those values, the NIOSH Standard is NIOSH 86-113, it's occupational exposure to hot environments. The values they provided was a band of 2.5 liters to 3.9 liters per person per eight hour shift.

So we picked the value to do a sensitivity analysis of about 3.5 liters per person, which is quite a lot. And we found that it didn't really affect the heat-up. It affected the humidity slightly, but not the --

CONSULTANT WALLIS: The condensers on the wall, you know.

MR. O'DRISCOLL: Yes, right. I mean, the humidity goes up in the room, but the actual value, you know, dry bulb does not or is not impacted that much.

MEMBER STETKAR: Jim, there is a curve. Unfortunately, it's a proprietary curve, so I have to be careful about not putting values from it in the open session here that shows the results from the calculation that you alluded to under the humid conditions.

You are not going to really talk about those results in this briefing, are you?

MR. O'DRISCOLL: We're going to provide the result of our sensitivity analysis on the applicant's worst case condition.

MEMBER STETKAR: Including humidity?

MR. O'DRISCOLL: For the humidity, yes.

MEMBER STETKAR: Later on in this presentation?

MR. O'DRISCOLL: Yes.

MEMBER STETKAR: Okay. I'll be quiet then.

MR. O'DRISCOLL: Okay. All right. So that's what we did for CONTAIN.

For GOTHIC, again, they provided this analysis pre-November. It is an RAI that they responded to a question we had about control room mixing. Okay. At the time, the design was different. The input deck used 20 percent lower sensible heat values than CONTAIN. And it used a lower value for EFU fan flow rate.

However, the initial heat sink temperatures were higher than what is assumed. They use a 78 degree temperature to start their accident scenario. So what we did for that, we just wanted to say well, let's see, if we update this to within reason, well, how close does it get to what we have now?

So what we did is we updated Items No. 1 and No. 2. We matched the heat sinks, the sensible heats load and we also changed the EFU fan flow rate. We did not change the heat sink temperatures, because that would have required a much higher level of effort that we didn't think was warranted.

The temperature, you know, we received similar results. It went up about 2 degrees.

CONSULTANT WALLIS: So you actually ran GOTHIC?

MR. O'DRISCOLL: Yes.

CONSULTANT WALLIS: Good. Thank you.

MR. O'DRISCOLL: So okay. What we conclude is that the GOTHIC and CONTAIN are close. The answers are close.

CONSULTANT WALLIS: Well, it's a very long time span. I mean, you expect in three days that thing is mixed pretty well.

MR. O'DRISCOLL: Right. I mean, right. And I think there is a lot -- what we were concerned about was the insight from this. What we found out, the fact was is that originally we had a single-node and there was no mixing. Everything is perfect. And we had a question. And the applicant demonstrated that.

What are the insights from that? Well, we need to describe the air flows. We needed to describe that you expect mixing in the control room. And you should be ensured that you are going to design this room to accommodate those design features.

So what we got from that was we asked the applicant to add some detail on this air flow pattern. And we added that to Tier 2.

Okay. The next thing we'll go into the first principles calc. Because of our questions on GOTHIC, the applicant provided us a CONTAIN analysis--

excuse me, a first principles analysis to support the GOTHIC analysis. It was even simpler than GOTHIC in its composition.

And so we looked at it. The overall heat sink mass and the heat loads are the same. The distribution of the heat sink is much simplified than CONTAIN, obviously. And the mass of the air is assumed to be fixed. There is no EFU fan flow operation in that simple analysis.

So I worked here with Syed who we looked at that and we both, you know, agreed that it's a little bit too simple for us to really make a -- support it as something that would help us. So instead of going another of RAIs, we figured let's find out what we need to ask them first and look at this and find out what is the required level of detail for what we think we should ask.

And so what we did is we developed a first principles calculation of our own. And, Syed, if you want to briefly talk about what this calc is?

MEMBER ABDEL-KHALIK: Before we get to that point --

MR. O'DRISCOLL: Sure.

MEMBER ABDEL-KHALIK: -- the assumed initial temperature is 74 degrees and that's a tech spec limit?

MR. O'DRISCOLL: That's correct.

MEMBER ABDEL-KHALIK: So what will tech spec say the operators must do to the temperature if the control room goes above 74 degrees?

MR. O'DRISCOLL: They need to verify the temperature of the heat sinks. So in other words, if your air temperature goes above the tech spec limit, you need to check the concrete temperatures, the heat sink temperature to verify you are still within your bounds.

I believe there is an alarm that goes off in the room at 78 degrees during all operation that tells you you have a high air condition -- high temperature condition of air in the control room. I believe there is surveillance that then you need to make sure that the control room is less than 74 degrees. I believe it is a daily surveillance, tech spec surveillance on that temperature.

So if that is exceeded, they must check the heat sink temperatures to make sure that they are in accordance with the assumptions, which is 74 degree heat sink temperature.

MEMBER ABDEL-KHALIK: And if they are not, they would have to shut down until they get the control room temperature --

MR. O'DRISCOLL: I believe they would have to restore those heat sink temperatures. Conceivably, you would have to crank up the AC and cool down the room to bring down the heat sink temperature.

MEMBER ABDEL-KHALIK: Well, presumably, they got the higher temperature because the AC for the control room had failed for some reason.

MS. CUBBAGE: GE, could you give the specifics on the tech spec, please?

MR. BARRETT: Yes. This is Antonio Barrett from GE. Yes, so what we did, we have a -- so basically, you have until you hit -- there is also an automatic shutoff. So basically, you're going to shutdown if you hit 85 degrees in the control room after an eight hour period. And we actually did our analysis conservatively assuming that the room is heated at 85 for that entire eight hour duration. And so we had a little conservatism there.

So basically, you have eight hours to restore your air temperature and to make sure your heat sinks are still within limits and if you can't do it within eight hours, you're going to shut everything down.

MEMBER ABDEL-KHALIK: And what are the

limits on the heat sink temperature, if you verified that?

MR. BARRETT: 74.

MEMBER ABDEL-KHALIK: The limit on the heat sink temperature is still 74?

MR. BARRETT: Yes. See, the heat sink temperature has to be below 74. So your maximum temperature in the control room air can be 74 degrees, but your heat sink -- so you are probably going to be going between 70 and 74 somewhere around that area. So your heat sink temperature could be 72 degrees, but your air temperature could be a little bit higher, like if you had an excursion or something like that where your HVAC goes out for a moment and it gets up, slowly heats up and you need to go ahead and fix it or get something -- make something happen in order to being the temperature down.

MEMBER ABDEL-KHALIK: So the LCO would say if the control room ambient temperature goes above 85 degrees or if the heat sink temperature goes above 74 degrees, you must shutdown? Is that what it says?

MR. BARRETT: I think that's correct. I think once it goes above 85, it will automatically, everything will automatically, trip off.

MEMBER ABDEL-KHALIK: I'm trying to nail

down the heat sink temperature.

MR. BARRETT: The heat sink temperature is 74, so you've got to bring it below 74.

MR. O'DRISCOLL: Within eight hours.

MR. BARRETT: Yes.

MR. O'DRISCOLL: So you have an LCO of eight hours to restore the heat sink temperature to 74 degrees or else you shutdown.

CONSULTANT WALLIS: These are thermal couples embedded in the wall or something?

MR. O'DRISCOLL: It's not defined. It could be in the wall or it could be surface. You could be, I presume, measuring it on the surface.

CONSULTANT WALLIS: Well, there must be something which tells them what it is.

MEMBER ABDEL-KHALIK: Yes.

MR. O'DRISCOLL: Well, I think, I mean, I guess you can, you know --

MS. CUBBAGE: There are devices that could be obtained to do this.

MR. O'DRISCOLL: Right. And I don't -- right. And --

CONSULTANT WALLIS: In any case, there is a clear indication with measurements for what the heat sink temperature is?

MR. O'DRISCOLL: Yes, right.

MR. BARRETT: That's correct.

MR. O'DRISCOLL: Okay.

MS. CUBBAGE: But I think there was a key point there that I don't know if it was missed. You are taking assumptions in the analysis that you have been in this LCO and have sustained some level of heat-up before the accident starts.

MR. BARRETT: That is correct. In the analysis, we assumed that the heat sink has gotten to 74. You've been in -- something happens and your temperature is at 85 degrees for an eight hour period. The heat sink is allowed to increase from 74 degrees to whatever it is going to be being exposed to 85 degrees fahrenheit for an eight hour period.

However, it's not going to -- you're not going to instantly jump from 74 to 85 degrees.

MEMBER ABDEL-KHALIK: We understand that. We just want to understand what the limits are.

MR. O'DRISCOLL: Okay.

MEMBER STETKAR: I was writing something else and I missed something that was said. Do your models and analyses account for the EFU operation?

MR. O'DRISCOLL: Yes.

MEMBER STETKAR: You did?

MR. O'DRISCOLL: Yes.

MEMBER STETKAR: Okay.

MR. O'DRISCOLL: That's one of the things why we thought we needed to look at it ourselves.

CHAIR CORRADINI: So this is the big -- I was just thinking the same thing. This is the big difference between GEH's first principles analysis and your first principles analysis, if I understand it?

MR. O'DRISCOLL: Yes.

CHAIR CORRADINI: Okay.

MR. O'DRISCOLL: So, Syed, do you want to just describe what you -- a description of what your analysis is?

MR. HAIDER: Okay. Sure. I was asked to deliver the first principles model for the ESBWR control room humidity needed to independently assess the CONTAIN analysis submitted by the applicant as the design basis. I'll try to summarize that in the next few minutes all of my efforts that I did for a couple of months.

The first principles model we developed is based on energy and mass balances on the control volume that encompasses the control room space and the 21 solid heat structures that define the control room physical boundaries.

The model account for all indoor/outdoor air and moisture mass enthalpy balances coupled with the transient heat transfer into the 21 solid structures treating it as a conjugate heat transfer problem for each structure. It also estimates any condensation taking place inside the control room due to excessive moisture.

The model accounts for significant outdoor air temperature and humidity heat and moisture generation inside the control room and the DCIS heat generation rate in the room underneath.

In a nutshell, the model predicts the transient dry bulb/wet bulb and wet bulb globe temperature radiations inside the control room over the 72 hours when filtered outdoor air is supplied after the failure of the HVAC system.

All these balances were moderate and solved using the Jacobian-based Newton method for convergence on linear equations. We used Visual C++ for quoting the model, high fidelity in modeling while ensuring by comparing all the outputs of the entire code at axis developmental stage.

CHAIR CORRADINI: So you used, just to repeat the last thing just so I'm clear, after checking the inputs and assumptions from the applicant and verifying you were okay with them, those are what you used in your analysis?

MR. HAIDER: As baseline.

CHAIR CORRADINI: So if one were to say you were doing a check calculation, your check calculation, say for the fan, ought to replicate in close stead their first principles calculation?

MR. HAIDER: That's correct.

CHAIR CORRADINI: Okay.

MR. HAIDER: That's correct. My baseline, our baseline for first principles were derived from the CONTAIN.

CHAIR CORRADINI: Right.

MR. HAIDER: All the inputs came from CONTAIN. After we had reviewed the first principles difference that part was to also simplify, we tried to replicate the CONTAIN 2.0.

CHAIR CORRADINI: Okay.

MR. HAIDER: Okay. Within our first principles.

CHAIR CORRADINI: Thank you.

MEMBER STETKAR: Since you modeled the EFU, where did you put the relief device? Where did you locate it physically?

MR. HAIDER: The basic assumption was that when 240 liters comes in, 240 liters would also go out. That was the basis.

MEMBER STETKAR: Well, that's a good assumption, but it depends a bit about where it goes out, doesn't it?

MR. HAIDER: Right.

MEMBER STETKAR: The physical location.

MR. HAIDER: Right.

MEMBER STETKAR: In other words, you are exhausting cool air --

MR. HAIDER: This model --

MEMBER STETKAR: -- from a particular location within this multi-cell model.

MR. HAIDER: -- doesn't show air -- does not model air flow. It does not model the air, you know. In other words, the location of that EFU--

MEMBER STETKAR: Okay.

MR. HAIDER: -- exhaust.

MEMBER STETKAR: You just brought in 466 SCFM at temperature and humidity and exhausted 466 SCFM at --

MR. HAIDER: That's right.

MEMBER STETKAR: -- the mixture.

MR. HAIDER: At the room temperature. That's the difference. And mixing --

MEMBER STETKAR: In the real world though, that exhaust is from under the floor some place.

MR. O'DRISCOLL: As specified in the DC.

MEMBER STETKAR: Which --

MR. O'DRISCOLL: That's correct. The mixing would be shown with GOTHIC, a multi-node code, which we --

MEMBER STETKAR: Right.

MR. O'DRISCOLL: -- didn't develop. But we had the -- the insight was is that we needed to remotely locate this remote exhaust. Excuse me, the applicant needs to remotely locate this remote exhaust below the floor and away from the input, so you won't have a short cycle. And we had that detail added to the description of the air flows expected by the design in Tier 2.

MEMBER STETKAR: Thanks.

MR. O'DRISCOLL: Any more on that comment?

CONSULTANT WALLIS: It's on the floor?

MR. O'DRISCOLL: It is below --

MEMBER STETKAR: It is below the raised floor someplace.

CONSULTANT WALLIS: It's usually in the bathroom. You take your hot humid air out from the ceiling, that's where it is.

MR. O'DRISCOLL: Well, it's the heat sinks, since they have cooled, brings -- the exhaust air will tend to go down. So you would want to have your remote exhaust so that the air laden with moisture and laden with any kind of CO_2 or odors would be going -- would be located on the floor and go out.

MEMBER STETKAR: It's not a pure -- tell me to be quiet, Graham, when I need to be quiet, because I don't understand the --

CHAIR CORRADINI: You get another 30 seconds.

MEMBER STETKAR: Okay. It is a pressurized volume.

MR. O'DRISCOLL: Yes.

MEMBER STETKAR: It's not a pure static volume. You are pressurizing this volume and maintaining it at an over-pressure and actively exhausting. So it's not a pure convective flow with cool air coming down and just sort of going out where it wants to go out. It's more complex geometry than that.

MR. O'DRISCOLL: And for modeling heat-up, if you have a single-node, I think it is more conservative because it doesn't assume cooling effect to these convective flows. So that's a conservatism on that aspect. However, when you talk about mixing and air quality, it's not a conservatism.

So the question is what do you need to put in to certify DC? And we feel that the single-node code for this design, because of their design, is sufficient.

CHAIR CORRADINI: Okay. Why don't you keep on going?

CONSULTANT WALLIS: Because of the time span.

MR. O'DRISCOLL: The time --

CONSULTANT WALLIS: We have plenty of time.

MR. O'DRISCOLL: And also the design of the room. It's a large open space room. They have -- their EQ requirements we will talk about. They are going to be testing equipment at a much, much higher temperatures than what you expect, even with thermal stratification that was shown in the GOTHIC analysis. You wouldn't get, in my opinion, close to challenging that equipment.

But I'll move on to the first principles. Go to the next slide, it's Slide 15. The insights from the staff review of CONTAIN is that there are some conservative assumptions in their analysis insofar as what they assume for concrete densities and some other assumptions.

GOTHIC does demonstrate convective mixing as expected. The highest average temperature in the occupied zone observed was in the GOTHIC model. So in other words, if you -- you know, GOTHIC is predicting higher temperatures. Okay.

The staff sensitivity input approach CONTAINS result when most inputs are matched. And to put a number on it, we are getting about 2 to 4 degrees higher than our first principles than with GOTHIC.

MR. HAIDER: With what CONTAIN is.

MR. O'DRISCOLL: With CONTAIN. Thank you. What we also have seen is that every time, with every heat sensitivity, the relative change in the room was the same. In other words, when we increased the sensible heat, the room temperature went up by the same amount, .8 degrees or .7. So the models behaved the same way when we did heat sensitivity.

Each sensitivity we did in CONTAIN, we did as well in our first principles analysis.

CONSULTANT WALLIS: So did your model meet the criteria? You said it was warmer than the model, did it still meet the criteria?

MR. O'DRISCOLL: No, it didn't.

CONSULTANT WALLIS: It didn't?

MR. O'DRISCOLL: There is two criteria.

CONSULTANT WALLIS: What's it verifying?

MR. O'DRISCOLL: It is verifying that CONTAIN describes the room adequately.

CONSULTANT WALLIS: But your results didn't meet the acceptance criteria?

MR. O'DRISCOLL: Right. But only because we -- the purpose of our approach was not to get all the clocks to align. We wanted to make sure that we have -- that we understand the assumptions used by the applicant. That was the purpose of our approach.

If we were to come up with some non-conservatism through the exercise, we would have raised an RAI. And we thought that was a more efficient way of going as opposed to looking at CONTAIN and GOTHIC and having a safety finding based on here is my apple, you know, my CONTAIN apple and my GOTHIC orange.

CHAIR CORRADINI: They differ.

MR. O'DRISCOLL: And the apples and oranges match.

MR. McKIRGAN: Jim, if I could, is it true that some of our analyses were consistently above

CONTAIN? So that the issue I'm trying to come to is that there were some assumptions in our analysis and some potential non-conservatisms that we didn't actually capture? And, Syed, you mentioned one to me earlier and perhaps you can discuss that a little bit about the heat sinks and the wall temperatures and how you partitioned that energy.

MR. O'DRISCOLL: Right. Before that, I just want to say that when you use the design input that the applicant has said they were going to use for this control room, it's a 150 pound concrete, you get very close to the acceptance criteria. And even in our model, it goes -- it drops the temperature by -- that's the most sensitivity one can --

CONSULTANT WALLIS: So you can meet the criteria if you make more realistic assumptions?

MR. O'DRISCOLL: Right. That's correct.

CONSULTANT WALLIS: That's helpful then.

MR. O'DRISCOLL: Right.

MR. HAIDER: Yes.

MEMBER ABDEL-KHALIK: The question was raised earlier as to where the concrete temperature would be measured for that satisfaction of that LCO. Now, let's say you have a sequence of many hot days in a row. The air conditioning is working fine inside the room. But the concrete that is in contact with the soil on the outside gradually gets hotter and hotter.

MR. O'DRISCOLL: Yes.

MEMBER ABDEL-KHALIK: Because the air conditioning is still working, the concrete temperature near the surface on the inside of the control room is cool. It's slightly higher than the ambient temperature in the control room, because the heat flow is coming in from that direction.

But how do you define that concrete, that acceptable concrete temperature for that LCO?

MR. O'DRISCOLL: Well, this is a good question. Because when we looked at modeling the walls in contact with the ground, we had to take a close look at the applicant's assumption for soil temperature and how we would handle that. And, Syed, do you want to talk about how you divided the wall?

MR. HAIDER: Yes. There are -- we believe that there are a couple of conservative assumptions in our first principles analysis. And one is that in my analysis, the wall that faces the soil assumes an initial temperature of 80 degree fahrenheit. When the soil temperature is assumed to be 86 by the applicant --

MEMBER ABDEL-KHALIK: Sorry. Could you repeat that? I did not understand what you said.

MR. HAIDER: The soil temperature is assumed to be 86 degrees fahrenheit in the applicant's analysis.

CHAIR CORRADINI: How much?

MEMBER ABDEL-KHALIK: 86 degrees?

MR. HAIDER: 86 degrees fahrenheit.

CHAIR CORRADINI: Where is the -- oh, okay, so that's a granted. But just so I understand reality, where is this relative to the surface?

MR. HAIDER: The building, I believe, is adjacent to the surface.

CHAIR CORRADINI: Right.

MR. HAIDER: It's facing one wall.

CHAIR CORRADINI: Oh, one wall?

MR. HAIDER: One wall.

MR. O'DRISCOLL: Right. And this is subterranean. This is a subterranean control room. I believe the back wall and part of the side wall of the control room are touching --

CHAIR CORRADINI: The soil?

MR. O'DRISCOLL: -- the soil.

MR. HAIDER: Touching the soil. While the analysis that is submitted assumes 80 degree fahrenheit temperature throughout the concrete thickness. I was not able to convert that situation because of the step change on the boundary condition that touches the soil from 80 to 86 degrees fahrenheit.

So what I assumed was along the lines of the first principles analysis that they did consider half of the wall, half of the thickness of the wall and considering that the remaining half is adiabatic and we believe that this is a conservative assumption.

CONSULTANT WALLIS: So you throw away half the wall?

MR. HAIDER: Half of the wall, because it is facing the soil. So that would account for some of the heat that is coming from the --

CONSULTANT WALLIS: It's very hot soil.

MR. HAIDER: Right, yes.

CHAIR CORRADINI: Very hot soil.

CONSULTANT WALLIS: It never happens in Minnesota or Wisconsin or anywhere like that, I suppose.

CHAIR CORRADINI: I don't even think it happens in Florida.

MEMBER ARMIJO: Even in the Carolinas, I don't think.

CHAIR CORRADINI: I don't think it happens.

MEMBER ARMIJO: No.

CONSULTANT WALLIS: And the dampness in the soil. The soil is conservative, I think, that's okay.

MR. HAIDER: Yes, because that's 86. While on the other side of the wall, the temperature goes above 86.

CONSULTANT WALLIS: So you assume that half the wall is at 74 or is it linear or something?

MR. HAIDER: Half of the wall is at 80 degree fahrenheit.

CONSULTANT WALLIS: The other half you throw that away?

MR. HAIDER: You threw that. So that is the --

CONSULTANT WALLIS: The one you keep, is it 74?

MR. HAIDER: It's at 80 degrees.

CONSULTANT WALLIS: Oh, it's 80?

MR. HAIDER: It's 80.

CONSULTANT WALLIS: The one you keep is at 80.

MR. HAIDER: Because that was --

CONSULTANT WALLIS: That's an average?

MR. HAIDER: -- temperature here.

CONSULTANT WALLIS: Okay. So this is a little conservatism, too.

MR. HAIDER: Right.

MR. McKIRGAN: Yes, so if I could, there were a number of points where the staff's confirmatory calculations also had some very conservative assumptions in it. And that's why you see a few of these discrepancies between those confirmatory calculations and the applicant's calculations.

So we weren't looking for an exact match to the degree or to the tenth of a degree between these. We were looking for trends and, again, to get the insights that Jim has talked about.

MR. HAIDER: Yes. And there was one more conservatism that I would like to mention here. Underneath the floor, there are four DCIS cabinets. We assume that half of the load from each cabinet is coming into the adjacent wall and that might be an old estimate, because if in the adjacent room one would expect that the load distribution would be about 25 percent. But while my analysis assumed 50 percent.

MR. O'DRISCOLL: So we are forcing some heat, artificially forcing some of that heat up into the room, as more than you would expect.

MR. HAIDER: So if we drop that ratio from 50 percent to 25 percent, then we gain by about 1 degree fahrenheit in the room temperature.

MR. O'DRISCOLL: Okay. So anyway, the highest average temperature we observed was in GOTHIC. Our sensitivity studies approach CONTAIN result when most inputs were matched. There are small differences between the models and I consider those inconsequential to the finding.

There is agreement and I agree that the model results support the use of CONTAIN.

CONSULTANT WALLIS: So you don't think that it would help to throw -- to show us the curves?

CHAIR CORRADINI: I was waiting for you to ask that question. It took this long to get to this point.

MR. O'DRISCOLL: Well, it's --

CONSULTANT WALLIS: They are the same and it helps to see the three curves.

MR. O'DRISCOLL: Right. We -- yes, our analysis was focused on getting the final room temperature and not look at the heat-up profile, because -- but, you know, that was when we were talking about how to present this.

MR. HAIDER: We don't have that information here, but our --

MR. O'DRISCOLL: We could do that.

MR. HAIDER: -- analysis is generating.

MR. O'DRISCOLL: Right.

MR. HAIDER: -- all the data that we can convert. And they were compared.

CONSULTANT WALLIS: Are they going to come before the full Committee some time? Maybe you could show the three curves or something.

MR. O'DRISCOLL: This will come in front of the -- this will come back in some fashion when we review with no open items, Chapter 6 and 9.

CONSULTANT WALLIS: Come back to us?

MR. O'DRISCOLL: Yes.

CONSULTANT WALLIS: As a Subcommittee?

MR. O'DRISCOLL: Well, it will come back to the Subcommittee, but I think if we want to see a curve, I'm sure they can give us a curve.

CONSULTANT WALLIS: Maybe they could just send it to us or the staff could send it to us?

MS. CUBBAGE: Right. This is planned for the September Subcommittee, but if that information is already available --

CONSULTANT WALLIS: Well, I suppose they

are in the RAI responses.

MS. CUBBAGE: Well, you are looking for staff.

CHAIR CORRADINI: Now, be careful. Be careful though, Graham. We have the RAI response. What you are asking for is their calculation, which is their audit calculation. I don't think we have that.

CONSULTANT WALLIS: No, okay.

CHAIR CORRADINI: Is that correct?

MS. CUBBAGE: That's right.

CHAIR CORRADINI: Yes.

MEMBER ABDEL-KHALIK: I'm afraid I still haven't received sort of an appropriate answer for my question as to where should you measure the concrete temperature for implementation of that LCO?

MR. O'DRISCOLL: That is not defined. That location is not defined in the DC.

MEMBER ABDEL-KHALIK: So if the applicant decides to measure a surface temperature of the concrete, would you consider that acceptable?

MR. O'DRISCOLL: Yes. In my opinion, it is a reasonable assumption to say that during normal operation, the control room is going to maintain a constant temperature and you are going to be in -- the temperatures are going to be in equilibrium. So you can basically -- so based on that, a surface temperature could be indicative of a temperature inside the wall.

And the applicant can -- I can see how the applicant can justify it, based on reasonable assumptions on previous history in the last 48 or 72 hours of operation, what an internal concrete temperature would be, based on the temperature of the surface of the concrete.

MEMBER ABDEL-KHALIK: All right.

MR. BARRETT: This is Antonio Barrett of GEH. Yes, so we had surveillances on all of the concrete walls, so all that is what is in the analysis. The only thing that we don't have or won't have a reasonable assurance are the surface temperatures of that soil. And since we assume it will be 86, we know it is going to be a lot less than that.

So we will know all of the temperatures of all of the rooms so they will be at equilibrium, so they will be at or below, the inside of the concrete, what the surface temperatures are on the outside.

MEMBER ABDEL-KHALIK: Well, yes, we -- that is correct.

MS. CUBBAGE: If I may, so you are taking assumption of a certain surface temperature and the analysis assumes a higher internal temperature, so you will be able to measure the surface temperature and infer that your assumptions of the calculation will be valid?

MR. BARRETT: That's correct.

CHAIR CORRADINI: But I think you guys are across purposes. I think Said is asking, I think he is asking, a different question. He is asking when you do have to determine your LCO, how are you going to measure the temperature? And I think your answer is that is yet to be determined. I thought that was the beginning of your answer.

MR. O'DRISCOLL: Right.

MEMBER ABDEL-KHALIK: And the question then is if the applicant determines that they are going to measure that temperature right at the surface of the concrete, would that be consistent with the assumptions?

Because under normal conditions, you have a temperature gradient in the concrete that is going in the direction where the temperature is decreasing towards the control room. And what determines whether or not this will work is the average initial temperature in the concrete.

And the question is how steep is that temperature gradient if I measured the temperature at the surface, would the average temperature in the concrete be low enough, so this analysis would still be applicable?

MR. BARRETT: This is Antonio Barrett of GEH. If you don't mind me answering that question, the answer to your question is yes. One thing that we did do in CONTAIN, for example, if you have two rooms, one of which being the control room habitability area, let's say it's maintained at 74 degrees. You have the outside corridor that is being maintained at 78 degrees. The CONTAIN analysis would go out for 72 hours, so you will have the appropriate weigh in within that concrete wall, which is consistent with our tech specs and so on and so forth.

CHAIR CORRADINI: You might want to not get so close to the microphone.

MR. BARRETT: Sorry.

UNIDENTIFIED SPEAKER: We're fixing it now.

CHAIR CORRADINI: Okay.

MEMBER ABDEL-KHALIK: Let me just point out, you know --

MS. CUBBAGE: From a staff perspective --

MEMBER ABDEL-KHALIK: -- that the staff really ought to check that.

MS. CUBBAGE: -- I believe our expectation was that they would be monitoring the surface temperature in the control room. And based on the conservative assumptions in the analysis of the hot soil conditions, that the analysis was based on that, would be an adequate surveillance.

MR. O'DRISCOLL: Okay. We can address that. I can address that. Okay. There is agreement that the model results support the use of CONTAIN. CONTAIN methodology was made Tier 2* information in the DCD. And the ITAAC was added also for the heat stress sensitivity for a separate acceptance criteria for verification of the heat stress condition in the control room, based on an analysis that is based on the as-built conditions.

And next slide. Okay. Now, we also found out, as we said, that their analysis is close to their acceptance criteria. So their CONTAIN analysis is getting about 92 degrees and the acceptance criteria is 93.

So on the other hand, the maintenance of the margin that they assumed is important for those sites located in hot dry or very humid locations.

And configuration control for the heat sinks is important for some sites. So some passive cooling of the control room, you know, the design detail has been added to Tier 2 on the air flows.

The other thing we saw was we needed some more information on how EQ surface temperatures would be determined and had that information -- and have that information added to the DCD.

And what that is, the fact is is that their GOTHIC analysis showed a thermal gradient in the control room. You had about -- you know, at the very top of the room, you had 104 degrees, you know, well-above people. And the question is is well, if you've got a thermal gradient and you have got air movement, well, how, you know, certain are you that there wouldn't be any located -- safety-related equipment located in areas where -- that see hotter temperatures?

Well, the applicant has clarified in RAI response to 3.11-28 that they are going to test the equipment, EQ equipment in the control room at 140 degrees. It will be qualified for mild environments, but it will be tested at 140. At the outside, preferably, you know, I&C computer-based equipment will be put together inside the cabinet once tested and that the temperature will be applied to the exterior of the cabinet.

So if you're going to test the equipment that is in a cabinet at 140 degrees on the outside, I believe that is a reasonable amount of margin that we can say that you don't have to model exactly the air flows more than we have done or the applicant has done with CONTAIN.

MEMBER STETKAR: So maybe GEH can answer this. That's a higher temperature than they are going to qualify the digital equipment in any other location in the plant. Is that correct?

MR. O'DRISCOLL: I can answer this. What the applicant has done is they have evaluated all of the rooms that have safety-related equipment and they are also passively cool. And they have done -- you know, this is in the reactor building. They provided a heat-up analysis for those rooms and they had determined that those rooms don't get above a certain temperature.

You know, these are unoccupied rooms. There are equipment in them. That temperature then is the -- they certified that that temperature is within their envelope for mild environment, environmentally-qualified equipment, which is zero to 144 degrees --

122 degrees fahrenheit.

And on top of that number, they are going to test to ensure that that equipment can survive that environment. And there is an amount of margin included to the test. So you have to -- so they are going to test it, this equipment, in its cabinet and they are going to add a margin to it. And it is going to be at a temperature above which was expected, you know, in that calculation.

MEMBER STETKAR: I didn't ask that. I know that they are -- you know, don't run around in circles.

MR. O'DRISCOLL: Yes.

MEMBER STETKAR: I asked are they going to qualify the digital equipment in the main control room at a higher temperature than they are in other locations in the plant? The other locations in the plant, they are going to qualify it at 122 degrees fahrenheit.

MR. O'DRISCOLL: Yes.

MEMBER STETKAR: I know that. You have a degree value that says 140 degree fahrenheit external air temperature, which means internal air temperature is going to be higher than that. So the question is are they going to qualify the equipment in then main control room at a higher temperature than the other locations in the plant? Yes or no?

MR. O'DRISCOLL: No.

MEMBER STETKAR: Okay. Why?

MR. YANDOW: This is Peter Yandow. What we are going to do is take the base temperature that we calculated --

CHAIR CORRADINI: Hang on, hang on.

MR. YANDOW: -- for the room --

CHAIR CORRADINI: Why don't you have a seat?

MR. YANDOW: Peter Yandow. I'm sorry.

CHAIR CORRADINI: There you go.

MR. YANDOW: Peter Yandow.

CHAIR CORRADINI: Go ahead, go ahead.

MR. YANDOW: Okay. What we can do is take the base temperature that we calculated for the room, the control room right now, I think the base temperature is 33.9 for equipment qualification. We add margin for the heat-up in the rack. In other words, this is a separate chassis. The CRTs that sit on the desk will be a certain temperature. They will heat up themselves. They will heat-up the room. And then we add 10 degrees margin because of the standards to say that compensates for inaccuracy in the equipment and that kind of thing, measurement and testing.

So that comes to 140. So we tighten to 140 no matter where that equipment is going to be located.

CHAIR CORRADINI: Does that help you, John?

MEMBER STETKAR: Yes. As long as I hear you saying you're going to type test to 140.

MR. YANDOW: Type test to 140.

MEMBER STETKAR: Regardless of --

MR. YANDOW: That's the point we made to the --

MEMBER STETKAR: Okay. Okay. Thanks. That's --

CHAIR CORRADINI: Okay.

MEMBER STETKAR: Even though it's only going to be officially qualified to, whatever, 125 --

MR. YANDOW: That's right. Whatever the temperature would be in that room.

MEMBER STETKAR: Okay. Thanks.

CHAIR CORRADINI: So are you clarified now?

MEMBER STETKAR: That does. Thanks.

MR. FORREST: My name is Ed Forrest. I'm

for the staff. And my understanding was the equipment is really qualified at 125, but tested at 140.

CHAIR CORRADINI: Yes, that's --

MR. FORREST: And that's the IEEE test difference required.

MEMBER STETKAR: That's what I heard him say.

MR. FORREST: Okay.

MEMBER STETKAR: So thanks. Thanks.

CHAIR CORRADINI: Thank you.

MR. O'DRISCOLL: Next slide.

CHAIR CORRADINI: We're done?

MEMBER STETKAR: One last question.

MR. O'DRISCOLL: Sure.

MEMBER STETKAR: Because we have been talking about temperature. And I thought you were going to tell me the results from your confirmatory calculations, but you didn't. You told me temperature.

Humidity. In the proprietary report there is, indeed, a heat-up curve and it shows the humidity which not surprisingly rapidly rises to the external air humidity. And the external air humidity is somewhere in the order of about 87, 88 percent. That humidity remains at that value, but I can say that because we are already in the open session here, we established that relative humidity.

MS. CUBBAGE: Excuse me. We can go closed if that is necessary.

MEMBER STETKAR: I don't think it's necessary, Amy. The question is if I now have people operating in an environment with 85 to 90 percent relative humidity for 72 hours, apparently, that is a habitable environment, that I know people live in the Gulf Coast, so apparently they can habituate in that environment.

Are there any -- what type of relative humidity will be applied during the equipment qualification testing? Is it qualified to that humidity environment also?

MR. HECKLE: This is Lloyd at GEH. We generally would follow the EPRI 10.73-30 Guidelines, which require up to about 90 percent relative humidity for qualification.

MEMBER STETKAR: So we are close, but below?

MR. HECKLE: Well, the standards required at 50 degrees C for the environmental withstand testing that you go up to 90 percent relative humidity. So that's what we would currently intend on meeting with these standards.

MEMBER STETKAR: The calculated --

MR. YANDOW: That was Lloyd Heckle?

MR. HECKLE: Yes.

MR. O'DRISCOLL: I was just going to say you calculate it, I won't say the number, you know, the relative humidity for the wet moist wet case is below that for the control room.

MEMBER STETKAR: For your's?

MR. O'DRISCOLL: No. For in CONTAIN, in CONTAIN. And using the applicant's model, and it's also below for us. So for both --

MEMBER STETKAR: It's below 90 percent?

MR. O'DRISCOLL: Yes, yes.

MEMBER STETKAR: Yes.

MR. O'DRISCOLL: That's correct.

MEMBER STETKAR: Okay. Thanks.

MR. O'DRISCOLL: Okay.

CHAIR CORRADINI: Okay. Other questions for the team or the staff? No other questions?

Okay. Thank you all. And --

MS. CUBBAGE: We have one action item for some plots.

CHAIR CORRADINI: That is correct. I wanted some plots from your audit calculation.

MS. CUBBAGE: Right.

CHAIR CORRADINI: Okay. Which we will get through Chris at the appropriate time. Just for clarification, Amy, when you guys to audit calculations, do you write it up or is it written up on a fashion that we would see pieces as you need to have us see them or is there a written up document?

MR. McKIRGAN: If I could? I think that varies. In this instance, the staff wasn't planning on documenting or providing curves in our SE, for example --

CHAIR CORRADINI: Okay.

MR. McKIRGAN: -- of these audit calculations.

CHAIR CORRADINI: Well, so then just for at least my own edification, if Syed could write up a little bit of a --

MS. CUBBAGE: Sure.

CHAIR CORRADINI: -- preamble to the calculations, so that you don't send us a curve and we send you a question and then we start an RAI trail. Okay?

MR. McKIRGAN: Yes.

CHAIR CORRADINI: So --

MR. McKIRGAN: I don't want to engage him.

CHAIR CORRADINI: No, I don't want to engage in any conversation with you guys at all. So to the extent that you just give us a little preamble, so we understand what you are sending us, that would help. Okay. All right.

So let go around. The consultants vanished on us and they are going to provide us with a report. They had nothing significant as they were marching out the door. So I'm going to turn to Jack and we will just go around the table with observations from the Members. Jack?

MEMBER SIEBER: I think that what the applicant and the staff have done is adequate and consistent with how I think they should have accomplished that. So I have no additional comments.

CHAIR CORRADINI: Okay. Mr. Stetkar?

MEMBER STETKAR: I guess I'm still a bit concerned having gone through environmental problems at some currently operating plants about the ability of even the multi-node model to adequately evaluate the convective heat flows in the control room.

On the other hand, I must admit I don't know anything about that modeling, so if I'm given assurance by modelers that, indeed, it can handle it in this geometry, I'm happy.

CHAIR CORRADINI: Can I ask you a question back at that? So even knowing that, I can't remember the gentleman that was sitting there a second ago said, they are going to do a 140 degree type testing, your concern is how that matches up with the boundary condition --

MEMBER STETKAR: Right.

CHAIR CORRADINI: -- that the model is predicting at that location?

MEMBER STETKAR: That's right.

CHAIR CORRADINI: Okay.

MEMBER STETKAR: That's right.

MEMBER SHACK: Well, the equipment seems to have more margin than the people do.

MEMBER SIEBER: Yes.

MEMBER STETKAR: Yes, it is not going to be a pleasant place to be operating and making decisions, but apparently we have rules that says that's okay.

CHAIR CORRADINI: But I guess what I'm after though, just to make sure we are clear about this, because I think from the staff's standpoint, they want to be clear about any of the things we have as significant issues that we can clarify.

So from the standpoint of significance, is this something that is a nagging concern or rises to a level that you want to see more analysis to close the gap? That's what I'm trying to get at.

MEMBER STETKAR: You know, honestly, Mike, I don't know, because I don't have the personal experience with running those multi-node codes. I have to defer to others who have better knowledge of that analysis process.

CHAIR CORRADINI: Okay.

MEMBER STETKAR: I'm just raising it from the perspective of the little that I do know, if they modeled that heat transfer process and those localized convective flows within the complex geometry with the EFUs operating pumping hot, moist air in the top and cool air being exhausted some place below a floor somewhere, whether, indeed, you get the right convective heat transfer localized to the panels that are actually generating that heat in the control room.

CHAIR CORRADINI: Okay. Let's go around and make sure we get everybody's comments. I want to come back to that one.

MEMBER STETKAR: Yes.

CHAIR CORRADINI: Because what I'm hearing you telling me is --

MEMBER STETKAR: And I'm --

CHAIR CORRADINI: But you can't tell --

MEMBER STETKAR: That's the only area. You asked me where I feel uncomfortable. That's the only area where I feel uncomfortable, but I'm willing to be --

CHAIR CORRADINI: Beaten down.

MEMBER STETKAR: -- comforted by folks who understand the model and the process.

CHAIR CORRADINI: Okay. All right. But let's get to the comforting part later. So that's your one concern. Okay. I'm sorry. Sam?

MEMBER ARMIJO: Yes. I share Jack's views as far as the applicant's submittal and the staff's confirmatory review. I think the issue of the bulk temperature of the concrete relying on surface measurements, I think, that kind of why it's so easy to review them. The temperature inside the concrete, I don't know why that would be a problem, but --

MEMBER STETKAR: It's a concern though.

MEMBER ARMIJO: So other than that, I don't have any problems.

CHAIR CORRADINI: Okay. Said?

MEMBER ABDEL-KHALIK: Yes. I would like to echo that last comment. But if tech specs are going to specify a limit on the maximum heat sink temperature, I would like to know what temperature and where and how it is going to be measured.

MR. O'DRISCOLL: I understand.

MEMBER ABDEL-KHALIK: Because you can shave this as close as you want by measuring the surface temperature.

MR. O'DRISCOLL: That's right.

CHAIR CORRADINI: Did you have any other?

MEMBER ABDEL-KHALIK: That's it.

CHAIR CORRADINI: Comments? Mike, no comments?

MEMBER RYAN: No comment.

CHAIR CORRADINI: Okay.

MEMBER BONACA: No further comments.

CHAIR CORRADINI: Okay. So now, let's try to understand how to comfort you. So I guess I want to understand though the -- I was looking for and I thought we had, I'm sure I saw, but I'm not sure I have it electronically, the GOTHIC analysis from the RAI.

So I guess I would like to go back to the applicant to ask a bit of a question. So from the standpoint of equipment qualification, what has GOTHIC -- what is done relative to the CONTAIN analysis coupling to your 140 degree type testing, in terms of what you are predicting as the temperature the equipment will see versus what you are testing at?

Let's start there, since I want to understand the difference from what you predict versus what you are testing at. Is there any information you can help us with in that regard?

MR. YANDOW: Yes. This is Peter Yandow again. The temperature that we -- that GOTHIC comes up with is used as an input value for calculating how -- what the type test will be run at. We use that plus the heat-up of the rack wherever it is going to be located plus 10 degrees margin.

CHAIR CORRADINI: Right. But what --

MR. YANDOW: So that comes to 140.

CHAIR CORRADINI: Right. So let me just say it differently. I think what John is questioning or I think what John is questioning is okay, now, let's work it backwards. You know the heat produced by these various systems. What is CONTAIN or GOTHIC predicting for the surface temperature? And what's that difference, so we get a feeling for are we close? Are we far away? That I think is where your concern was, yes?

MEMBER STETKAR: Yes.

MR. BARRETT: This is Antonio Barrett of

GE. So in the control room specifically, there is a temperature gradient in the control room and the highest temperature is at the top of the room and the lowest temperature is at the bottom. So that temperature that we are going to be testing to will be one of the hotter temperatures, not one of the lower temperatures where all the equipment would be.

CHAIR CORRADINI: Right. But so let me push the coin. Here is my laptop. I'm sitting here for 72 hours enjoying myself during the accident. I'm worried about the temperature below my keyboard and its operability when the room is sitting at 93 F and what, I don't remember what the humidity was.

And I think John's question is is there some calculation or some estimate to know that if you actually tried to estimate what was below the keyboard, it's not 160.

MEMBER STETKAR: Yes. And what does the surface temperature of your laptop need to be to get the appropriate --

CHAIR CORRADINI: Right.

MEMBER STETKAR: -- convective heat flow to --

CHAIR CORRADINI: Correct.

MEMBER STETKAR: -- indeed remove said

heat?

CHAIR CORRADINI: I think that's where he is going.

MEMBER STETKAR: BTUs per hour.

MR. YANDOW: Okay. Peter Yandow again. The vendor will take the input temperature that we give them, whatever it is, and he will use that. And we really don't get into what his internal temperature is. He has to qualify and make sure the equipment is operable for that temperature range of input.

MEMBER SIEBER: Which is --

MR. YANDOW: So if we say it's 140, he proves that the equipment, whatever is internal, it could be 200, I don't know, whatever the power supplies are running.

CHAIR CORRADINI: So --

MEMBER STETKAR: So you are just specifying external cabinet.

MR. YANDOW: That's right. And then he is required to qualify -- to prove that it is operable during that period. Just like the battery test we talked about.

MEMBER STETKAR: Okay.

MR. YANDOW: They provide for the battery proof whatever the battery internal cell temperature is, I don't care.

CHAIR CORRADINI: So you --

MR. YANDOW: I can think that, but I don't want --

CHAIR CORRADINI: So the bottom line is I want that laptop when you find it.

MEMBER STETKAR: And the GOTHIC, yes, that's right.

MEMBER SIEBER: Well, get a better laptop.

CHAIR CORRADINI: But are you now better off? I think I understand what your --

MEMBER STETKAR: I'm better off as long as that 140 still gives me the adequate heat transfer.

CHAIR CORRADINI: What I understand your answer, just to push it, to be is you're putting the burden of proof on the manufacturer to supply you equipment that meets that type test.

MEMBER SIEBER: Right.

MR. YANDOW: Correct.

CHAIR CORRADINI: Okay.

MR. YANDOW: That is correct, yes.

CHAIR CORRADINI: Okay. Other questions for the staff or the applicant, at this point? No. Amy, can I turn to you and you can give us preview of coming attractions, a/k/a June 22nd?

MS. CUBBAGE: June 22nd we are going to be going over seven different chapters: Chapter 5, 8, 11, 13, 17, 19 and 22. And on Chapter 19, we are going to be focusing on aircraft-impact that is an issue that was not addressed in previous Subcommittee meetings. We have had a lot of -- we had the Subcommittee meeting on Chapter 19 on this SER with open items and multiple follow-ups to talk about audit results.

So we are not going to rehash that information. We are just going to strictly focus on aircraft impacts. That's a lot of chapters to do in one day.

CHAIR CORRADINI: So if I may, I didn't mean to stop you if you were on a roll.

MS. CUBBAGE: Okay.

CHAIR CORRADINI: Did you have more?

MS. CUBBAGE: I can.

CHAIR CORRADINI: Okay.

MS. CUBBAGE: But I don't --

CHAIR CORRADINI: So what she said quickly, I want to emphasize to the Subcommittee and all the Members that we invite and encourage to attend with us is that their plan for that day is to take the open items, the significant things that we identified in our previous interim letters and make sure they touch on those.

If we did not touch on them before, they will not touch them this time.

MS. CUBBAGE: That's right.

CHAIR CORRADINI: And the preponderance of that day will be this new item relative to aircraft impact.

MS. CUBBAGE: Right. That will be one of the significant items.

CHAIR CORRADINI: Right.

MS. CUBBAGE: That's right.

CHAIR CORRADINI: And we are going to go along because of Dr. Shack. It's totally his fault. We are doing SOARCA on Monday, the 21^{st}, and we will start at 8:30 and go as long as we need to to get through these seven chapters on the 22^{nd}.

MS. CUBBAGE: Right. And I would ask that the Subcommittee Members feed information to the Subcommittee Chair if there are any particular items they want to be discussed on June 22^{nd}, because I don't want there to be left --

CHAIR CORRADINI: Right.

MS. CUBBAGE: -- issues that don't get discussed.

CHAIR CORRADINI: But right now, the plan is the interim letters that you all have, I'm sure you keep a copy in some folder, to essentially go over those recommendations, those observations and clear those up as we were worried about them. They have closed them. And then focus on Chapter 19 and this particular issue.

MS. CUBBAGE: That's right.

CHAIR CORRADINI: We are not going to rehash anything that has been hashed.

MS. CUBBAGE: That's right. And I'll give another example. Chapter 8, one of the significant issues we had was the battery qualification, which we discussed this morning. So I don't anticipate any substitutive discussion on Chapter 8 on June 22nd, but you will have the staff's safety evaluation.

CHAIR CORRADINI: Okay.

MEMBER STETKAR: When you said just for clarification on the aircraft impact, that's from a PRA perspective of non-intentional aircraft impacts?

MS. CUBBAGE: No, this is intentional.

MEMBER STETKAR: Okay.

MS. CUBBAGE: Yes.

MEMBER STETKAR: So we --

MS. CUBBAGE: It happens to reside in

Chapter 19.

MEMBER STETKAR: Oh, it does in this one?

MS. CUBBAGE: Yes, it does.

MEMBER STETKAR: Okay. Okay. That's not normal?

MS. CUBBAGE: Because it's a beyond design basis.

MEMBER STETKAR: Okay. Yes.

CHAIR CORRADINI: That's what I thought.

MEMBER STETKAR: Thanks.

CHAIR CORRADINI: Okay. So I just want to make sure everybody understood the ground rules, because this is the start, today is the start of a series of Subcommittee meetings that will have no open items and staff, with the applicant's help, will explain to us how things have been resolved.

And so the next one is June 22^{nd}.

MEMBER STETKAR: Right.

CHAIR CORRADINI: Okay. Thank you all. Have a good time at lunch. We're adjourned.

(Whereupon, the Open Session was concluded at 11:32 a.m.)

Presentation to the ACRS Subcommittee

ESBWR Design Certification Review
Chapter 9.4,"HVAC," and
Section 6.4, "Control Room Habitability System"

May 19, 2010

Purpose

- Brief the Subcommittee on the staff's review of the ESBWR design certification application, Chapter 9.4, "HVAC," and Section 6.4, "Control Room Habitability System"; ventilation issues
  - Previous briefing on this issue was given to the subcommittee on November 17, 2009.
- Answer the Subcommittee's questions

Project and Technical Review Team

Project Managers

- Dennis Galvin, Project Manager (9.4)
- Ilka Berrios, Project Manager (6.4)

Technical Reviewers

- Jim O'Driscoll (6.4, 9.4.1 - 9.4.8) – Lead
- Ed Forrest
- Syed Haider
- Shie-Jeng Peng

Staff Focus

Expected performance of the passive cooling of Control Room Habitability Area (CRHA) and Reactor Building (RB)

- Ability to maintain habitability and operability of equipment for 72 hours following an accident.

Post Accident Emergency Filter Unit (EFU) Operation

- Quantity of Air Supply
- Air distribution, mixing, flow paths, and temperature
- Carbon Dioxide Levels
- Power Supply

RAI Status Summary

Chapter 9.4

- Issued RAIs = 58
- Resolved = 58
- Open Items = 0

Section 6.4

- Issued RAIs = 25
- Resolved = 25
- Open Items = 0

RB and CRHA Temperature Control

Can passive cooling of ESBWR CRHA and RB maintain habitability and operability of equipment for 72 hours following an accident?

Key Questions for a review of this feature:

- Determine reasonable habitability acceptance criteria (AC) for CRHA temperature/humidity
- Review applicant's AC and method of demonstration
- Determine required level of detail/verification for a supporting heat up analysis
- Determine important assumptions and appropriate level of configuration control to maintain them

Staff Review Approach – CHRA Temperature and Humidity

- Review supporting heat up analyses of RB and CB
  - Review proposed performance acceptance criteria
  - Review input assumptions in design basis calc
  - Review verification methodology / analyses
    - Identify sensitivities
  - Review results of analyses
  - Identify documentation of insights in analyses vs. design basis information
  - Review proposed ITAAC

Staff Review Approach – CHRA Temperature and Humidity

cant Actions completed

- ONTAIN 2.0 analysis submitted
  - as the design basis calculation for the CRHA analysis
- RHA GOTHIC analysis submitted
  - to demonstrate mixing in MCR
- rst principle calculation submitted
  - As alternate method of demonstration of passive heat removal
- AAC added
  - to update and validate design basis calc with as-built building dimensions, thermal properties, and exposed surface areas, heat loads, and environmental assumptions.

Actions Completed

- aff review of CONTAIN 2.0 analysis of CRHA and RB
- aff review of CRHA GOTHIC analysis results
- aff review of applicant's first principles calculation
- aff review of DCD changes and ITAAC
- aff performed confirmatory calculations

Staff Review Approach – Temperature

ant's CRHA Maximum Temperature Criteria

sed on EPRI Utility Requirements Document guidance: CRHA max perature rise limited to 15°F for a MCR with a normal temp range of 73-F

Proposed ESBWR CRHA temp acceptance criteria: <93°F

- ESBWR CRHA max temp limited to 74°F per TS; allowing a maximum rise of 19°F

Staff concludes this criteria is consistent with URD guidance

ant's Outside Temperature Input Assumptions

°F coincident with 80°F wet bulb

Site envelope 0% exceedance value per EPRI URD guidance

nperature daily swing of 27°F chosen for DCD calculation

Applicant used ASHRAE Fundamentals handbook to develop representative swing

Swing amount to be updated with site specific information in COL analyses ITAAC

Staff concludes that the input assumptions are acceptable

ted States Nuclear Regulatory Commission
tecting People and the Environment

Staff Review Approach – Humidity

ant's Operator Functionality Criteria

- licant uses Wet Bulb Globe Temperature (WBGT) Index, a widely used ustry standard to assess heat stress
- F WBGT index maximum was proposed by applicant
  - NIOSH standard is WBGT <86ºF allows unlimited stay time for light work
  - NUREG 0700 recommends stay times implemented for WBGT >90ºF

ant's Outside Humidity Input Assumptions

- F non-coincident wet bulb temp per DCD chapter 2
  - Highest coincident Dry bulb temp of 92ºF chosen (86% RH)
- daily temperature swing allowed
  - Based on weather station data from 3 gulf coast states
  - results in outside air relative humidity to cycle daily from 86% to 100%;
- al CHRA humidity is assumed 60% (maximum of normal range in DCD)
- ff concludes that the input assumptions are acceptable

U.S.NRC
United States Nuclear Regulatory Commission
Protecting People and the Environment

Summary of Submitted Analyses

CRHA Temp/ Heat Stress at the end of 72 hour passive cooling

- Design Basis: CONTAIN single node model
  - To demonstrate bulk room temperature and heat stress conditions meet proposed acceptance criteria.
- Supplementary models
  - GOTHIC
    - To demonstrate that some convective mixing is expected in CRHA
  - First Principles calculation
    - To support the use of CONTAIN as design basis method

ted States Nuclear Regulatory Commission
tecting People and the Environment

CONTAIN Review

- eviewed CRHA heat up calc report and data files
  - Heat sinks and heat source information does not conflict with DCD Tier 2 information.
- aff Sensitivity Studies
  - Concrete density and specific heat
  - Heat transfer Area
  - EFU fan flow rate
  - Moisture generation rate (i.e. perspiration and respiration)
  - Outside Air temp; not likely to be higher than assumed
  - Humidity of outside air; not likely to be worse than assumed

<u>\ bulk temperature value varies most with concrete thermal properties; other rameters are less sensitive</u>

<u>\ heat stress index value varies most with respect to outside air relative humidity sumption</u>

GOTHIC Review

pplicants provided multi node GOTHIC analysis in order to emonstrate convective mixing in the MCR due to temperature fferences in room

1. Used 20% lower sensible heat loads than CONTAIN
2. Used lower EFU fan flow
3. Used higher initial heat sink temperature

taff compared GOTHIC against the design basis analysis

- Case 1: Staff run of Applicant's input file- no changes
  - Staff obtained similar results (93°F average of nodes)
- Case 2: Staff revised GOTHIC input parameters #1 and #2.
  - CRHA bulk temperature obtained was close to CONTAIN
  - Revising parameter #3 further would likely result in lower calculated CRHA temps.

<u>Staff considers GOTHIC results support use of CONTAIN for this</u> application.

First Principles Calculation Review

licant submitted analysis as an alternate demonstration of the CRHA sive cooling mechanism

- Bulk room temp shown to be 91°F
- CRHA heat up rate profile graph similar to CONTAIN

ff compared against the design basis analysis

- Overall heat sink mass and heat load is same
- Distribution of heat sink mass simplified
- Mass of CRHA air assumed to remain constant

ff modeled CRHA using first principles

- In order to check the design basis winter case
- In order to obtain insights in sensitivities on other cases
- Used Visual C++ to model room
- Same heat sink mass and properties as CONTAIN
- Using same input assumptions as applicant, the bulk room temp shown to be close to CONTAIN and GOTHIC results

Staff considers first principles results support use of CONTAIN for this application.

Insights From Staff Review of Analyses

- NTAIN model has some conservative assumptions
- THIC demonstrates convective mixing is expected
- hest averaged temperature in the occupied zone observed in GOTHIC del
  - Staff's sensitivity study approached CONTAIN result when most inputs were matched.
  - The small differences between the 3 different model's temperature results is small and considered inconsequential.
  - Agreement in model results support use of CONTAIN.
  - CONTAIN Methodology made Tier 2*
  - ITAAC added for verification of heat stress conditions using site specific environmental data and as built heat sink information.

Staff concludes that supplemental analyses support the use of CONTAIN for demonstration of performance of CRHA passive cooling features for the ESBWR.

U.S.NRC
ted States Nuclear Regulatory Commission
tecting People and the Environment

Insights From Staff Analyses

pplicant's CONTAIN results are close to the acceptance criteria of 3ºF at end of 72 hours

- Maintenance of margin may be important for sites located in hot dry, or very humid locations.
- Configuration control of heat loads and sinks may be important for some sites.
  - Some passive cooling CRHA design detail description added to Tier 2.
- Details on how EQ service temperature will be determined was added to DCD
  - CRHA Computer-based I&C systems will be type tested at much higher temperatures than observed in these analyses (140ºF), and preferentially as a complete system (inside cabinets)

The Tier 2 CRHA Description, EQ service temperature description and proposed ITAAC provide confidence that CRHA will meet AC when built.

Discussion/Subcommittee Questions