Official Transcript of Proceedings

NUCLEAR REGULATORY COMMISSION

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

Docket Number: (n/a)

Location: Rockville, Maryland

Date: Monday, August 16, 2010

Work Order No.: NRC-384 Pages 1-124

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

+ + + + +

MONDAY

AUGUST 16, 2010

+ + + + +

ROCKVILLE, MARYLAND

+ + + + +

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

SUBCOMMITTEE MEMBERS:

MICHAEL CORRADINI, Chair

SAID ABDEL-KHALIK

JOHN W. STETKAR

CONSULTANTS TO THE SUBCOMMITTEE:

THOMAS S. KRESS

GRAHAM B. WALLIS

ACRS STAFF:

CHRISTOPHER BROWN, Designated Federal Official

AMY CUBBAGE

BRUCE BAVOL

GEORGE THOMAS

LAMBROS LOIS

JAMES GILMER

DENNIS GALVIN

JIM XU

LESLIE PERKINS

ALSO PRESENT:

WAYNE MARQUINO

GARY ANTHONY (via telephone)

JERRY DEAVER

ERIC KIRSTEIN

DAVE HAMON

TABLE OF CONTENTS

P R O C E E D I N G S

Time: 8:29 a.m.

CHAIRMAN CORRADINI: This meeting will come to order. This is a meeting of the Advisory Committee on Reactor Safeguards on the ESBWR. My name is Mike Corradini, Chairman of the Subcommittee. Currently, Subcommittee members in attendance are Dr. Said Abdel-Khalik, Mr. John Stetkar, soon to be Dr. Sam Armijo and Charlie Brown, and our consultants Dr. Tom Kress and Graham Wallis.

The focus of this meeting is to be briefed on the final SER for Chapters 2, 10 and 12, 14, 15, 16, 18, 20 and 21 associated with the ESBWR design.

In addition, the Subcommittee will be briefed on the staff's evaluations associated with jet impingement, ATWS, AOOs, stability, LOCA and fuel rack analysis for the ESBWR.

The Subcommittee will hear presentations by and hold discussions with representatives of the NRC staff and the ESBWR applicant, General Electric Hitachi Nuclear Energy, regarding these matters.

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

Christopher Brown is the Designated Federal Official for this meeting. The rules for participation in today's meeting have been announced as part of the Notice of this meeting previously published in the Federal Register on July 29, 2010.

Portions of the meeting may be closed to protect the information that is proprietary to the GEH Nuclear Energy and its contractors, pursuant to 5 USC 552(b)(C)(4).

A transcript of the meeting is being kept and will be made available as stated in the Federal Register Notice. It is requested that speakers first identify themselves, speak with sufficient clarity and volume that they can be readily heard. Also, silence every conceivable electronic appliance/device so we don't hear them ring.

We have not received any requests from members of the public to make oral statements or written comments. Do we have GEH staff on the phone lines? I believe we do.

PARTICIPANT: Yes, we do.

CHAIRMAN CORRADINI: Okay. And you will put it on Mute until we call you.

Just to give some further background to those that are currently in attendance on this bright and sunny Monday morning, we are now in the third of four Subcommittee meetings which are going to be reviewing the SERs -- the final SERs with no open items.

We have gone through a group of chapters back in June. We talked about long term cooling and some ancillary still unresolved issues relative to hydrogen, vacuum breakers in July, and we are back here with this group of chapters in August.

We will have one other Subcommittee meeting -- Well, I should say we currently have scheduled one other Subcommittee meeting in September, and one may be occurring in October before we go to the final SER.

Let me turn it over to Amy Cubbage, the ESBWR team leader, to kick off today's meeting. Amy.

MS. CUBBAGE: Thank you. Good morning. As the Subcommittee Chairman mentioned, we have a number of topics to cover today. I apologize for the random order here. We tried to group some of the topics that might have proprietary content together and based on staff availability.

So we are going to start off today with Chapter 15. You heard from the staff at a Subcommittee -- I guess that is about over two years ago now with the staff's SER with open items. You also heard from the staff in the fall. We covered selected topics, including the feedwater temperature operating domain. We are not going to focus on that here today.

So I will let GE start off the day here, Wayne Marquino.

CHAIRMAN CORRADINI: Wayne.

MR. MARQUINO: Thank you. I am Wayne Marquino. I work at GE Hitachi, and I will be covering Chapter 15.

For Chapter 15, we have some specific topics that were requested by the staff that we hit on, and then we reserved a lot more time for the staff so that they can go through their review and alternate calculations and such. Next slide, please. Oh, and I am backed up in Wilmington by Dr. M.D. Alamgir and Antonio Barrett.

So the topics that staff asked us to cover are the select control rod run-in and select rod insert features of the ESBWR, the reactivity insertion event frequency classification, and control rod drop accident, and then I will summarize Chapter 15.

ESBWR provides rapid power reduction through the SCRRI, or S-C-R-R-I, and SRI features.

The power reduction is intended to prevent a scram or other undesired conditions.

The function is similar to recirc core flow run-back in other BWRs. Of course, we don't have forced recirc flow control system. So we don't have any way to reduce core flow, and this provides a similar function with the control rods.

SCRRI or S-C-R-R-I is electrical insertion of rods to a preset pattern. So we have the fine-motion control rod drives. They have motors that can screw them in and out. We have a control system that has a pre-set pattern, and when SCRRI activates, the rods start inserting at their normal speed. They only have one electrical speed, and they go to that predetermined position and stop.

SRI is hydraulic scram of predetermined rods, and this feature has been in BWRs going back to the BWR-4 plants. So the insertion is hydraulic, same as the scram, and we are triggering only a subset of the rods to scram.

In the initial submittal we only included the SCRRI feature in the design. SRI was added later to effect a more rapid global reduction in power.

CONSULTANT WALLIS: That is without a scram. It is just a reduction?

MR. MARQUINO: Right. Next slide.

So the types of events that these systems would trigger are a load rejection where we have lost the grid load. We want to get the power back quickly in anticipation of the turbine running back and the feedwater temperature dropping. So we SCRRI and SRI rods together.

CHAIRMAN CORRADINI: Can you repeat that again? I am sorry.

MR. MARQUINO: Yes. If we have a load rejection, we have to reduce the turbine power. So the turbine control valves are going shut. The bypass valves are opening. The feedwater temperature is going to be dropping, because the feedwater heating is substantially lost. In anticipation of that feedwater temperature drop and power reduction, we insert control blades to get the power down and keep it down.

CHAIRMAN CORRADINI: But with both systems. That is what I was trying to --

MR. MARQUINO: Both systems. So now whenever one system -- Whenever one insertion mode actuates, the other insertion mode also actuates.

MEMBER ABDEL-KHALIK: What is the time constant for the feedwater temperature reduction in the scenario?

MR. MARQUINO: Thirty seconds to a minute.

MEMBER ABDEL-KHALIK: So it is a lot slower than the response time for these systems. Otherwise, the two would be sort of bucking each other.

MR. MARQUINO: Yes. We want to get the power down to reduce the load on the condenser. It makes it easier to size the condenser. Then we have this anticipation of the temperature reduction and power increase.

CONSULTANT WALLIS: So you need this hydraulic thing to get things to happen quicker, really, because the electric thing is taking its time.

MR. MARQUINO: The electric thing is taking time, and also it is shifting power to the top of the core as the rods insert. So the hydraulic is a way to get a global reduction fast and then follow it with additional reactivity from the electrical insertion. Also, we group the SRI so that we kind of are -- we are putting in four rods, four rods, so we don't have a large water level reduction.

CONSULTANT WALLIS: Does rod pattern vary, depending on the fuel loading? It does.

MR. MARQUINO: Yes.

CONSULTANT WALLIS: So it has to be computed somehow.

MR. MARQUINO: Yes. The rod pattern -- We do rod sequence exchanges over the cycle where we take inserted rods out and replace them with other rods. So just in those instances, we will have to change the program to make it appropriate for the conditions. Next slide, please.

The activity insertion events: Initially, in the DCD we classified all reactivity insertion events as infrequent events, or IEs, which means they are not expected to occur during the life of the plant, and they have a frequency of less than once per 100 years.

CHAIRMAN CORRADINI: Now just to -- This is more -- You have explained this to us a while ago, but just to remind me. So this is a classification you guys have take on internally to group them, but these are still not DBAs. This is just a subclass of various AOOs. Is that correct?

MS. CUBBAGE: I would rephrase that.

CHAIRMAN CORRADINI: Well, please rephrase then, so that I get it right, because I can't remember. I know there is a subclass of infrequent events.

MS. CUBBAGE: Right. There is subclass of accidents.

CHAIRMAN CORRADINI: It is a subclass of accidents?

MR. MARQUINO: Thank you.

MEMBER STETKAR: Wayne, I am sorry. Before you get onto the AOOs and things, could we go back to the SCRRI stuff a little bit?

MR. MARQUINO: Sure.

MEMBER STETKAR: When I was going through some of the transient analyses in Chapter 15 of the DCD, there is one for fast closure of a turbine control valve, and it shows -- It starts from 100 percent power. It shows stable steady-state reactor power after the initial spike, stabilizes at 100 percent power, which tells me that SCRRI did not activate. Is that true?

MR. MARQUINO: That is right.

MEMBER STETKAR: Now how does this work in the real world if my generator output demand is set at 100 percent power, and my turbine is now putting out probably about -- I don't know -- how much power?

MR. MARQUINO: Well, 100 percent -- You are saying you are operating at 100 percent power?

MEMBER STETKAR: Right.

MR. MARQUINO: There is a power-load unbalance device in the turbine control system that is designed to prevent overspeed of the turbine.

MEMBER STETKAR: But I won't get over -- This is a turbine control valve went closed on this.

MR. MARQUINO: Yes, okay. So one turbine control valve went closed, and the control system may not know -- The control system probably didn't demand the valve to control close. There is some mechanical or hydraulic problem that caused it to close. So in that case, there is no triggering of the SCRRI/SRI system.

MEMBER STETKAR: Well, how does the plant really respond, though, because this shows reactor power at 100 percent, turbine steam flow at about 82 percent. So I got a mismatch. So I obviously have turbine bypass valves open, but the generator demand is still sitting at 100 percent power.

MR. MARQUINO: Right.

MEMBER STETKAR: What does the rest of -- What does the Plant Automation System do under these conditions? Does it have a trigger for SCRRI or anything?

MR. MARQUINO: No.

MEMBER STETKAR: So the generator -- I

would have a generator-turbine load mismatch signal. I don't know, in your design, whether that does anything.

CHAIRMAN CORRADINI: Do you want to take that under advisement?

MEMBER STETKAR: I was just curious why you didn't get SCRRI on this thing.

MR. MARQUINO: Because the signals that initiate SCRRI are not present.

MEMBER STETKAR: Are not any one of those.

MR. MARQUINO: And at least at this point in the design, we don't have any kind of automation that, in this particular -- that is designed to detect and mitigate this particular scenario, the failure of one control valve. So basically, what happens is the control valve went closed. That caused pressure to increase, and now the pressure controller opens the bypass valves to get the pressure back where we want it. Okay.

MEMBER STETKAR: I understand how some stuff does okay.

MR. MARQUINO: Okay. Now there are limits to both control system and the automation systems, like we won't allow the automation system to increase core power above the licensed thermal power. So it is not going to try and pull rods to get the generator power back up to 100 percent, which I think is where you were going.

MEMBER STETKAR: That is where I was going. Is there a signal -- You know, right now we are sitting with a generator load demand set at 100 percent, which I am assuming you set in somehow, and an actual turbine power, however you measure it, at something like 80 percent. I was curious what the automation system does in response to that sort of thing.

CHAIRMAN CORRADINI: Just let me make sure. I will interject. So your point is, at least to you now, it doesn't cause any sort of control rod movement. But it won't cause control -- That won't initiate any control rod movement.

MR. MARQUINO: No. We will open the control valves. It will demand all the control valves to open --

CHAIRMAN CORRADINI: Yes, sure.

MR. MARQUINO: -- to preset limits, and after that it will open the bypass valves, and then it says, okay, I have done everything within my limits, and in this case where one valve failed, the plant would sit there and wait for the operator to figure out what happened and respond.

CHAIRMAN CORRADINI: Okay.

MEMBER STETKAR: Okay, but the key for no SCRRI is that it just -- Those particular conditions aren't any of the initiating signals to drive the rods?

MR. MARQUINO: Yes.

MEMBER ABDEL-KHALIK: How much does the feedwater temperature change in this event?

MR. MARQUINO: This one, at about 200 degrees. Well, at zero power with no heating, the feedwater temperature is either the circ water temperature or the temperature established by our start-up heating system, which is 80 degrees C. Normally, it is 420 degrees C. So potentially we have a reduction of several hundred degrees fahrenheit, if you reduce down to, say, 10 percent steam flow.

CHAIRMAN CORRADINI: But that -- That is the range, but that is not the delta here.

MR. MARQUINO: No. In this event Mr. Stetkar is referring to, there is a power reduction of about -- of 80 percent, so a much smaller feedwater temperature drop in that event.

MEMBER STETKAR: Well, but even the total steam flow is still the same, though, because you have still got 20 percent going out through the bypass.

MR. MARQUINO: Right, but it is not being -- and that is not being heated.

MR. ANTHONY: Wayne Marquino, Gary Anthony just joining the conversation.

CHAIRMAN CORRADINI: I was waiting for Wayne to ask for help. No offense.

MR. ANTHONY: I was just sitting at my desk getting ready to come to Washington. I fly out in a couple of hours.

What is the specific question on the balance of plant that I can assist you with today?

CHAIRMAN CORRADINI: John, did you want to ask the question again?

MEMBER STETKAR: If it is worth taking the time. If it is not --

CHAIRMAN CORRADINI: We will give you two more minutes. Go ahead.

MEMBER STETKAR: The question I had was on a turbine control valve, spurious closure of a turbine control valve.

MR. ANTHONY: All control valves, or one?

MEMBER STETKAR: No, no, just one. In the DCD it is -- Figure 15.2-2 shows a transient response. It shows that the reactor power stabilizes at 100 percent. The steam flow, turbine steam flow stabilizes at a little over 80 percent, which means that we must have about 20 percent turbine bypass flow.

My question on the secondary control was: I still have 100 percent electrical power demand set in for the main generator. So I now have a generator demand versus turbine load mismatch of about 20 percent. I have absolutely no idea how the secondary control system -- I don't know whether it is the Plant Automation System or what -- what that does in this situation.

MR. ANTHONY: Well, that is one of the cool things about the new digital automation control system, that we can select how it actually responds to these type of transients. What you are seeing in Chapter 15 is a worst case scenario of what would actually be seen.

In reality, what we are going to see, and we will find that out during our first start-up testing, is the plant will actually run with one control valve closed at about 92 percent power. It won't actually drop down to 80. That is more of a worst case scenario.

We have quite a lot of capability in our bypass valves and our control valves, and since we do control valve testing on, basically, a quarterly basis with one valve of each one being closed, the plant will actually run at a higher power output still. But based on the Chapter 15 analysis, we could be at 80 percent, which allows the mismatch of the bypass valves, control valves, and operating system to analyze the situation that we will be in, and we will actually be setting up in, I think, Chapter 14, the start-up tests, these check responses of the system.

MEMBER STETKAR: Okay.

MR. ANTHONY: The trigger analysis of -- Go ahead.

CHAIRMAN CORRADINI: Go ahead and finish. We were trying to understand where you are going.

MR. ANTHONY: Okay. The trigger analysis for SCRRI and SRI will be set up under plant automation about how big of a differential mismatch between generator output and reactor output is.

MEMBER STETKAR: Is it reactor output or turbine output?

MR. ANTHONY: Well, we have a generator output, and it is looking at total reactor power, what is being put into the system. My understanding from Ira Poppel is that they will be setting the SRI and

SCRRI to reduce that mismatch, if it gets beyond a specific point, and I thought that was 35 percent, because the bypass valves will take a -- Basically, we have 110 percent bypass capability. Even with one failure, we can still survive an island mode with one valve out.

That particular spot of the triggering of the SRI or SCRRI, I am not sure has been actually selected yet, is part of the details of our start-up testing where we trigger that piece.

CHAIRMAN CORRADINI: So I think we have enough to go on, but let me repeat the last part of this. What you are telling me is at this point the setpoint at which you would initiate these two control rod run-ins has not been exactly decided.

MR. ANTHONY: I do not have the numbers at this time. Maybe Ira has set that out. It would be based on the -- I think it was the Dodewaard test -- The Leibstadt test.

MR. MARQUINO: Let me be clear. There are some setpoints that we credit in the safety analysis, like a 30 degree drop in feedwater temperature triggers the SCRRI/SRI; a load rejection SCRRI triggers the SCRRI/SRI. There may be other times that we want to initiate it from the automation system, but that hasn't been determined yet, and we didn't credit it in Figure 15.2-2.

CHAIRMAN CORRADINI: Okay, thank you. Thank you. Go ahead.

MR. MARQUINO: Okay. Reactivity insertion events: Infrequent events. We determined that some reactivity insertion events are higher frequency and fall in the anticipated operational occurrences category. We revised Section 15.2-3 and reclassified control rod withdrawal error during start-up and during power operation as AOO events.

These scenarios don't cause fuel rod failure or dose consequences. So that change didn't have any -- didn't challenge the acceptance criteria, but we did have to make it to properly bin the events in the right category.

CONSULTANT WALLIS: So you reclassified, because you had different thoughts about possible human error. Is that what it is?

MR. MARQUINO: Yes. Actually, that is one of the reasons why we reclassified it, because for control rod withdrawal during start-up, the operator can manually pull rods and, just as in an operating plant, if you are not careful, you can put the reactor on a short period and scram it. So that is a reactivity insertion event, and we don't have data that shows the human performance would keep that from happening over the life of the plant. So we put it in the AOO category.

CHAIRMAN CORRADINI: So actually, Graham was going down the path that I wanted to get clear, because again you explained all this to us, but it was a couple of years ago. So just bear -- So the purpose is to move things from -- This new classification, which is not in the NRC jargon but is a jargon you have put together, moves events -- just use the general term, events -- from the AOO category into this or from the DBA category into this? That is what I am still a bit fuzzy on.

MR. MARQUINO: Right. We moved a bunch of events from AOO into infrequent, and we moved these two events back in a subsequent DCD revision.

CHAIRMAN CORRADINI: Okay. Thank you.

CONSULTANT WALLIS: In terms of NRC jargon, they are presumably still AOOs, are they?

CHAIRMAN CORRADINI: Yes. That is what I am trying to --

CONSULTANT WALLIS: So what is being achieved by this, I am not quite sure.

CHAIRMAN CORRADINI: So that is what -- I guess we will ask the staff.

MR. MARQUINO: They are accidents, which means they have a defined dose acceptance criteria versus AOOs which have a -- 99.9 percent of the rods don't fail acceptance criteria.

So by making this change, we are acknowledging that we have more reliability in the equipment, including the control systems, and we are getting improved thermal limits from it, because we have changed the acceptance criteria and relaxed it for these infrequent events.

CONSULTANT WALLIS: So they are not quite AOO. They have new acceptance criteria.

CHAIRMAN CORRADINI: Well, again just to clarify, I think we should ask the staff this, but your purpose in doing this is essentially to -- is that their frequency has been reduced, and their criteria for -- Their acceptance criteria has to deal with very specific things rather than just fuel reliability on a global basis. That is the way I heard you answer the question.

MR. MARQUINO: Yes.

CHAIRMAN CORRADINI: We can ask the staff later about from their perspective.

MR. MARQUINO: Yes, and GE didn't invent

the acceptance criteria.

CHAIRMAN CORRADINI: No, that I understand.

MR. MARQUINO: That is written in COR.

CHAIRMAN CORRADINI: That I gather, yes.

MR. MARQUINO: We coined the name to make it easy to talk about these events.

Next slide, please. Control rod drop accidents: To avoid control rod drop accidents, we have redundant safety related switches in the ESBWR and ABWR control rod drives to detect uncoupling of blade movement from drive movement. By that, I mean if a blade was uncoupled from the drive and bound in the core, if the drive is moved, we can detect that the blade is not moving with it.

If the drive is not seeing the weight of the blade on it, then we know there has been an uncoupling, and we block motion of the drive. So we prevent the situation that we can pull a drive all the way out and have a blade drop from fully inserted to the bottom.

CHAIRMAN CORRADINI: And has that setpoint where you determine that had been at least scoped out what -- You said that --

MR. MARQUINO: It is in the operating

ABWR, they are running with these load cells or switches in the drive.

CHAIRMAN CORRADINI: So this is similar to an ABWR design?

MR. MARQUINO: Yes.

CHAIRMAN CORRADINI: Okay, thank you.

CONSULTANT WALLIS: It makes it incredible?

MR. MARQUINO: Yes.

CONSULTANT WALLIS: I would think that it would be a probability instead of incredibility.

MR. MARQUINO: Well, that is what these slides are about. In the ABWR licensing, we documented these features. We stated it is incredible. We didn't provide fuel failure analysis or dose consequences, and --

CONSULTANT WALLIS: If the blocking logic fails or something, then this doesn't work, does it? It seems to me there is a credible way in which it could not operate properly.

MR. MARQUINO: So the NRC asked questions like that, and we quantified the reliability. It is up in the E minus 5 or 6 range. After documenting the reliability, the NRC requested quantification of the dose consequences, and that is on the next slide.

We calculated the blade worth and enthalpy rise using the PANACEA code and the TRACG code. Our rod worth is lower than operating BWR 2 through 6 plants, because we have tighter control of the rod positions during start-up, and also the core is larger.

With the lower rod worth, the enthalpy rise in the event of a control blade drop didn't exceed the SRP 4.2 criteria and, therefore, there would not be fuel damage and, therefore, there are no dose consequences.

so we have provided this analysis. The results are in the DCD, and we have established a rod worth criteria that can be used to evaluate future cores, as long --

MEMBER ABDEL-KHALIK: How would the tighter control of rod position affect the total rod worth?

MR. MARQUINO: Good question. If you can establish a pattern that has one blade fully inserted with no blades around it, then that is going to be a very high worth blade. On the other hand, if --

(Whereupon, the foregoing matter went off the record briefly at 9:02 a.m.)

CHAIRMAN CORRADINI: Wayne, we are on

again.

MR. MARQUINO: I am going to use old-fashioned pencil and paper to explain this.

CHAIRMAN CORRADINI: I am not sure we can handle that. That could be horrific.

MEMBER ABDEL-KHALIK: Words should be sufficient.

MR. MARQUINO: Okay. So if I have three blades in the core, and two of them are on the periphery, one is in the center, compare that to four blades in the core where I have two blades in the center, and they are sharing the activity worth.

So the worth of the blade in the center in this case is higher than that case. So this may be a simplification, but we have a rod worth minimizer in all the operating BWRs that controls patterns like this, and in the ESBWR we control to a tighter pattern than in previous plants.

CHAIRMAN CORRADINI: Just so I understand that, when you say a tighter pattern, you mean the setpoint that you arrive are blades to be -- I don't want to say askew, but -- in different locations is a smaller gap, window, or dead band. Is that what you are getting at.

MR. MARQUINO: Right. We are withdrawing

the blades together at different positions in the core versus pulling one blade more notches.

CHAIRMAN CORRADINI: Okay. Thanks.

CONSULTANT WALLIS: The main thing is, you have a rod worth minimizer criteria. That is the main thing. That is how you do it. That is how you reduce the rod worth.

MR. MARQUINO: Yes.

CONSULTANT WALLIS: Then it is lower. How much is it lower than it was before?

MR. MARQUINO: I don't -- I can't tell you.

CONSULTANT WALLIS: It is significant, though, isn't it?

MR. MARQUINO: Yes. Next slide, please.

So in summary on Chapter 15, all the open items are closed with the NRC, or I guess I should be letting them say that in their presentation.

CHAIRMAN CORRADINI: Yes, I think so.

MR. MARQUINO: We have reduced the event frequency in this BWR by providing redundancy in control systems and components. Our larger steam space in the RPV provides a softer pressure response, and the fast closure of one control valve is an example of that.

We don't have SRV opening in AOOs, unlike the operating plants, and the safety analyses in Chapter 15 show that the 10 CFR acceptance criteria for SAFDLs and dose are met.

So this is our brief summary of Chapter 15, and I will take any questions, and then let the staff come up and give their viewpoint.

CHAIRMAN CORRADINI: Questions to Wayne? All right. Oh, you do have a question? I am sorry. Excuse me. Go ahead.

MEMBER ABDEL-KHALIK: Maybe I will ask the staff.

CHAIRMAN CORRADINI: You are going to wait?

MEMBER ABDEL-KHALIK: I will wait.

CHAIRMAN CORRADINI: Thanks, Wayne.

MR. MARQUINO: Thank you.

CHAIRMAN CORRADINI: So the staff will come up and give their views. Just to remind everybody, we do have a CD for Rev. 7 of the DCD. Bruce, are you going to be the lead?

MR. BAVOL: Yes. Good morning. My name is Bruce Bavol. I am the lead Project Manager for Chapter 15, final safety evaluation, and we are going to jump right in. I am going to turn this over to

George Thomas, and we also have Dr. Lambros Lois, who is going to be assisting in the presentation today.

MR. THOMAS: Okay. This Chapter 15 was a team work. They are not all on there. So it was a big job.

If you look at the ESBWR, there are no active safety pumps, and also after he told us just now, they might have to offer 110 percent as compared with only 25 percent is for the current ones. Also, the level is very big compared with current BWRs. So most of the -- as Wayne told you, there is no lifting of the safety relief valves, and they are really there for -- only for ATWS.

Because of all these changes in the design of the ESBWR, some of the AOOs are now characterized as infrequent events. So go to the next slide.

CHAIRMAN CORRADINI: But what is -- Since you have brought that up, let's -- Maybe this slide will help us. From the standpoint of General Electric, GEH, I guess I understand where they are coming from, but my sense of it is, although this is maybe a nice way to subdivide things, this doesn't affect the staff's evaluations, but can you kind of weave that into what you are going to explain on this, because I am still a little bit fuzzy.

MR. THOMAS: You know, we followed the basic philosophy that you say you want this less frequent. Then the criteria can take more severe consequences. That is the basic philosophy we are at.

CHAIRMAN CORRADINI: But that philosophy and the criteria don't change, depending upon how you name the event.

MR. TURNER: Right. Yes. The philosophy is the same, right.

MS. CUBBAGE: Actually, it does change. So an event that previously was categorized as an AOL would have a certain acceptance criteria in the operating plans now has a different acceptance criteria for ESBWR, because they were able to justify that based on the frequency being reduced for this event -- or for this plant.

So where you previously had the consequences not involving a dose criterion, now you do.

CHAIRMAN CORRADINI: Ah, where before it was simply a fuel failure fraction. Thank you. Sorry. I didn't catch that. Thank you.

MEMBER STETKAR: Let me ask you the question I was going to ask GEH, and they can chime in, and it is on a specific event that is now classified as an infrequent event, and that specific event is a stuck-open safety relief valve.

The current analysis calculates a frequency, I think -- There are several different numbers that I have found for this. As best as I can track it down, it is something on the order of about three times 10^{-4} event per year.

I think that analysis accounts for something like a challenging event occurs and all isolation condensers fail, and one or more safety relief valves sticks open; and because this is a rather convolved quantification, I don't think we have time to go through it all.

There seems to be some sort of fundamental difference between the frequency that is calculated for that event and the actual Chapter 15 safety analysis that is done for that event. For example, the frequency says we are going to assume that there is a 10 percent probability that all isolation condensers fail -- All isolation condensers fail. I will reiterate. All isolation condensers fail.

That sounds rather conservative, but that number is used to quantify this low frequency. The safety analysis for a stuck-open relief valve accounts for the fact that all isolation condensers are available.

You can't have it both ways. You can't reduce the frequency by assigning a failure probability to something, and then take credit in the safety analysis for the availability of that same thing that you assumed was failed and, in fact, assigned a probability of its failure.

You can't do it both ways. It is either failed and has some probability of being failed, and you can't take credit for it in the safety analysis, or it is not failed and the frequency is higher, because you can't take credit for the probability of its failure.

So I am curious about how now the frequency of these infrequent events jive with the success criteria that are used in some of the very specific safety analyses.

MS. CUBBAGE: I didn't follow exactly what you said.

MEMBER STETKAR: It is a long, convolved thing, Amy.

MR. THOMAS: Dr. Caruso from the PRA Branch --

MEMBER STETKAR: Perhaps GEH might want to answer it.

MR. LOIS: Can I -- I am Lambros Lois. Yes, indeed there is a dichotomy, and there is a conundrum, so to speak, between what the regulations say and what ESBWR presents us with; namely, if we go back to historical development and, in fact, even the GDCs, the GDC requires that -- GDC-28, for example -- that we have an analysis of the consequences to protect the boundary, the pressure boundary.

Yet GEH comes up and says, no, we have to violate two safety-related systems to reach in that particular situation. So if we were to follow what GEH says, then we violate what General Design Criterion 28 requires us to do. So that is why you saw the reclassification of some of these events.

The staff said, well, yes, you are right, and we believe what you said, GEH; however, we on the other hand, we have the regulations that they impose that we require you to consider some of these events as AOOs, and GEH did perform that analysis, reclassified them one way and the other, as Amy pointed out before, and that is why we arrived to the problem that you are facing there. We have already been there.

CHAIRMAN CORRADINI: So what you just told me is you are aware of this inconsistency, but I really don't understand your explanation. Do you understand the explanation?

MEMBER STETKAR: No.

CHAIRMAN CORRADINI: Okay. So can you try that again?

MR. LOIS: I will try again. The explanation is that we need to obey -- We need to follow the regulations, and we need to ask GE to commit to GDC-28. That says that you shall prove that.

The only way they can do that, if they assumed that they violated at least two safety related systems, one after the other.

MS. CUBBAGE: They have to have more failures. Is that what you are getting at, Lambros? They have to have more failures than a single failure to have the event happen.

MR. LOIS: Indeed. Yes.

MS. CUBBAGE: So that is, hence, recategorization. I think that is what he said.

MR. MARQUINO: This is Wayne Marquino with GEH. In Appendix 15A we are calculating the event frequency, and it is conservative in 15A to calculate a higher event frequency which would move the event into the AOO category.

So I see some cases in 15A where it assumes the failure of one isolation condenser with a stuck-open relief valve. There may be other cases where we assumed multiple isolation condenser failures, but in terms of the event frequency we tried to deviate in the direction of calculating a higher event frequency in 15A, which would move it into the AOO category.

It is true that there is not a correspondence between the 15A event frequency analysis and the corresponding transient analysis in the main part of 15.

The failure of multiple isolation condensers is a PRA event. So we have not addressed it in 15. That would be addressed in the PRA.

MEMBER STETKAR: You did address it in 15A, because in Section 15A(310-2) there is a nominal probability of 0.1 applied for the unavailability of the isolation condensers. Now you might say that is a PRA number. It is just a number. That number is, in fact, used in Section 15A to justify the infrequent frequency of this event. It is an applied factor, and the way it is applied is it says all of the isolation condensers are not available.

As I said, that might be a conservative

number, but it is a number that is used, regardless of who decided why it should be used. It is indeed used to justify a number in the DCD.

CONSULTANT WALLIS: But then you say, when they evaluate consequences, they assume --

MEMBER STETKAR: When they do the safety analysis in Chapter 15, they take credit for all four isolation condensers.

CONSULTANT WALLIS: There is an inconsistency which I have not seen explained yet.

MEMBER STETKAR: That is right. if the frequency of X is X, and that frequency says, well, the only way X can happen is if all of the isolation condensers fail, then the subsequent analysis for X should be done consistently, I would think, without taking credit.

If you say, well, we really want to do the analysis, taking credit for all four isolation condensers, then the frequency that you have assigned to X must be wrong. I don't know what the correct frequency is, but it must be wrong.

MR. MARQUINO: In that same section, in the first paragraph it says one of the isolation condensers does not open on demand. Is there another part where it says multiple isolation condensers fail or are we using the product of that .1 probability to come up with the probability of --

MEMBER STETKAR: I am not sure, and I need to go back and read. I wrote these notes a couple of years ago. So I need to go back and double-check. I wrote "unavailability of all isolation condensers." So I am assuming I found that somewhere, but I need to double-check that; and rather than us taking time, Mr. Chairman --

MR. MARQUINO: Yes, because .1 is certainly one isolation condenser, not all isolation condensers.

MEMBER STETKAR: Let's go on, and let me double-check my reference.

CHAIRMAN CORRADINI: I think staff has one last parting clarification. Go ahead.

MR. LOIS: Mr. Stetkar, we are aware that there is this inconsistency, and --

MEMBER STETKAR: But it doesn't bother you.

MR. LOIS: On the other hand, we do have General Design Criteria to obey, and that is our job, and that is what we will try to apply. Therefore, instead of violating GDC-28, we asked GE to perform some more calculations. That is where we came from.

Thank you.

MR. THOMAS: I wanted to say, you know, the government is talking about -- the plan. Because of that, we ask questions about this issue. Initially, there are their number was very much different than the number shown in the GDC. So these numbers were all changed, actually. So the numbers you see there is not the same number that came at the beginning, actually.

CONSULTANT WALLIS: Which number are you talking about?

MR. THOMAS: The relief valve -- yeah, that number. That is the number, right.

MEMBER STETKAR: I found the quote, and you are right. The first paragraph -- Again, for reference, for the record, 15A.3.10.2. The first paragraph says -- let me quote: "For an SRV event to occur, first the transient with potential for reactor overpressurization must occur. Second, one of the isolation condensers designed to actuate on demand does not open. Third, the number of SRVs open to relieve the pressure, and then finally, one of the SRVs fails to reclose after opening." Then there are some bullets.

Under there, it says the probability that

Isolation Condenser System is not available on demand is conservatively estimated to be 0.1. Now that is only one isolation condenser.

This means that, if I have a transient and only one isolation condenser of the four fails, I get the relief valves demanded. I thought that the success criteria was that, if only one of them worked, I didn't get a challenge to the relief valves. That is why I assumed --

MR. MARQUINO: That is true, but it is conservatively assumed in this analysis, that if one IC didn't work, there was an SRV open.

MEMBER STETKAR; Okay. Then it is -- We should go on. It is probably not as bad as I initially characterized it, if indeed this does assume only one failed. There is still a bit of a dichotomy, but thanks.

CHAIRMAN CORRADINI: Let's go on, please. Thank you.

MR. THOMAS: Okay. This whole chapter 15 was analyzed with TRACG, and we are going to discuss about TRACG this afternoon.

CHAIRMAN CORRADINI: The whole afternoon.

MR. THOMAS: The whole afternoon, right. And the Reactivity analysis was done by PANACEA, and

PANAC-11 is the latest of that, actually.

For reload analysis, we agreed with GE that they had to do only very few cases, which are the limiting cases for the GE14E, but if they change that, then they have to do the whole Chapter 15 analysis again.

So now Lambros will talk about the reactivity transients.

MR. LOIS: Thank you. Next slide. Well, I am afraid that, with Dr. Stetkar's question, you sort of preempted my discussion. That is exactly what I was going to say, but anyhow be it as it may.

RAI 15.3-33 requested that the reactivity transients be reanalyzed and recategorized. The point that GEH brought up said, well, look, I need two violations of safety-related systems. Therefore, here is my PRA. Here is my analysis. Here is proof of it. So I don't have to do any further calculations.

We pointed out that GDC-28 requires that we establish that such transients, reactivity transients, will not violate the -- or will not threaten the containment -- I'm sorry, the pressure vessel. Therefore, they need to perform some more analyses. Well, GE accordingly did perform that analysis, which was submitted, and we closed 15.3-33.

Next slide. Now I guess what is left for me to point out is that those calculations based on GD-28 were quite conservative. Now again, it has already been mentioned that conservatism comes from the fact that all impacts of those transients, and CRDA in particular, comes from the fact that the work of the control rods, because being a large plant, a large core, the reactivity in each one of the control rods is very small compared to the existing plants with smaller cores and larger reactivity per rod.

As you may recall from the older plants, we used to have quite a bit of an impact with the largest control rod dropped out from the core. Well, that is not the case with ESBWR, for obvious reasons, and they also made quite a number of conservative assumptions in doing that.

One of them is that the fact that they assumed adiabatic heating of all the fuel which, of course, does not provide any feedback because of the moderator reactivity kickback.

They assumed that the -- I don't have my glasses, and I can't see my notes.

CHAIRMAN CORRADINI: That's okay. You can hold it further or closer. We don't mind.

MR. LOIS: Several of these I remember by heart. They seem to have ignored, and Wayne may suggest something of that -- ignored the feedback from the Doppler effect because, obviously, you are going to wind up with higher temperature fuel temperatures and, therefore, have feedback from Doppler, which is not there. It is also conservative.

They also, for the safety or the violation of the cladding principles, instead of having the location of the maximum or the average maximum heat generation, which may not match, obviously, especially toward the end of the -- end of cycle, they assumed the maximum heat generation will coincide with the location of the maximum power production, which essentially says that the hydration -- or the cladding is more vulnerable at that particular position, and these two coincide.

All of these seem to contribute to the conservatism, and the bottom line was that, really, there was not the distance or the margin between the criteria -- obviously, it is Appendix B, which are provisional criteria there -- are quite large. The ratio of the criteria to the worst calculated value of the heat generation and breaching the cladding is between a factor of nine to a factor of 150. So, obviously, the margins are extremely high.

CONSULTANT WALLIS: This is in calories per gram or something?

MR. LOIS: Calories per gram, yes, joules per gram, I'm sorry. I'm sorry?

CONSULTANT WALLIS: A factor of nine, you said?

MR. LOIS: Between the criteria, what you expect and what you -- Yes, factor of nine.

CONSULTANT WALLIS: That is huge.

MR. LOIS: It is huge. It is, absolutely.

CONSULTANT WALLIS: Much huger than it is in some other reactors.

MR. LOIS: Absolutely, and that is the feature of the ESBWR, and the reasons for those are the fact that the reactivity vested in each one of them is so much, much smaller than the other ones.

Essentially then, this was -- RAI 4.6-23 was discussed with GE quite extensively, and we decided that, really, that it was very, very conservative.

CHAIRMAN CORRADINI: John?

MEMBER STETKAR: I have one general question. What revision of the DCD is the basis for the final SER?

MR. BAVOL: DCD Rev. 8. It will be eight.

CHAIRMAN CORRADINI: So we don't have -- We have 7.

MEMBER STETKAR: But the final SER should be consistent with Rev. 8?

MR. BAVOL: Yes.

MEMBER STETKAR: Is consistent with Rev. eight?

MR. BAVOL: Yes. The final -- Go ahead.

MS. CUBBAGE: Will be. We don't have Rev. 8 yet, but we have incorporated the resolution of RAIs that will be included in Rev. 8.

MEMBER STETKAR: I got confused, because there are some -- Back to these event frequencies, which is the only thing I understand, and apparently don't even understand that very well.

CHAIRMAN CORRADINI: You don't have to characterize it. Go ahead.

MEMBER STETKAR: No, that is okay. There are some numbers quoted in the SER that are consistent with Rev. 5 of the DCD, but not Rev. 7. In other words, if I go look at Rev. 7 of the DCD -- They changed between 5 and 6, basically, and the same number is carried through 6 to 7.

So if I look at the number in Rev. 7, it is a different number than the number that is quoted in the SER.

MS. CUBBAGE: Well, I would like you to inform us of those specifics, and we can address those. Hopefully, they do not have any impact on our conclusions.

MEMBER STETKAR: I doubt that they will. I just got confused what was the basis for the analyses.

CHAIRMAN CORRADINI: But just so I understand just the logic -- so it is a logic question -- the way I saw it relative to this is that the initial -- the SER's being closed in essentially in responses to the RAIs where the basis was Rev. 6, not Rev. 5. That is a question I had.

MS. CUBBAGE: On a specific RAI?

CHAIRMAN CORRADINI: Well, as I was reading through the summary and various things, my general impression was, as RAIs were being asked and answered, this current round of answered RAIs and closures were based on facts in 6 and changed to be reflected in 8.

MS. CUBBAGE: That is true of probably a large group of RAIs. Of course, some were resolved in Rev. 2, 3, 4, 5.

CHAIRMAN CORRADINI: Sure. Of course.

MS. CUBBAGE: I know, if this is giving you a discomfort level with the SER relative to the current Rev. of the DCD, I just wanted to let you know that this is -- What you have now is the advance final version of the SER.

We are going to have a contractor looking at the DCD to make sure there aren't any little loose ends like this. Assuming they don't affect any conclusions, we will go forward and make those changes.

MEMBER STETKAR: The two that I found here wouldn't affect anything substantive, but there were numerical differences. The only reason I was trying to track them is to see where the numbers came from, and the two at least that I found here -- as I said, they aren't substantive in terms of any conclusions for the safety evaluation, but there are discrepancies. So I am hoping that your contractor looks at things pretty carefully.

CHAIRMAN CORRADINI: Other questions for George or Lambros or Bruce? Hearing none, thank you. We will move on to Chapter 9. I think the first topic is -- Just to be clear, the first topic is in open session for sure, which is fuel storage racks, and the next one we will take after break in case we need to close the session.

MS. CUBBAGE: Before we get into Chapter 9, I would just like to set the stage here. This is not the entirety of Chapter 9. This is topical reports on the specific topic of the spent fuel rack design, and Chapter 9 will be coming soon to be presented in the September Subcommittee meeting.

CHAIRMAN CORRADINI: So these are clearing up a specific thing.

MS. CUBBAGE: This is just a presentation on the topical reports for the fuel racks, which have not been presented to the Committee previously.

CHAIRMAN CORRADINI: Okay. Thank you very much.

MR. DEAVER: Are we ready?

CHAIRMAN CORRADINI: Sure.

MR. DEAVER: My name is Jerry Deaver. I will be giving the presentation on the spent fuel storage racks. I guess I am doing everything today.

In this LTR, which is the mechanical side of fuel storage racks, there were five topics covered, and there is five sections. Three of them have to do with the dynamic loads and the structural analysis of the three types of spent fuel racks.

One is the racks that are for permanent

storage that are in the spent fuel pool in the fuel building. Then we have similar racks, but they are in the buffer pool. They are for temporary storage of fuel in the reactor building itself. Then we have racks for new fuel, which would be for staging fuel prior to an outage in the buffer pool.

Then we have a load-drop impact analysis of a fuel assembly dropping in the fuel pool or in the new fuel storage rack. Then we have a thermal hydraulic analysis of what is happening in the spent fuel pool.

For the spent fuel storage racks -- well, all the fuel racks -- we design to the ASME Section 3, Subsection NF for design purposes. For the spent fuel storage racks, our initial reference design is for 10 years of storage with a full core offload, but the pool actually has more space and is capable of being expanded to 20 years with full core offload.

We have 20 freestanding racks with 3504 cells. Typically, the racks are an array of 15 by 12, which would have 180 cells in a rack. The racks are structurally linked together to prevent individual movement away from the group of racks, and the design uses borated stainless steel plates, and they are not credited for any structural integrity within the design.

Spent fuel racks in the buffer pool: There's only 154 cells, and as I mentioned, they are only for temporary storage during refueling. That is if the inclined fuel transfer system is backed up, can't handle the movement of bundles going out of the reactor building.

Then we have the new fuel storage racks. The fuel storage racks in the buffer pool are bolted to the floor as opposed to the ones in the fuel storage refueling building. Those are freestanding, and the new fuel racks in the buffer pool -- there we have 7x2 arrays of racks with a capability of 472 assemblies, fuel assemblies, and they are bolted to the pool floor, and there is a side entry with mechanical mechanism for placing those bundles in the racks themselves.

This is the spent fuel storage rack design. What it is, is there is basically a baseplate at the bottom with structural supports running through the structure, and you can see that there is side entry holes to allow fluid to get under the bundles that are being stored there.

The sections going up are actually egg-crate sections where they are interconnected. There is a row of stainless steel plates at the bottom level. Then it transitions into the borated stainless steel plates, and then at the top we have another section of stainless steel plates which are -- in the interior part are 7 millimeters thick. The borated stainless steel plates are 3.4 millimeters thick. So because of the narrower thickness, that is why there is no structural contact with the borated plates.

Then on the outside of the design, we have thicker plates that are 10 millimeters thick. They are called enveloping plates, and the outside structure, the vertical wells are vertical connections, and the horizontal connections are welded. In the interior of the rack, there are no welds.

The fuel storage racks in the buffer pool are a similar design with the same type of materials. It is just a different configuration of the cells.

This is the configuration in the spent fuel pool. This shows the 20 different racks. Right now, we have been maximizing the amount of fuel in the north-south direction, and we have a gap of 92 millimeters on each of the north and the south sides.

What you see also is at the intersections of these racks is a pad at the bottom. This is a feature which basically captures the base of these racks. There is a bolt that goes down that supports the rack, and it is captured in these pads such that now it is locked and won't allow separation of one rack to the other. We also have a feature at the top, which is a cruciform shape that also locks the top of the racks.

So these are minimum pool dimensions shown in the figure. Typically, we would have potentially another 500 millimeters of extra space because of the large tolerances in the civil construction.

CONSULTANT WALLIS: So what is going on at the bottom of this picture? This is just extra space, is it?

MR. DEAVER: That is the extra space that we would -- A COL applicant would in the future add additional racks to go to 20 years of storage.

In the analysis that we performed where we looked at both the seismic displacement, and we also looked at thermal growth simultaneously, the displacement in the north-south direction was 44.5 millimeters, and in the east-west direction it was 51.6. So in both cases, we have been able to demonstrate that we will not impact the wall of the pool itself.

These are the stress results of the different components in the spent fuel storage racks. In most cases, we have fairly large margins or good margins, and we have been able to satisfy all of the design criteria with fairly conservative assumptions, such as damping with four percent, and so forth.

Here is the similar one for the spent fuel racks in the buffer pool. This is the smaller rack, and we even have larger margins, because the structure is smaller. It doesn't have as many cells.

Then we go to the side entry storage rack design. This is a little bit difficult to understand the concept, but basically, bundles come in from the side. There is a rod that is spring-loaded where the two doors -- there's actually two plates that are shown there that, in the open position, they are rotated and --

CONSULTANT WALLIS: Jerry, could you explain this margin? How is the margin related to the other numbers in the table?

MR. DEAVER: Which one?

CONSULTANT WALLIS: Well, either of them. There is page 6 and 7. The ratio of what?

MR. DEAVER: This is the remaining margin.

CHAIRMAN CORRADINI: I think he is asking you, what is the definition of the ratio?

CONSULTANT WALLIS: Well, there's two things. There is the ratio on Slide 6. Where does that come from? It doesn't seem to be the ratio of the numbers in the chart. Then the stress margin doesn't seem to be any different, and I am not sure where stress margin comes from. What is the ratio of that? Ratio of what things?

MR. DEAVER: That should have been stress margins, and that righthand column, it should have been stress margin instead of ratio.

CONSULTANT WALLIS: It should have been the difference between those two? Okay.

MR. DEAVER: No. What it is, it is the subtraction of the limit minus the stress divided by the stress limit.

CONSULTANT WALLIS: Oh. So it is not a simple thing. Okay. It is just a difference. Then it is divided by something.

MR. DEAVER: Yes, it is. Right.

Okay. So in the righthand side there, you can see, this is the array of seven cells by two. So we have entry points on both sides of the rack. There is a spring-loaded device that actuates the retainer plates. There is also a lower fixed plate where the fuel would go over the plate, and then go into the channel section which confines the fuel assembly. Then as it is lowered, the spring activates and closes the door to hold the fuel in place.

These are the stress results of the side entry storage racks. Again, stress margins are the deltas divided by stress limit.

CONSULTANT WALLIS: Well, I am still trying to figure this out. The stress looks close to the limit, and yet the ratios are huge. So I don't understand it.

MR. DEAVER: Well, like in the top one, there is a case where the calculated stress is closer to the stress limit.

CONSULTANT WALLIS: Right. And yet the stress margin is big.

MR. DEAVER: So the margin is 8.8, which says it has got lower margin.

CHAIRMAN CORRADINI: So one last time, because Graham got it, but I still don't get it. What is the definition of the last column?

CONSULTANT WALLIS: I still don't get it. Doesn't seem to be consistent with anything.

CHAIRMAN CORRADINI: So what does stress margin mean? What is that definition? I don't understand.

MR. DEAVER: That is the remaining amount of margin that the design has before it would reach the limit in percentage.

CHAIRMAN CORRADINI: Thank you.

CONSULTANT WALLIS: Oh.

CHAIRMAN CORRADINI: I missed that. I'm sorry.

CONSULTANT WALLIS: Well, you ought to say it, because otherwise it looks like a huge margin, and it really isn't a huge margin.

MR. DEAVER: Well, we should have put percent underneath that -- in that title. Sorry.

So moving along, so that was the results of the stress analysis of the three designs. Then we also did a load-drop impact analysis for the spent fuel racks.

The most demanding impacts were those that were taking place against the top of the racks where we had a drop of 6.4 meters onto a single plate rack. Because of the egg-crate type design, you have one side of the rack which is a solid beam going all the way, but the other ones have just the thickness between the two plates. So it weaker, because it is slotted. So that is the limiting case where you would impact the middle of one of those sides of the plate.

So in that worst case condition, the effect of a drop would cause deformation 20 centimeters into the rack, if it falls with a fuel handling device over 400 pounds of extra weight in addition to the fuel assembly itself, and without the handling tool, it has 10 centimeters of deformation.

In either case, the active fuel zone is not impacted by a fuel assembly that would be already in the rack.

CONSULTANT WALLIS: What happens to the fuel assembly? Does it sustain significant damage? The dropped one?

MR. DEAVER: Well, the assembly itself -- it would be a compressive type loading on the assembly. Eric, do you have any comment on what might happen? I guess you would not know that. I'm sorry.

CHAIRMAN CORRADINI: You can come up to the mike here. Please identify yourself.

MR. KIRSTEIN: This is Eric Kirstein.

CHAIRMAN CORRADINI: Smack on it. See what happens.

MR. KIRSTEIN: This is Eric Kirstein, GE-Hitachi. Could you please repeat the question?

CONSULTANT WALLIS: Well, this protects

the material in the pool from the dropped element, but what does it do to this dropped assembly itself, when you have a capture for the dropped assembly? Presumably, you want to stop it going into the fuel in the pool, but you also want to protect it from breaking up too much itself, don't you? You want to protect this dropped assembly from shattering in a disagreeable way.

MR. KIRSTEIN: Well, I can speak for -- I know in Chapter 15 we do consider a fuel handling accident where we do fail quite a significant amount of rods, and I would say -- we could maybe check on that, but this case would be bounded by the Chapter 15 evaluation.

CONSULTANT WALLIS: But it is in another chapter?

MR. KIRSTEIN: Yes, that is correct.

CONSULTANT WALLIS: Is this designed to have a sort of soft landing for this dropped assembly? Is it?

MR. KIRSTEIN: I'm not sure.

CHAIRMAN CORRADINI: I don't think he can speak to that.

MR. DEAVER: I can say, in our analysis we assumed that there was no deflection of the fuel assembly itself, that it was like a solid rod, so to maximize the impact load on the top.

CONSULTANT WALLIS: It maximizes that impact load?

MR. DEAVER: Yes.

CONSULTANT WALLIS: Then there is another question. You have got a very solid roof of this thing.

MR. DEAVER: Right.

CONSULTANT WALLIS: Presumably, the assembly would be shocked more when it dropped on it.

MR. DEAVER: Yes. This analysis didn't attempt to analyze the fuel assembly itself.

CONSULTANT WALLIS: But presumably, that is handled somewhere else?

MR. KIRSTEIN: Yes. Like I said, I think the only place where we consider failure of rods due to a -- in a drop is in Chapter 15, and that is an evaluation of a drop over the core. So you are feeling the rods and the drop on those as well as --

CONSULTANT WALLIS: It is not considered over the fuel handling pool?

MS. CUBBAGE: So, basically, the fuel handling accident is discussed in Chapter 15, and I think a different scenario is considered.

CONSULTANT WALLIS: Do you think that covers what could happen to the fuel assembly?

MS. CUBBAGE: I think so, yes.

MR. DEAVER: Yes. The heights are much more significant.

CONSULTANT WALLIS: Much higher. Okay. So the answer is it is covered in the worst situation over the core.

MR. DEAVER: Right. Okay. For impacts that would happen at an intersection between cell walls, the deformation is much smaller. It is limited to 3 centimeters, as you would expect.

In the case of a bundle actually going into the cell and then impacting the bottom pate, we assumed a height of 1.8 meter drop above the rack, and that results in strains that are below the ductility limit of the material. So that was a less stressful case.

Then in the new fuel storage rack, because of the limited heights associated with the pool, we only needed to assume a one meter drop, in which case that was not a significant event as far as the drop and the structures were concerned.

In the thermal-hydraulic analysis, we looked at heat load for the 10 year worth of spent fuel, and we have a maximum pool temperature of 48.9 degrees and a flow rate of 545.1 cubic meters per hour. This assumes a single train of the FAPCS system.

In the abnormal condition or operation, that is where we would have a full 10-year plus the full core offload. So that would have all the new fuel or at least a high radiation fuel coming out of the core. In that case, we are allowed to go up to 60 degrees C in the pool, and in that case we would have two trains of the FAPC in operation.

So those were the conditions we analyzed.

CHAIRMAN CORRADINI: Remind me what the FAPCS is. I am sorry.

MR. DEAVER: The fuel and auxiliary pool cleaning system -- cooling system.

CHAIRMAN CORRADINI: Cooling. And this takes suction from where to -- So it is a closed loop that takes suction from the pool, goes through some sort of cooling heat exchanger, and then returns it back to the pool?

MR. DEAVER: Right. Exactly. One of the next figures -- You can see the inlet cooling on this figure. It starts at the far side of the pool or the bottom side in this case, in this orientation, and it would be taken out. This is at the bottom -- Actually, the next one shows it better.

The cooling flow comes in at the base of the pool itself, and then it exits out the top on the other side of the pool. So this is a closed loop system that goes basically out to a heat exchanger.

CHAIRMAN CORRADINI: And it only services the pool? Nothing else.

MR. DEAVER: Right.

CHAIRMAN CORRADINI: Okay, thank you.

CONSULTANT WALLIS: Are you required to do an analysis of the loss of water from this pool?

MR. DEAVER: Yes.

CONSULTANT WALLIS: For the fire potential?

MR. DEAVER: We have analyzed all the conditions related to loss of cooling and the evaporation rate and how long that takes, and then what options we have. Yes, that has all been considered.

So the abnormal case, which has the higher heat rate coming from the fuel, is the most challenging case. In this case, you can see that the racks that are toward the back have the highest temperatures in this condition, but the peak temperature only reaches 73.03 degrees C when our allowable temperature is 121 degrees C.

CHAIRMAN CORRADINI: So I am looking down at it.

MR. DEAVER: Yes, you are looking down at this point.

CHAIRMAN CORRADINI: And just as you said, this is a design question for my edification. The reason the injection is in the open area versus underneath the racks is because what?

MR. DEAVER: Well, eventually we expect the pool to be filled with racks.

CHAIRMAN CORRADINI: Okay. So this is a worst case condition where I have an open area and a closed area on -- or a full and a partially full on the opposite side of the pool?

MR. DEAVER: Yes.

CHAIRMAN CORRADINI: All other orientations or moving would result in a cooler scenario? That is what I am asking.

MR. DEAVER: Yes, that is true. Yes, this is with all the fuel at the furthest point away from the cooling.

CHAIRMAN CORRADINI: That is what I was trying to get at.

MR. DEAVER: Yes.

CHAIRMAN CORRADINI: Thank you very much.

CONSULTANT WALLIS: So you put the cold water in at the bottom?

MR. DEAVER: Yes.

CONSULTANT WALLIS: The natural circulation isn't going to do much good then.

MR. DEAVER: The orientation of the fuel and so forth -- you get a lot of natural circulation and cooling in the rack itself.

CONSULTANT WALLIS: But you could still have a cold layer at the bottom. Anyway, I am sure this analysis is okay. I think this is a sophisticated CFD analysis.

MR. DEAVER: Yes, it is.

CHAIRMAN CORRADINI: Don't start making jokes now. So just out of curiosity -- since he brought it up, it is his fault -- is this -- ANSYS really doesn't do it. So what is being used within ANSYS to do this?

MR. DEAVER: This is a CFD program within ANSYS that is doing it.

CHAIRMAN CORRADINI: Which one? You can pick them. Not that I disagree with it. I am just trying to understand what it is, which program. You have FLUENT, CFX and their own internal one. So I am curious which one you are using.

MR. DEAVER: Dave Davenport?

MR. GILMER: Jim Gilmer from staff. It is CFX.

CHAIRMAN CORRADINI: Okay, thank you.

MR. DEAVER: Okay. So this is the -- Well, the 121 degrees is the boiling point at the depth of the rack that we are talking about.

CHAIRMAN CORRADINI: You have a pretty good depth.

MR. DEAVER: Yes, a lot of depth. And this is just a streamlined diagram showing the inlet and outlet of the abnormal case, which is the most challenging case. So you can see that the cooling flow as it comes in the bottom -- A lot of the heating comes basically at the top of the racks, and that then is effective in heating the water, which then can be pulled out and cooled.

CONSULTANT WALLIS: So a lot of this space is just water, isn't it? Above the rack.

MR. DEAVER: It is all water.

CONSULTANT WALLIS: there is a lot of depth above the rack.

MR. DEAVER: Yes, a large amount of water above the rack.

CONSULTANT WALLIS: That is where all these green lines are.

MR. DEAVER: Yes. Yes, that is where it picking up the heat from the racks.

So in summary, we have met all the stress criteria required by the ASME code. We have been able to demonstrate that there is no significant issues associated with the fuel drop, and we have been able to demonstrate that we met the temperature limits and criteria during the thermal-hydraulic analysis of the racks themselves.

So we have concluded that we have met all the design criteria, and we have resolved all the issues that the NRC has brought up.

Any other questions?

CHAIRMAN CORRADINI: No, I don't think so.

CONSULTANT WALLIS: Seems sort of backwards. I guess the way you design it is you have criteria, and you designed to meet them. It is not as if you make it and then you figure out if it meets the criteria. It must be a rational design to meet the criteria right from the start.

MR. DEAVER: Well, we have assumed that

the maximum temperature limits had been reached in the pool to make sure that we don't get boiling in the core.

CONSULTANT WALLIS: Yes, that is to sort of check at the end of the design, but the way you design it is you purposely designed it to meet the criteria with some purposeful margin. It is not just happenstance that it works. The design process is the reverse of what you presented today. You start with the criteria, and then you design it.

MR. DEAVER: Well, what we are trying to assure is that we don't get any boiling in the rack, and to do that we have to assume that we have achieved the maximum --

CONSULTANT WALLIS: When you design it, do you do these kinds of CFDs or you design it first and then -- and then see if it meets the criteria with CFD?

MR. DEAVER: Actually, we just used this criteria. If it meets this, then it --

CONSULTANT WALLIS: Do you see what I am getting at? I think one of the points made at the beginning of this whole exercise was that you used rational design. You sort of started from the criteria and everything, then worked back to what was a really good design.

The way it is presented in all these meetings as what is the thing doesn't meet the criteria. But did you use this kind of stuff in the design process?

MR. DEAVER: Well, we have used it as a design tool, I would say. It helps us to understand what temperatures we need.

CONSULTANT WALLIS: And how to optimize the design and all kinds of things.

MR. DEAVER: Well, yes. These represent worst case conditions.

CONSULTANT WALLIS: I thought you would be more forceful and saying, of course, you did.

MR. DEAVER: Of course.

CHAIRMAN CORRADINI: He gave you a soft ball, but you weren't hitting it. That is what he is trying to ask.

CONSULTANT WALLIS: I am looking for a home run here.

MR. DEAVER: Yes, we definitely designed it to be conservative, and we have a lot of margin in the design thermally.

CHAIRMAN CORRADINI: Other questions? All right. Thank you very much, Jerry. I think staff will come on up. Mr. Galvin. Couldn't do lunch without seeing you.

MR. GALVIN: That is right.

CHAIRMAN CORRADINI: Somebody has got something on some microphone somewhere that is making weird noises.

MR. GALVIN: We are here to present the staff's review of the dynamic load drop and thermal-hydraulic analysis that you just heard about. We are doing it in two parts. Jim Xu is going to present on the dynamic load drop analyses, and Jim Gilmer is going to present on the thermal-hydraulic analysis.

MR. XU: Good morning. My name is Jim Xu. I am a senior structural engineer in NRO Division. I will first present the staff's review on structural analysis, and followed by thermal-hydraulics review by Jim Gilmer.

This slide summarized what Mr. Deaver had presented on the structural analysis. The storage racks were ASME Class 3 plated structure, and it was designed in accordance with Subsection NF Class 3 plate and shell type of supports, and the racks were treated as seismic Category 1 and were analyzed for dynamic response to SSE and SRVD and the loss of coolant accident loads.

The racks were also demonstrated for operational and accidental load loss. The combination were performed in accordance with the SRP Appendix D to 3.8.4, Table 1.

This slide just acknowledges the regulatory criteria that the staff used to evaluate against, and which include GDC-1, 2 and 4. Next slide, please.

The staff reviewed the source analysis based on Appendix D for SRP 3.8.4, and we have issued 33 RAIs since 2008, and NEDO has four revisions, and all RAIs up to date has all been successfully resolved.

Some key review findings: The first one is to do with the design temperature. The original application required the temperature for 10 years, the licensing, I think, about the height of the accident temperature, and staff identified that the standard design rely on the FAPCS for spent fuel cooling. The system is non-safety related, therefore shouldn't be relied on in accident conditions.

So we issued RAI requesting justifications. In the end, the applicant did a re-analysis based on the accident temperature and the mature property limit was based on accident temperature for the design. So that issue was resolved.

The second issue has to do with the ASME Service Level D load combination. The original application neglected the thermal -- the accident load which, according to ASME, Service Level D should be combined with the seismic SSE load, but the applicant required the FAPCS for the spent fuel cooling, and again the same issue because the FAPCS is non-safety system, shouldn't be relied on in SSE events.

So we issued a RAI and requested justification. The applicant reanalysis include the thermal expansion in the Service Level, either combination with the SSE, which resulted in resizing of the pool dimensions to accommodate the combined seismic and thermal expansions.

The third key issue is the analysis applicant used for the SSE conditions in the spent fuel pool in which the racks were freestanding, not bolted to the base of the pool. The original analysis utilized a 2-D nonlinear model, which could not account for the certain model, especially the cubical model. The vibration against the corner point and, you know, when you drop back, impact on the pool, and that effect cannot be accounted for using 2-D type of analysis.

So we issued RAI, and the applicant redid the analysis based on a very elaborate 3-D model, an the applicant also analyzed the sliding aspects for the lower bound of the friction coefficient of 0.2, to ensure no impact of the racks on the liner.

In conclusion, the racks are designed for ASME requirement of Class 3 plate and shell type of supports, and also treated as seismic Category I in accordance with the staff guidance in Appendix D to SRP 8.8.4, and staff concluded that the structural analysis and design of racks meet applicable regulations.

That concludes my presentation. Questions, or do you want to wait for the end?

CONSULTANT WALLIS: When they do this coupled fluid and solid motion, it is a fully coupled analysis?

MR. XU: Yes, it is fully coupled.

CONSULTANT WALLIS: It is not a business of calculating one thing and then applying it to the other?

MR. XU: No. The 3-D analysis included flow-structure interaction.

CHAIRMAN CORRADINI: How do you do that?

MR. XU: It is quite an elaborate process. Maybe GE can give some detail on that. Use analogies.

MR. DEAVER: This is Jerry Deaver with GEH. It was a fairly sophisticated approach. We did an initial analysis to get the properties and characteristics of the rack itself, which was the detail model, and then there was a B model made which then we checked all the characteristics of the B model to make sure it matched the detail model, and so we applied the water masses and the included couplings in the different directions between the fuel and between the actual racks and so forth, such that an individual rack, although it is a simplified model, has the full characteristics of the interaction between it and the fuel and the other racks.

CONSULTANT WALLIS: That is done with an added mass or something like that?

MR. DEAVER: Yes. So that is, in a nutshell, the process that was used.

CHAIRMAN CORRADINI: Thank you.

MR. GALVIN: Okay. We will proceed to -- Jim Gilmer will present on our staff review of the thermal-hydraulic analysis for ESBWR fuel racks.

MR. GILMER: Good morning. The staff

review -- we asked our resident expert, Chris Boyd from the Office of Research, to do the detailed review. Unfortunately, he was not able to be here, but we are very confident that he has done a thorough look at it.

CONSULTANT WALLIS: Are you as prepared to answer technical questions that Chris would have?

MR. GILMER: I will make every effort.

CHAIRMAN CORRADINI: He is totally capable, but be nice.

MR. GILMER: I will certainly try and, if I don't know, we will take it back for Chris' help.

The regulatory criteria is GDC 62, which requires that the storage rack design be capable of removing the residual heat from the spent fuel, and the Standard Review Plan 912 for and new spent fuel storage. There is also some guidance in the Regulatory Guide 1.13 which I did not have as a bullet there, some general guidance.

The specific items that the staff examined: The detail of rack design drawings and specifications and the fuel and auxiliary cooling system design specifications we reviewed by an audit at GEH's Washington facility.

The original submittal came in

proprietary. So it was necessary to look at details about it by audit. Since that time, GEH has made the decision that the Topical Report can be issued as non-proprietary.

CHAIRMAN CORRADINI: So a different or a redacted Topical Report has been released? I didn't understand what you were saying. I'm sorry.

MR. GILMER: Actually, all the details are in the non-proprietary final NEDO.

CHAIRMAN CORRADINI: Okay, thank you.

MR. GALVIN: There is no proprietary version anymore. They had contracted out with Spain, the Spanish company, when they relooked at it, they determined that it really didn't need to be proprietary at all.

CHAIRMAN CORRADINI: Okay, thank you.

MR. GILMER: The supplier has furnished them operating rewrites as well. The main difference is that ESBWR, because the fuel is shorter, the racks are shorter as well or they are not at shorter height.

Mr. Deaver from GEH already defined the normal and abnormal definition. Normal is considered at 10 years of spent fuel accumulation, and the abnormal is 10 years plus the fuel for offload. Staff reviewed the detailed calculations for the heat loads during the audit, and these are normal engineering design calculations.

The CFD model, as I mentioned earlier in answering the question, used an ANSYS CFX tool, which is an industry standard used for a lot of different applications. The detailed review looked at the turbulence model selected. They used the built-in model and CFX, and Chris Boyd and I felt that that was adequate.

CHAIRMAN CORRADINI: Just a side question. It is kind of unfair, but under these flow conditions, I can't imagine any of the turbulence models really matter. You could choose A,B,C or D, and you get the same answer.

MR. GILMER: That is a good point.

CONSULTANT WALLIS: Well, Mr. Deaver presented a slide covered with green swirlies.

MR. GILMER: The stream lines, yes.

CONSULTANT WALLIS: And nothing seems to go through the rack at all, and the green things are doing very peculiar things. Presumably -- I have great faith in Chris Boyd, but someone -- There must be a better figure than this to show what is happening. Did your review find more realistic figures that actually showed something -- that the fuel was being cooled? This doesn't show anything cooling the fuel at all.

MR. GILMER: We don't have a better figure, but we did look at the --

CONSULTANT WALLIS: Are there better figures in their report?

MR. GILMER: No. That's probably the best one.

CONSULTANT WALLIS: The best one?

MR. GILMER: Yes.

CONSULTANT WALLIS: Is it supposed to demonstrate that the fuel is cool?

CHAIRMAN CORRADINI: Well, don't answer that question.

CONSULTANT WALLIS: There is nothing going through the fuel at all. The important thing, presumably, is the temperature distribution within the rack.

CHAIRMAN CORRADINI: That is on the previous figure?

CONSULTANT WALLIS: No, no, no. That a view down looking from the top. It doesn't show any stream lines or anything like that.

CHAIRMAN CORRADINI: But I assume that is a hot --

CONSULTANT WALLIS: I was just surprised that this figure was presented as showing -- to sort of convince us that CFX is working properly.

MR. GILMER: There is another figure that showed the --

CONSULTANT WALLIS: Looking down from the top, but that is not a useful --

CONSULTANT KRESS: That other figure, is that at the location of the exit line?

CONSULTANT WALLIS: It doesn't show any stream lines or anything.

MR. GILMER: Yes.

CONSULTANT KRESS: It is a location of the exit lines, and it is coolant temperatures.

MR. GILMER: That is correct.

CONSULTANT KRESS: it doesn't have any fuel temperatures shown on there.

MR. GILMER: Right. It is only coolant temperatures.

CHAIRMAN CORRADINI: So another inappropriate question, but why not since we seem to be a little bit early. I am kind of curious about the flow split of what goes through the racks versus what goes around the racks, because as -- I can't remember if it was Jerry that said this, that you guys -- that

GEH purposely created a situation which essentially had a bunch of the stuff far away from the inlet, and that would have the least amount of flow in versus around.

So what was that split, and did you guys evaluate that split and it looked conservative to you, da, da, da, da? GEH can help.

MR. GILMER: Well, i probably will have to get back with you on that.

CHAIRMAN CORRADINI: I think that is kind of where Graham is going.

MR. GILMER: Yes, I understand that.

CONSULTANT WALLIS: This is supposed to show that the racks are cool, and there is nothing going through the racks at all. So this is a very strange figure to present to show that the racks are cool. There must be better figures somewhere.

MR. GILMER: Well, there is another figure in the GEH presentation that --

CONSULTANT WALLIS: Maybe GEH has a better figure you could show us tomorrow or something.

MR. DEAVER: This is Jerry Deaver with GEH. These are the only figures. We have one for the normal and one for the abnormal, but basically, when we reviewed it, we kind of concluded that we weren't necessarily seeing the flow stream through the rack. As you look at some of the lines that are going up to the rack, they seem to terminate.

So our conclusion was that we weren't seeing everything in the picture in the vicinity of the racks and so forth.

CONSULTANT WALLIS: But then you should go back and say let's see a figure which does demonstrate that the reactor is cool. I am kind of puzzled by the presentation of this very mysterious figure.

CHAIRMAN CORRADINI: My suggestion, I guess, would be, at least that you guys take an action item. Is there some way to quantify -- I mean, you have a temperature map from looking above. I guess, in some sense, I am kind of curious, and maybe I am -- It is a different question than Graham's.

I am curious on what the flow split is of what is going through versus bypassing, and does that make sense.

CONSULTANT WALLIS: Why don't you ask questions like that. I would expect Chris Boyd probably did ask questions like that, but he is not here.

MR. DEAVER: This is Jerry Deaver with GEH again. I also should mention that, as part of our analysis, we assumed as a worst case a blockage in the actually fuel assemblies of 80 percent.

CONSULTANT WALLIS: So that explains perhaps why the flow doesn't go through. It is blocked.

MR. DEAVER: This could be the case with the 80 percent.

CONSULTANT WALLIS: So there is some kind of recirculation inside the element, which should be shown in another figure somewhere.

MR. GALVIN; With the 80 percent blockage, so that is probably what -- why you don't see a whole lot of flow.

CONSULTANT WALLIS: In this report available?

CHAIRMAN CORRADINI: Well, I was looking for it. I am sure we have it somewhere.

CONSULTANT WALLIS: Do we have it? I don't think so.

MR. BROWN: I didn't want to bombard you with a whole lot. I got the report. I can send it.

CONSULTANT WALLIS: All that I would be interested in would be the report from GEH and the review by Chris Boyd, which presumably was written.

CHAIRMAN CORRADINI: We do have that.

CONSULTANT WALLIS: We have it?

CHAIRMAN CORRADINI: We have the SERs on the LTRs. I just can't find the LTR immediately on my computer. We were sent the Safety Evaluation Reports of their Licensing Topical Report.

CONSULTANT WALLIS: I was on vacation. There is no way I could read all that.

CHAIRMAN CORRADINI: Well, we will get you the topical.

CONSULTANT WALLIS: But this stuff isn't in that, is it? This stuff isn't in there.

CHAIRMAN CORRADINI: No, because that is from the original licensing --

CONSULTANT WALLIS: Well, I am interested in what was shown on the topical and why Chris Boyd assumed that it was convincing. I have great faith in him, I'm sure, but again it seems -- I am puzzled by this particular -- this being a good figure and proving something, demonstrating something.

MR. GILMER: Really, that only shows that you do have substantial natural circulation.

CHAIRMAN CORRADINI: I have noted the action item.

MR. GILMER: And we will get back with you on that.

CONSULTANT WALLIS: Thank you.

MEMBER STETKAR: Jim, regarding flow splits -- and this is probably for GEH more than you -- during refueling, do you line up the FAPCS to cool all of the fuel pools in the reactor building?

MR. DEAVER: This is Jerry Deaver with GEH. FAPCS during an outage is also servicing the other pools in the reactor building.

MEMBER STETKAR: Did your analysis account for that amount of flow going up to those other pools also, and the heat loads in those pools?

MR. DEAVER: Well, the trains are independent. You know, there is a train that is servicing pools and lowering and --

MEMBER STETKAR: But your abnormal analysis accounts for full flow from both trains of FAPCS, doesn't it?

MR. DEAVER: Yes. At that stage all the pools are stable. We are not trying to change water levels in the other parts of the reactor. There is, basically, the GDS pool. There is the reactor cavity. There is IC pools and so forth.

MEMBER STETKAR: I am not worried about IC pools. I am worried about the -- you know, what I would call a refueling pool above the reactor, so that when you are refueling, that volume of water is being cooled by FAPCS?

MR. DEAVER: That is reactor water clean-up.

MEMBER STETKAR: That is being cooled by reactor water clean-up?

MR. DEAVER: Yes.

MEMBER STETKAR: Okay, because you can line up a couple of different systems to cool those.

MR. HAMON: This is Dave Hamon from GE. That case you are talking about from the abnormal, we've got the entire core offloaded into the spent fuel pool

MEMBER STETKAR: Yes. What I was thinking about, though --

MR. HAMON: There's no other pools that really need heat removed, and we put multi-phase PCS trains into that one cooling loop.

MR. DEAVER: But the core cooling is taken care of by reactor water clean-up, and shutdown cooling system.

MEMBER STETKAR: From the vessel, but I am talking about the upper -- Of course, they are connected. So I am not quite sure how that works.

MR. HAMON: The abnormal case he is doing, all the fuel in the reactor and all spent fuel has been moved down to the fuel pool.

MEMBER STETKAR: I understand that. I just wanted to make sure that under those conditions there couldn't be some water going somewhere else, under a normal situation after you have offloaded the core. Okay, thanks.

CONSULTANT WALLIS: Mike, could I ask, there is this action item to get me the LTRs. I am just interested in the time involved. This is something I can review when I go home or am --

CHAIRMAN CORRADINI: You will have it today.

CONSULTANT WALLIS: Have it today. Thank you.

CONSULTANT KRESS: Could we get two of those, please?

CHAIRMAN CORRADINI: I think we will all get them. We get a mass mailing.

MS. CUBBAGE: So you are looking for the incoming topical report?

CHAIRMAN CORRADINI: Yes.

MS. CUBBAGE: I can e-mail that to you.

CONSULTANT WALLIS: Is there any kind of a review written by Chris that we can look at, too?

CHAIRMAN CORRADINI: It is in the SER. Is that correct?

CONSULTANT WALLIS: That is what we go on? We go on that?

CHAIRMAN CORRADINI: Yes.

MR. GALVIN: The staff took Chris' input, and that is what the SER is.

CONSULTANT WALLIS: The SER often doesn't tell us very much, though.

MR. GALVIN: Actually, we expanded what Chris wrote.

CONSULTANT WALLIS: You expanded it ?

MR. GALVIN: Yes.

CONSULTANT WALLIS: Okay. So we will have it tomorrow?

MR. GALVIN: I think the key -- Chris spent three weeks on the key assumptions and the modeling assumptions, and their thing for how they implemented the CFE, and he assumed they were reasonable, and the results show that there was a substantial amount of margin.

Initially, he had thought about doing his own analysis, but when it came out with so much margin, he said there was really no --

CONSULTANT WALLIS: I just think that, if

Chris had written a report, I think he would have had more of these that showed more stuff, and he had also talked about flow splits and stuff, which would have been more informative. That is what I hope will be in the LTR. Okay.

CHAIRMAN CORRADINI: We will get it to you.

CONSULTANT WALLIS: And if Chris had done the analysis --

MR. GALVIN: The issue is he never really -- He never did an analysis --

CONSULTANT WALLIS: He didn't need to, because it was so good. This was so good.

MR. GALVIN: Yes. There was reasonable assumptions throughout, after we asked our RAIs. Okay, Jim.

MR. GILMER: Well, if there are no more questions, I will run quickly.

One of the key conservatisms is on the flow loss through the racks. GEH used an operating fleet rack pressure drop measurements to develop a curve of pressure drop versus flow, and that was for 12-foot fuel, and because the GE14E is much shorter, that is an inherent conservatism.

Staff looked at the definition as defined for normal and abnormal based on the guidance we have, and are satisfied that --

MEMBER ABDEL-KHALIK: For the normal case, the heat load is about 7.6 megawatts.

MR. GILMER: Correct.

MEMBER ABDEL-KHALIK: And for the abnormal case, the heat load is 17.3 megawatts. So presumably, the difference is the decay heat in the full core offload, which is about 10 megawatts, which is about 2.5 percent of thermal power.

The question is what is the assumption as far as the length of time between reactor shutdown and the point when the core was totally offloaded?

MR. GILMER: It has been a while since we've done the review, but I believe that was -- I want to say five days, but --

CONSULTANT WALLIS: It may be conservative. Do you assume it is instantaneous?

MR. DEAVER: This is Jerry Deaver with GEH. I believe we used five days as the offload time.

MEMBER ABDEL-KHALIK: At five days, decay heat drops to a quarter of a percent?

MR. DEAVER: The decay heat?

MEMBER ABDEL-KHALIK: Right.

MR. DEAVER: Well, I forget the curves.

We have curves starting at the point when power was cut off, and we know the heat rate loss. For each point in time, we have curves with that.

MEMBER ABDEL-KHALIK: It just seems too low, even for five days.

MR. GILMER: It was based on the ANS standard. We didn't redo the calculations.

MEMBER ABDEL-KHALIK: But the assumption was five days?

MR. DEAVER: Yes. That would be the earliest time that we would have the core offload.

MR. GILMER: Are there more questions on that?

CHAIRMAN CORRADINI: Go ahead.

MR.GILMER: Chris and I also looked at the selection of the CFE code -- the CFX code, and agreed that it is qualified to do this particular calculation. We also looked at validation problems that were similar to give further assurance that it is a reasonable tool.

One of the RAIs requested a sensitivity analysis for mesh spacing and other assumptions, and those are ultimately incorporated into the Topical Report.

CONSULTANT WALLIS: Now the flow through

this thing is steady? Are there any large scale fluctuations in the flow in your CFX output?

MR. GILMER: No. We didn't see any. Next slide.

CHAIRMAN CORRADINI: I mean, just for the record, I guess what Graham is asking is you achieved some sort of steady state temperature, but I would expect, like he is, you would see some sort of flow variability if you watched it as a time -- in a time situation.

CONSULTANT WALLIS: You would see plumes or something. That is what you do in order to convince yourself that your are modeling something realistically.

MR. GILMER: Right. Yes.

CHAIRMAN CORRADINI: Okay.

CONSULTANT KRESS: What is the area in a sensitivity or a CFD code? Is it k-epsilon?

MR. GILMER: The mesh size --

CONSULTANT KRESS: The actual structural.

MR. GILMER: The actual structural, and key review findings, as Dennis mentioned, there was a very large margin between the design and the calculated pool and the fuel exit temperatures as well. Adequate natural circulation was demonstrated, and the staff feels that the GDC-61 requirement to remove residual heat has been met.

As an aside, we found that the guidance in the SRP 912 is somewhat lacking in terms of the acceptance criteria. So there is a plan to update the Standard Review Plan for advanced reactors, and I think as a lesson learned, we will add more guidance in the SRP.

CHAIRMAN CORRADINI: Other questions? Hearing none?

MR. GALVIN" I guess we just repeated that.

CHAIRMAN CORRADINI: So other questions? Otherwise, we are ahead of schedule. I guess I want to ask, before we go to break, are we going to be in closed session or possible closed session?

MR. GALVIN: We are going to be in closed session. I think GE's slides are proprietary.

CHAIRMAN CORRADINI: Okay. So we will do a room check at break time. Okay. So let's take a break, and we will be back at ten 'til.

(Whereupon, the foregoing matter went off the record at 10:33 a.m., and returned to Open Session at 3:56 p.m.)

CHAIRMAN CORRADINI: Are we all set?

MR. HAMON: I think this last topic is going to go fairly quick.

CHAIRMAN CORRADINI: Mr. Stetkar is ready for you. Okay, go ahead.

MR. HAMON: Okay. I am here to cover Chapter 20, which is generic issues. I am Dave Hamon from GE. I was the lead Chapter Engineer for Chapters 1 and 2 of the DCD and a few other areas, and in charge of a lot of the more generic requirements for the plant.

As an introduction to generic issues, the requirements come from 10 CFR 52.47 where it states in paragraph (a) that the application must contain a final safety analysis report that, among other things, must include the following information:

Under sub-bullets to that, I picked out a few specific items that relate to generic issues. The first is paragraph (8), which talks about addressing the Three Mile Island requirements from 10 CFR 50.34(f).

Item (21) talks about addressing unresolved safety issues and medium- and high-priority generic safety issues from NUREG-0933. Then there is an Item (22) that is more general about taking into account operating experience insights that come primarily from NRC generic letters and bulletins.

There are additional requirements related to this in NUREG-0800, Standard Review Plan Section 1.0 that was issued in about 2007, and responses to al RAIs related to generic issues have been submitted.

From the SRP 1.0, Section 1.9 of that SRP talks about generic issues and Three Mile Island requirements, and it requests that you include a table that summarizes all the unresolved safety issues and medium- and high-priority generic safety issues that are identified in NUREG-0933 on the version current up to six months before you submitted your application, and also to look at the -- include a discussion of the Three Mile island issues from 10 CFR 50.34.

The way we have addressed this is that we include it in DCD Chapter 1. Table 1.11.1 addresses the generic issues, and then we took the TMI issues in a separate appendix, Appendix 1A and Table 1A-1, and we used NUREG-0933 with all supplements through Supplement 30, which is October 2006, which is actually slightly a year past the date of our original submittal. So we have more than fulfilled the requirement for that particular part.

In terms of operational experience, it says that you need to provide information on how operating experience insights from generic letters and bulletins issued after the most recent revision of the applicable standard review plan and six months before the docket date of the application have been incorporated into the plant design.

For this, we went back and looked at -- We provided two tables in the DCD. Table 1C-1 is for generic letters, and Table 1C-2 addresses the bulletins. The bulletins and generic letters that appear in these tables are based on the ABWR DCD as a starting point, and then a Draft Regulatory Guide DC-1145. In Section C.IV.8 of that, there was a table of generic letters and bulletins that the NRC felt were of interest for design certification applications.

They subsequently removed that table when they formally issued this as Reg Guide 1.206, but we actually had already taken the information out of that Reg Guide and used it in the DCD preparation. So that is how we came up with the list of which ones we considered for the certification.

So in summary, our DCD has addressed requirements of 10 CFR 52.47 --

CONSULTANT WALLIS: Wait a minute. Now just listing them doesn't say how you used them.

MR. HAMON: Okay. What is in these tables is, first of all, there is -- I didn't bring a copy of the table. Basically, we have got the ID number for the bulletin or the generic letter. We have then got a column that says what the topic was, and then there is a column that says how ESBWR has addressed this.

So that is how we came up with the list of the ones that we looked at in detail, and then we went through each one at a time and provided a basis for how we addressed them and whether or not they applied or not, and referenced other sections of the DCD with additional details, if somebody wanted to look at it more specifically.

CONSULTANT WALLIS: Thank you.

MR. HAMON: And the same thing was done even on the previous one with the Table 1.11.1 that went through -- We went through NUREG-0933 item by item, and looked at what NUREG-0933 said was the resolution basis, and then from there we pointed to where in ESBWR we addressed the various items.

So we went through each item one by one and provided a basis for how it was considered and whether it applied or not.

So like I say, in summary, we have gone through all the requirements of 10 CFR 52.47 related to generic issues and operational experience insights, and we have no open RAIs at this point.

MEMBER STETKAR: Dave, a couple of questions. One was: Apparently you have an exchange with the staff regarding its TMI action item issue related to qualification of accumulators on ADS valves. I went back through the DCD. This is a design or operational question, but I was trying to understand what the concern might be.

The DCD says that the accumulators -- The accumulator capacity is sufficient for one actuation at drywell design pressure. I guess the TMI action item says you have to do an evaluation that does not give any credit for non-safety related equipment or instrumentation and must account for normal expected air or nitrogen leakage through the valves.

So you can't take credit for the non-safety related air system to recharge the accumulators. You can't take credit for the nitrogen system.

MR. HAMON; Right, yes.

MEMBER STETKAR: What is sufficient capacity for one actuation of a valve? I mean, I understand that the valve will open. How long will it remain open until it closes, because that is what we are really concerned about, if you are thinking about normal leakage.

MR. HAMON: Right. For the ADS function, which is the one actuation that you would need, especially since we have the depressurization valves as well, you are probably talking a max of about five minutes or so before you are -- five to 10 minutes at the absolute max.

MEMBER STETKAR: So there is no safety analysis that requires the ADS valves only and not the DPVs --

MR. MARQUINO: Right. We have credited the ADS valves and the DPVs in the safety analysis, and we assume a single failure of an SRV, and we look at a single failure of an EPB. I am not speaking to the PRA, but there is no Chapter 6 analysis that fails all of the SRV, ADS valves or all of the EPBs.

MEMBER STETKAR: But is there a Chapter 6 or 15 analysis that takes credit for the SRVs, assuming a single failure, but in -- whatever in is -- SRVs remaining open for pressure relief, heat removal, whatever you want to call it, for an extended period of time.

So you are looking at an intermediate or high pressure plant response.

MR. HAMON: If you stay at high pressure

and your are actually cycling the SRVs, which we don't expect to happen for AOOs, they are designed, I believe, to take about five cycles on each valve from the size of the accumulator.

MEMBER STETKAR: Well, but -- Except that the design certification just says the accumulator capacity is sufficient for one actuation. Doesn't say five.

MR. HAMON: That is at drywell pressure.

MEMBER STETKAR: At drywell pressure, yes.

MR. HAMON; I would have to double-check the DCD. I don't remember offhand.

MEMBER STETKAR: Well, I started to talk about confirmation that the accumulator capacity is sufficient to meet the design objectives without any non-safety supplemental make-up.

I was trying to understand what that meant, and just simply popping a valve open for an indeterminate period of time is different than keeping the valve open long enough to satisfy the success criteria for the safety analysis. That is a much different type of evaluation of that accumulator -- the check valve integrity, essentially.

MR. HAMON: And the way these SRVs are designed, I don't remember the exact -- But as you start getting down close -- getting down to low pressure, there is a spring in these valves that will cause them to reclose.

MEMBER STETKAR: Right. So you have to overcome that spring valve.

MR. HAMON: No. That is why we have the DPVs. Once we get to that point, the DPVs will keep you below that indefinitely.

MEMBER STETKAR: That is essentially what I was asking.

MR. HAMON: After that first initial depressurization and closure, we don't rely on the SRVs at all.

MEMBER STETKAR: None of the Chapter 6 or Fifteen?

MR. MARQUINO: No. The Chapter 6 analyses assume that SRVs open. They are open, and we don't assume they close On for any reason after that. However, because the DPVs are large open flow paths to the drywell and the SRVs submerged in the discharge line in the suppression pool, the flow from the reactor changes from going out the SRVs to going out the DPVs when the reactor is depressurized.

I don't know what time that is, but I could look it up and give it to you.

MEMBER STETKAR: What I was -- I think what I was asking is are there any of those Chapter 6 analyses that account for the fact -- I mean, if level never gets down below level 1 and stays below level 1, the DPVs will never fire. Right?

MR. HAMON: Right.

MEMBER STETKAR: So you are looking at some type of pressurized transient response where you never get a level 1 signal to fire the DPVs, and yet you are accounting for the ADS valves for heat removal to the suppression pool.

I didn't go back and look to see what analyses may or may not do that. You are saying -- Oh, great, as soon as the DPVs fire, I don't care about the ADS valves.

CHAIRMAN CORRADINI: Can you say it again, John? I guess I didn't appreciate your point. Your point is you are caught where the DPVs don't actuate?

MEMBER STETKAR: If you in a situation at high pressure with high pressure make-up and level remains above level 1, the DPVs will never actuate, period.

MS. CUBBAGE: So I am looking at the DCD, and it is talking about the pneumatic. Is the accumulator capacity sufficient for one actuation, but it doesn't prevent the valve from opening the mechanical safety pressure. So they are dual acting.

MR. HAMON: It is still there, regardless. Yes.

MEMBER STETKAR: Okay. So as long as there is no analyses that credit extended active opening, if I can call it that, of the ADS valves --

MS. CUBBAGE: So a scenario where you would want them open, but they are below their mechanical lift point.

MEMBER STETKAR: Right. And I don't know.

MS. CUBBAGE: I think, if you got into that scenario --

MR. HAMON: I don't think you will find it in Chapter 6 or 15, because that would have to be an event with multiple failure. It would either be an ATWS or an event with multiple failures.

MS. CUBBAGE: Because your normal event doesn't even require any SRV open.

MR. HAMON; But as long as we have got at least three isolation condensers, we don't expect any SRV openings for AOOs.

MEMBER STETKAR: If that is the case. I just didn't have the time to go back and think about all of the different analyses that were there.

MS. CUBBAGE: Wayne, do you agree?

MEMBER STETKAR: The whole genesis of this is what type of criteria do you use in your analysis to say that indeed the leak tightness of those accumulators, the check valves, is sufficient to satisfy all of your design basis accident analysis events?

MR. MARQUINO: So I think you are trying to come up with a scenario where you don't have an ADS actuation for some time period.

MEMBER STETKAR: You don't have a DPS actuation.

MR. MARQUINO: Anytime you actuate the ADS, you actuate the DPVs. They are tied together in a sequence. So they are not off of different signals. The signal that opens the ADS valves always opens the DPVs after a time delay.

MEMBER STETKAR: After a time delay, and an interlock on -- well, time delay with level 1.

MR. MARQUINO: Yes.

MR. HAMON: I mean, the DPVs are considered part of the ADS function. So anytime you get an ADS permissive, the ADS SRVs as well as DPVs are all going to go off with appropriate time delays.

CHAIRMAN CORRADINI: But I thought his

question was did you need to go below a level to have the DPVs eventually open? I thought that was his question.

MEMBER STETKAR: You can take a transient drop below level 1, come back above level 1, and still have the ADS valves open and not the DPVs.

MR. MARQUINO: No. No, because as soon as you make up the logic to open the ADS valves, it opens two valves, two valves, two valves, and then after another time delay two DPVs, two DPVs, two DPVs. So it is a fixed sequence once you have been below level 1 for 10 seconds, and if the level goes above level 1 during that sequence, it doesn't matter. The sequence continues.

MR. HAMON: Right. Once you trace the logic, the signal seals in, and it doesn't matter what happens after that.

MEMBER STETKAR: Got it. Thank you.

CHAIRMAN CORRADINI: Do you have another question?

MEMBER STETKAR: I do. Another TMI action item is far as leakage detection for sources where you might have primary coolant outside the containment. I don't have the benefit of the RAIs.

The staff asked an RAI on this, and you

basically screened out the main steam system, because you said, well, the main steam system will be isolated during any design basis events. But I thought that the design includes credit for steam flow to the main condenser through the turbine bypass valves, because you don't have an MSIV leakage collection system on this plant.

So that, under some accidents, you are taking credit for a flow path through the main steam system, turbine bypass valves to the main condenser to collect leakage past the MSIVs, and then taking credit for the condenser hotwell to dilute that, aren't you?

If that is the case, do you still -- are you still able to screen out leakage detection from the main steam system as a source?

MR. HAMON: Well, the main steam isolation valves have normal leak detection tests on them as part of Appendix J testing. So we have got limits on those that we know what they are.

Basically, the way we addressed that RAI eventually is we went back and looked specifically at the TMI action item, and it had a table in it that said these are the functions that you need to consider in this, and we went function by function and said, okay, this is the equivalent ESBWR device or system that performs that function, and that is how we came up with a list of what we left on there.

MEMBER STETKAR: Maybe I will ask the staff. It is just that I haven't seen the answer to that RAI. I only know that there is a basis from that RAI response.

MR. HAMON: It turned out initially, part of what triggered the RAIs in the first place was whatever we had drafted originally, staff had a different opinion on the interpretation of the TMI requirement, and as we went back and finally reached common agreement on how we ought to proceed.

MEMBER STETKAR: I will ask the staff about it.

MR. HAMON: We changed that table around a little bit and finally got agreement on it, and then we added one more item to it due to a design change late in the game. Basically, we followed the logic exactly as TMI 3(d).1.1, I think it was.

MEMBER STETKAR: Boy, you are good.

MR. HAMON: So we went back to the original TMI item and, like I said, there is a table in there that says these are the areas we are concerned about and are trying to limit the leakage from, and we went item by item through that. So this is our closest match to that system, and it should be part of the program.

CHAIRMAN CORRADINI: Thank you.

MR. HAMON: Thank you.

CHAIRMAN CORRADINI: We will have the staff come up. Ms. Perkins, are you the designated staff of the day for this topic?

MS. PERKINS: Good afternoon. My name is Leslie Perkins, and I am the Project Manager for Chapter 20, Generic Issues. I will be giving you an overview of the staff's review of Chapter 20, and there is also some technical staff here to answer some additional questions.

Just as background, the agency just presented applicable regulations, 52.47, paragraph (a)(8) requires that DC applicants demonstrate compliance with the TMI action plan requirements found in 10 CFR 50.34(f), technically relevant to the design.

52.47, paragraph (a)(21) requires the applicant to address resolution of unresolved safety issues and medium and high priority generic safety issues defined in NUREG-0933.

Then 52.47, paragraph (a)(21) requires the applicant to include information to demonstrate how operating experience insights have been incorporated into the design, and that is done by addressing generic letters and bulletins.

The Chapter SER provides the staff's evaluation for certain generic issues. I will highlight a couple of examples in a few minutes. Additional generic issues are discussed in other SER chapters. So Chapter 20 provides a point to the appropriate chapters and sections of the SER that provide the staff detailed evaluations.

In the DCD, GEH addressed the generic issues in DCD Tier 2, Tables 1.11-1 in Chapter 1, and the TMI requirements in Table 1A-1 in Appendix 1A. Operational insights are addressed in DCD Tier 2, Section Appendix 1C, and that is Tables 1C-1 and 1C-2.

One of the issues I am going to highlight is issue A-17, which addressed the concern about adverse system interactions in nuclear power plants, and this issue is addressed in Table 1.11-1 of the DCD.

GEH analyzed features and actions that are designed to prevent postulated adverse interactions . GE submitted an assessment of the significant adverse interactions in response to an RAI. The purpose of the assessment was to identify possible adverse interactions among the safety-related passive systems and also between safety and non-safety related active systems.

They studied the interactions for the GDCS, ADS, ICS, and the SLCS system as well as the PCCS and looked at their interactions with the other systems such as FAPCs, main steam line, containment and suppression pool.

The staff reviewed the study as part of their review of RTNSS, which is discussed in SER Section 22.5. As a result, the staff concludes that GEH addressed issue 17 by completing the assessment of the possible adverse interaction systems and the potential consequences.

CHAIRMAN CORRADINI: So I guess, from my perspective, I wrote this at the end of every one of the letters after seven interim letters, and now you tell me there are no adverse interactions. So I want to understand. This is for my own edification.

This is between safety systems and non-safety systems or just -- I am trying to understand what is being looked at to compare about the adverse interactions. So it is actuation of non-safety systems that may affect the first line safety systems? That is what I am trying to struggle with.

MS. CUBBAGE: It is basically in the context of the RTNSS assessment to determine what SSCs may need to be elevated to RTNSS classification.

CHAIRMAN CORRADINI: So t his is for RTNSS classification.

MS. CUBBAGE: Right. So any systems that are designed to prevent or preclude an adverse systems interaction would end up getting elevated to RTNSS classification.

MEMBER STETKAR: This issue was essentially resolved by saying that the applicant has established criteria for RTNSS. Right? And populated the RTNSS list. Is that right?

MS. CUBBAGE: That was an output of the process, yes.

CHAIRMAN CORRADINI: So given an acceptable RTNSS list, this is effectively satisfied?

MS. CUBBAGE: That is right.

CHAIRMAN CORRADINI: And is FAPCS, for example, on RTNSS? I don't even know what it stands for anymore. You used it three times.

MS. CUBBAGE: FAPCS is a RTNSS system. So any SSCs that would -- For example, if there was a valve that needed to be isolating this system from another system, then that valve could get pulled into

RTNSS.

CHAIRMAN CORRADINI: And then that has -- Okay, fine. That helps. Thank you. Thank you very much.

MS. PERKINS: The next example identified is the generic letter for 92-04 and bulletin 93-03, which dealt with the resolution of issues related to reactor vessel water level instrumentation in BWRs.

For GL 92-04 they requested information regarding the adequacy and corrective action for BWR water level instrumentation with respect to non-condensable gas on system operations.

The staff's concern was that the non-condensable gases would dissolve in the reference leg of the water level instrumentation and lead to false indication of high level after rapid depressurization.

Following that, the staff issued bulletin 93-03 requesting hardware modification for operating reactors.

CONSULTANT WALLIS: What do they do about non-condensable gases? They bleed them out or something, or what?

MS. PERKINS: This is the next slide. To address the issue, GE incorporated a backfill modification system that will constantly purge the reference leg with a flow rate supplied by the CRD system. This flow rate will prevent the dissolved gases from migrating down the reference leg.

So as a result of GE incorporating the modifications in the ESBWR for the reactor pressure vessel level instrumentation system, the staff found that they addressed the issues that were identified in the generic letter and bulletin.

AS a result, for Chapter 20 the staff concludes that GE addressed all the applicable generic issues and demonstrated compliance to the regulations in Part 52.47, paragraph (a)(8), (a)(21) and (a)(22).

CHAIRMAN CORRADINI: Mr. Stetkar?

MEMBER STETKAR: Thank you. Leslie, I will ask you, and again I have to apologize. I don't have the RAI response, but apparently it was RAI 20-16 where you asked -- and I didn't know whether it was a generic RAI about screening out specific systems. I don't have enough notes here around.

I was curious, because GEH does take credit for the part of the main steam system through this turbine bypass valves, whatever you want to call them, to the main condenser as a method for disposing of leakage through the MSIVs, the associated dilution.

Is that function a function that would

classify those portions of the main steam system as candidates for leakage detection criteria to prevent off-site releases?

In other words, if I had a leak in the turbine bypass line via, you know, a crack, a break in the turbine bypass line, during the conditions when I am using the turbine bypass valves to account for leakage, I would have a release into the turbine building, which indeed can get out into the outside environment.

MS. CUBBAGE: I would like to propose that we come back to this tomorrow when we have our radiation protection folks here for -- They are here for Chapter 12, but --

MEMBER STETKAR: Also, Amy, I don't know if you could quickly get us that RAI 20-16.

MS. CUBBAGE: I have it right here.

MEMBER STETKAR: If you can give it to Chris and get it, I can at least read through that, because I am trying to read between lines without a lot of back-up information. Perhaps it is addressed explicitly in there.

MS. CUBBAGE: I wouldn't count on that, but I will provide it.

MS. PERKINS: And if I remember correctly, I think the reason we issued the RAI, I think the concern was making sure that they did include all the appropriate systems --

MEMBER STETKAR: The sense that I got reading the SER was that it was kind of a generic screening type RAI.

MS. PERKINS: We just wanted to know what their screening process was for identifying those systems. That was the intent of the RAI.

MEMBER STETKAR: At least in the SER that the response to that RAI seems to be cited as the basis for their screening process was okay and, therefore, by implication why the main steam system is okay, that and the assertion that it would be normally isolated during a design basis event. Thank you.

CONSULTANT WALLIS: I have a question about Slides 4 and 5. This business about generic letters there, I guess, use TMI requirements. You seem to simply say that they have some tables where they address these.

It doesn't end up with a conclusion that the way in which they addressed them was adequate. Presumably, there is a staff conclusion that they reviewed these tables and that the discussion in those tables was adequate to meet the requirements. I just don't see that here.

MS. PERKINS: In the SCR we do document our evaluation.

CONSULTANT WALLIS: Do a conclusion?

MS. PERKINS: Right.

CHAIRMAN CORRADINI: It doesn't appear on the slides.

MS. PERKINS; Right. In the safety evaluation and other chapters where we are predominantly pointing to.

CONSULTANT WALLIS: There was nothing missing in those tables?

MS. PERKINS: No. No.

MEMBER STETKAR: That is what started me on the main system.

CHAIRMAN CORRADINI: Any other questions? Thank you very much. Now we can go on and get people's comments for today. We will have another set of chapters tomorrow. Dr. Kress?

CONSULTANT KRESS: Well, it is a lot to get your arms around today. It is so squishy, it is hard to get a hold on them. Most of it was pretty good. I felt the fuel analysis was okay. The criticality looked good.

I felt there was an issue that we didn't quite discuss much, and that was when you validate the calculations with a criticality assembly, and then try to translate that to say it is applicable to the actual geometry, I am not sure we really covered that very well.

The coolant with the spent fuel pool -- I am sure it is all right with the CFD calculations, but I am still trying to digest the stuff they gave there. The figures still look funny to me, but --

CHAIRMAN CORRADINI: Which figures? Oh, the cooling?

CONSULTANT KRESS: The flow steam lines and velocities. The pictures look like they are probably about right.

CHAIRMAN CORRADINI: I do think the only thing that I guess I didn't read, and I checked on it, is I think the ones we were shown were with 80 percent blockage.

CONSULTANT KRESS: Yes. I think so. I particularly thought the plans for the 3-D analysis of the jet shock and jet impingement looked like a good thing to be doing. I doubt if it is going to be very useful for GSI-191, but maybe it is something staff can think about later. But that looked like good stuff to me.

I have very little to say about the generic safety issues. Looked like they addressed them all. I thought TRACG code validation and qualification looked like it was in pretty good shape now. Maybe I will have more to say when I go through the slides a little more carefully.

CHAIRMAN CORRADINI: Okay. And you will be here tomorrow for another whole set.

CONSULTANT KRESS: Yes.

CHAIRMAN CORRADINI: Graham?

CONSULTANT WALLIS: Yes. I agree with Tom. i have real problems with this spent fuel cooling. I mean, there is a figure that we got handed out here. It shows the two stream lines coming in and two going out, and they wander around for about 100 seconds before they go out, and this doesn't really convince me that they cool the fuel. They don't even seem to go through the fuel. there is something very strange about this. It may well be that --

CHAIRMAN CORRADINI: It may be just pictorial?

CONSULTANT WALLIS: -- that it all right, but the way it is presented there is very confusing.

Yes, the analysis of the impinging jet really represents, I think, a step forward in the analysis of this problem, which is welcome. It is using up to date technology, which we don't always see. We see what is approved instead of what could be done.

CHAIRMAN CORRADINI: I spoke to the staff separately offline, and apparently Dr. Li, who was one of the presenters, and one of the other staff are going forward with a --

CONSULTANT WALLIS: Experiment.

CHAIRMAN CORRADINI: Well, no. No, actually, with a need analysis. It is something from NRO to research for a need --

CONSULTANT WALLIS: I heard her say that.

CHAIRMAN CORRADINI: Right. But whether or not it will be calculational or experimental is still up in the air.

CONSULTANT WALLIS: If there will be any money for it, and so on.

CHAIRMAN CORRADINI: But I do think that is an important step forward.

CONSULTANT WALLIS: I think it is very ambitious. I am a little bit nervous about them being able to complete it, and I am nervous about it being evaluated by the ITAAC process, but maybe it will be looked at by the Thermal Hydraulic Subcommittee or someone, because I think it is a significant problem. That is probably where it should go.

I don't really have other -- Most of this is just cleaning up details of previous questions and answers, and I don't have problems with that.

CHAIRMAN CORRADINI: Thank you. John?

MEMBER STETKAR: Nothing real significant, pending this last question about the steam line leakage for the generic issues.

I would make a note that somebody does need to check the SER for consistency with DCD, Rev. -- pick a number -- 7 or 8, because there are places where it is not consistent in terms of numerical values that are cited.

I will say more about this tomorrow, but in Chapter 15 at least a number of those event frequencies that were recalculated by GEH between DCD Rev. 5 and 6 apparently have not been -- or have not been updated in the SER that addresses those sections. So that is more bookkeeping.

As I said, I didn't find anything that would change the overall conclusions of the safety evaluation, but if you are quoting specific numbers after three significant figures --

MS. CUBBAGE: If I could train reviewers

not to quote numbers, then we wouldn't get into this problem.

MEMBER STETKAR: Or at least not to choose significant figures, because in some cases it was different only in the second significant figure, for example.

I wasn't real happy with the response that we got from GEH this morning regarding how the plant automation system might interact with either select rod insertion or SCRRI, and I have forgotten what SCRRI is an acronym for, under certain types of transients.

Now I don't necessarily think -- I don't think that would affect any of the safety analyses, but I am not sure, because if indeed you drove power differently, you might get a different thermal response of the plant, if indeed you accounted for that system working the way it might.

I just didn't have a good sense from hearing that, well, we are going to get around to figuring out what those subpoints might be and how the system might respond after we finish the design of the system and get it into operation.

MS. CUBBAGE: They are certain.

MEMBER STETKAR: I didn't get the sense

that it wasn't going to interact with selected rod insertion or SCRRI somehow.

MS. CUBBAGE: The setpoints that are credited in the safety analysis have to be -- That is what they have to design the plant to do. Running the plant is a different story.

MR. MARQUINO: And in general, the automation system is substituting for something the operator could do, and the protective features of the plant are separate from the automation. So you might look at it as I can have this automation system, and also we do evaluations to look into what would happen if the automation system started driving the plant in adverse direction, and usually while it is already covered, we looked at the operator driving the plant in the wrong direction.

MEMBER STETKAR: I couldn't think of anything -- I don't know anything about the automation system, because there isn't much documentation of it, and most of my questions, when I looked at the plant transient response, was wasn't the automation system work to limit the transient more than the safety analysis shows.

So again, that is why I say, I don't think it is an issue in terms of the safety design of the plant. it is just how realistic or how -- yes, how realistic are the actual transient analyses that are used.

In other words, would you be getting the same demands, which again isn't -- It is an uneasiness but not an uneasiness in terms of the safety. So I will just leave it there. That is not a big issue.

CHAIRMAN CORRADINI: Okay.

MEMBER ABDEL-KHALIK: I have just two issues. One is the assumed decay heat.

CHAIRMAN CORRADINI: Something we haven't answered yet. We are going to get that clarified, hopefully, tomorrow.

MEMBER ABDEL-KHALIK: Right. The assumed decay heat for thermal hydraulic analysis of the spent fuel pool under abnormal operation with full core offload.

The second, the question that I am still not clear on is the sensitivity studies for the jet impingement. I think that is --

CHAIRMAN CORRADINI: Specifically, I want to make sure I understand that one. The first one, hopefully, is just a clarification.

On the second one, your concern is that they are biting off a very big apple. They don't know how big it is?

MEMBER ABDEL-KHALIK: Right. At least, my understanding of the problem, but I could be wrong.

CHAIRMAN CORRADINI: Okay.

CONSULTANT WALLIS: Maybe with modern computers you can do anything.

CHAIRMAN CORRADINI: I was most -- I guess the only thing that -- I guess I would turn to Amy on this one. The staff's consultants seem to think it is a doable problem.

MS. CUBBAGE: Well, and I think, at the end of the day, GE has to do it, no matter how much it costs them.

MEMBER ABDEL-KHALIK: But my concern would be that there would be clear communication as to what the expectations are.

MS. CUBBAGE: With regard to how far out?

MEMBER ABDEL-KHALIK: What you expect them to do, because based on the presentation and even the response to the question, still in my mind this is a very nearly intractable problem.

MS. CUBBAGE: I think the point is open space versus closed space and how that is defined.

MEMBER ABDEL-KHALIK: What the boundary of the analysis is.

CHAIRMAN CORRADINI: All right.

CONSULTANT WALLIS: What happens when they get to the ITAAC stage, and they found they couldn't really do what they said they were going to do?

CHAIRMAN CORRADINI: Well, I don't think they are going to wait until then.

CONSULTANT WALLIS: Well, that is the place that this will be resolved.

MS. CUBBAGE: They have to do this before they can actually install the piping and build the plant. So this is an ITAAC that would get resolved early.

CHAIRMAN CORRADINI: Okay. Tomorrow we have -- Well, I don't have it with me. Tomorrow we have Chapters -- oh, it is on the other side; of course, it is -- Chapters 2, 12, 18, 10, 14 and 16, to name just a few.

To remind everybody, simultaneously for the members we have private meetings to get ourselves clear on the AIA assessment for ABWR. So everything is happening together.

MEMBER ABDEL-KHALIK: That, by the way, is going to start at 7;15 a.m., and people will just accommodate their own schedules.

CHAIRMAN CORRADINI: Right.

MEMBER ABDEL-KHALIK: They definitely will be here at 7:15.

CONSULTANT KRESS: I think that is not --

CHAIRMAN CORRADINI: That is not you.

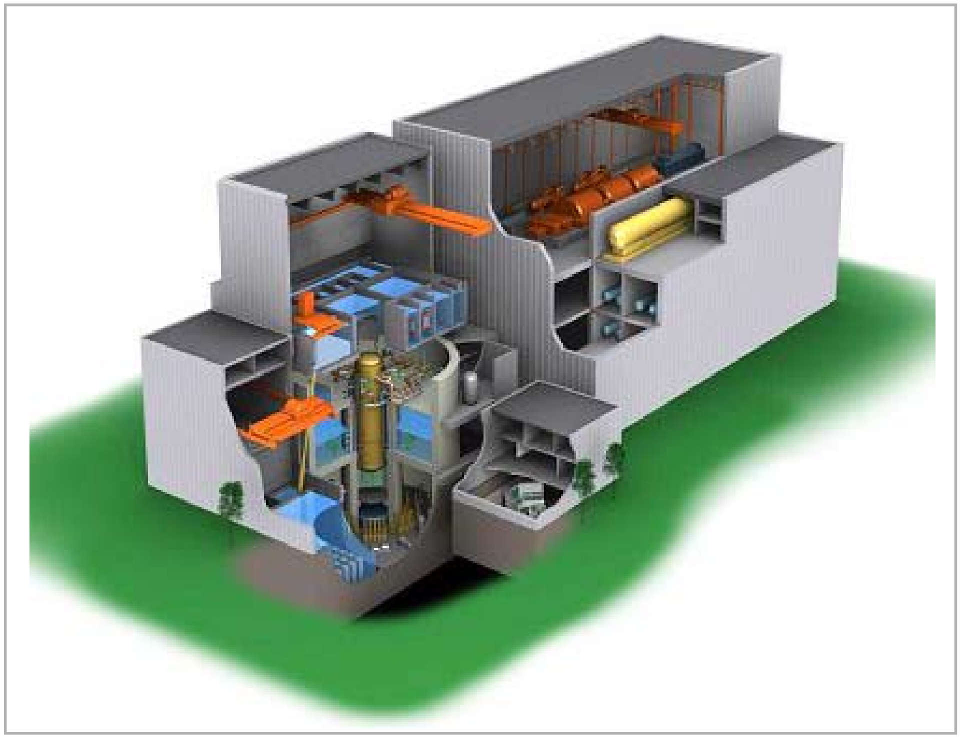
CONSULTANT KRESS: No, no.

CHAIRMAN CORRADINI: With that, we will adjourn for the day, and be back here at 8:30.

(Whereupon, the foregoing matter went off the record at 4:41 p.m.)

GE Hitachi Nuclear Energy

Chapter 15, Safety Analyses



Advisory Committee on Reactor Safeguards

Wayne Marquino

Md Alamgir

August 16, 2010

HITACHI

Introduction

Review selected topics requested by NRC staff

GEH Presentation
- Select Control Rod Run-In/Select Rod Insert features
- Reactivity Insertion Event frequency classification
- Control Rod Drop Accident
- Summary

SCRRI/SRI

ESBWR provides a rapid power reduction through SCRRI/SRI

- Power reduction is intended to prevent a scram or other undesired conditions
- Function is similar to recirculation/core flow runback in other BWRs
- SCRRI=Electrical insertion of rods to a pre-set pattern
- SRI=Hydraulic Scram of pre-determined rods

Initial submittal included only SCRRI, SRI was added to effect a more rapid global reduction in power

Reactivity Insertion Events

- Initial DCD submittal classified all reactivity events as Infrequent Events (IE) not expected to occur during plant life, < 1/100 yr.
- GEH determined that some reactivity events are higher frequency, Anticipated Operational Occurrences (AOO), > 1/100 yr.
- GEH Revised 15.2.3, reclassified Control Rod withdrawal error during Startup and during Power Operation as AOO's
- These AOO scenario's do not cause fuel failure or dose consequences

Control Rod Drop RAIs 4.6-23 S0-02& 38

Avoidance

- Redundant Safety related switches in the ESBWR & ABWR CR Drives will detect uncoupling of blade movement from drive movement
- Drive movement is then blocked to avoid the possibility of rod drop
- RAI responses documented the reliability of this feature which makes CR incredible
- NRC requested quantification of the dose consequences

(cont'd)

HITACHI

Control Rod Drop RAIs 4.6-23 S0-02& 38

Consequences

- GEH calculated the blade worth & enthalpy rise using PANACEA and TRACG
- ESBWR rod worth is lower than BWR2-6 because of tighter control of rod position and the larger core.
- The enthalpy rise curve in Appendix B of Revision 3 to SRP Section 4.2 would not be exceeded.
  - Therefore no fuel damage or dose results
- A rod worth criterion is provided to evaluate future cores

Summary

- All open items closed
- Reduced event frequency is provided by redundancy in control systems and components
- Larger steam space in RPV provides softer pressure response, no SRV opening in AOO's
- Safety analyses show 10 CFR acceptance criteria for SAFDLs and dose are met.

United States Nuclear Regulatory Commission

Protecting People and the Environment

Presentation to the ACRS Subcommittee

ESBWR Design Certification Review
Transient and Accident Analyses - Chapter 15

August 16, 2010

ACRS SC Presentation ESBWR Design Certification Review Chapter 15

<u>Review Team for Chapter 15</u>

- Lead PM
  - Bruce Bavol
  - Amy Cubbage
- Technical Reviewers
  - George Thomas
  - Jay Lee
  - Benjamin Parks
  - John Lai
  - Dr. Lambros Lois, Consultant, ORNL

ESBWR Unique Design Features

- Elimination of active ECCS

- 4 (I&C) channels for safety systems

- Redundant processors for control systems

- Event frequency is changed and hence re-categorized with respect to SRP

- Some transients classified as AOOs in current operating BWRs are classified as Infrequent Events for ESBWR due to the unique design features

ESBWR EVENTS CATEGORIZATION

Event	Frequency Events/year	Acceptance Criteria
AOOs	>0.01	RPV Level above TAF, MCPR > SLMCPR, RPV Pressure ≤ 1375 PSIG
Accidents Infrequent Events DBA	 < 0.01 $<10^{-4}$	 RPV Level above TAF 10% of 10 CFR50.34 (a) (ii)(D)(1)- 2.5 rem TEDE, RPV Pressure ≤1500 psig 25 rem TEDE,
Special Events (ATWS,SBO etc)	Varies	Case by case

Analyses Methods

- TRACG used for analyses (except for reactivity transients), TRACG capabilities will be addressed in Chapter 21
- PANAC-11 is used for Reactivity Events
- Staff accepted that only Limiting Events need to be reanalyzed for subsequent reloads using GE14E fuel

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

Reactivity Transients

- RAI 15.3-33
- The DCD proposed to analyze all Reactivity transients as Infrequent Events.
- Staff requested GEH to consider Rod Withdrawal Error (RWE) as an AOO
- GEH analyzed RWE as AOO during power operation and start-up
- RAI 15.3-33 was resolved

Control Rod Drop Accident (CRDA)

- RAI 4.6-23
- The Fine Motion Control Rod Drive Mechanism (FMCRD) System has Been Accepted in ABWR
- GDC 28, “Reactivity Limits,” shall be designed with appropriate limits on the potential amount and rate of reactivity increase.
- CRDA Analysis was requested to Satisfy GDC 28 Regardless of the Estimated Event Frequency

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

CRDA (Continued)

- Interim Acceptance Criteria per SRP Section 4.2 (Rev. 3) Appendix B
- The Applicant Performed Analyses (PANAC-11) to Determine Limiting Rod Worth and Corresponding Fuel Burn-up
- Conservative assumptions were made regarding: rod worth and adiabatic heat that ignores core void feedback
- The calculated results demonstrate large margin to the acceptance criteria
- RAI 4.6-23 was resolved

Conclusion

- No Open Items
- Acceptance criteria met with large margin
- Overall, the accident analyses indicate ESBWR is more resilient than conventional BWRs

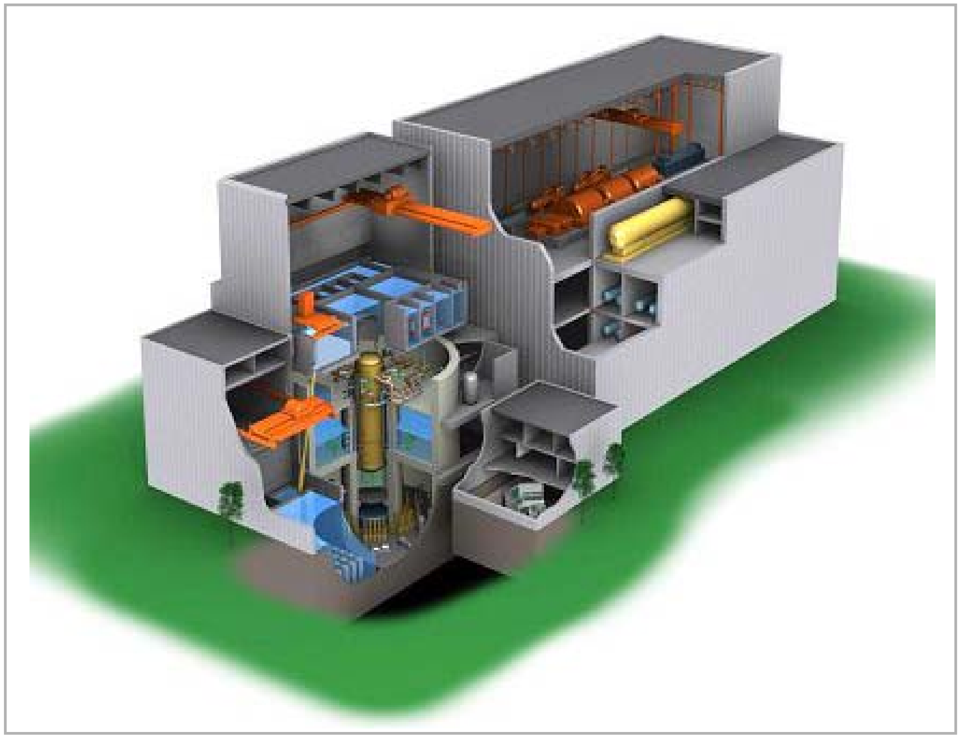
GE Hitachi Nuclear Energy

LTR NEDO-33373, "Dynamic, Load-Drop and Thermal-Hydraulic Analysis for ESBWR Fuel Racks"

Advisory Committee on Reactor Safeguards

Jerry Deaver

August 16, 2010



HITACHI

Introduction

- LTR NEDO-33373 Contains 5 sections
  - Dynamic loads for spent fuel racks in spent fuel pool
  - Dynamic loads for spent fuel racks in buffer pool
  - Dynamic loads for new fuel racks in buffer pool
  - Load-drop (Impact) analysis
  - Thermal Hydraulic Analysis

Fuel Storage Rack Designs

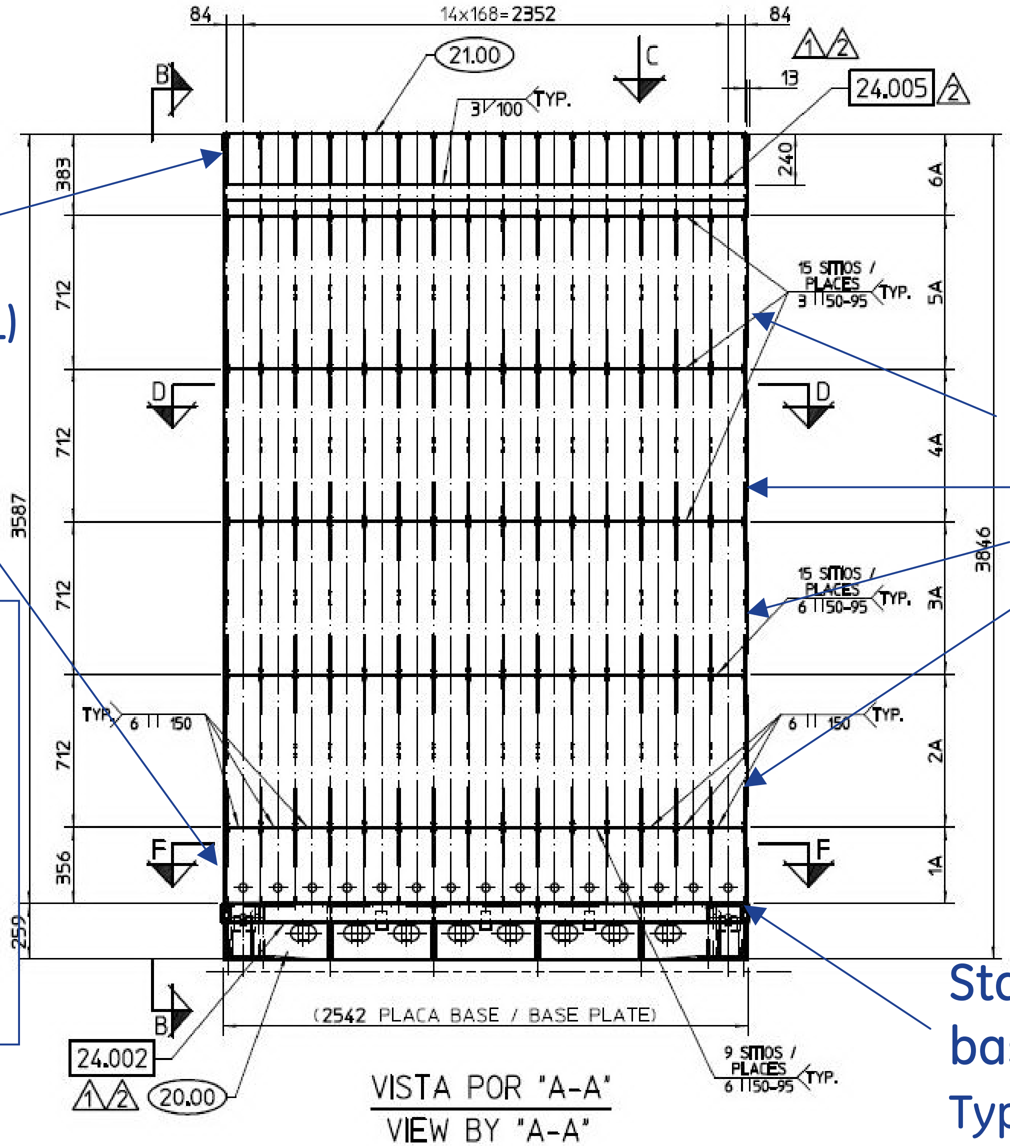
- General: ASME B&PV Code, Section III, Division I, Subsection NF used for design
- Spent fuel storage racks in refueling building
  - 10 years storage with full core offload; capable of being expanded to 20 years
  - 20 freestanding racks with 3504 cells
  - Racks structurally linked to prevent individual rack movement
  - Borated stainless steel plates; not credited to provide structural integrity
- Spent fuel racks in buffer pool (reactor building)
  - 154 cells; only used for temporary storage during refueling
  - Bolted to pool floor
- New fuel racks in buffer pool (reactor building)
  - 476 cells in 7X2 array; bolted to pool floor
  - Side entry with mechanical device to close cell

HITACHI

Spent Fuel Storage Rack Design

Stainless steel support plates (SA-240 Type 304L) - Interior plates; 7 mm thick

Stainless steel enveloping plates (SA-240 Type 304L) - 10 mm thick



Borated stainless steel Plates (ASTM A 887 Type 304B7) - Interior plates; 3.4 mm thick

Stainless steel base plate (SA-240 Type 304L) – 20 mm thick

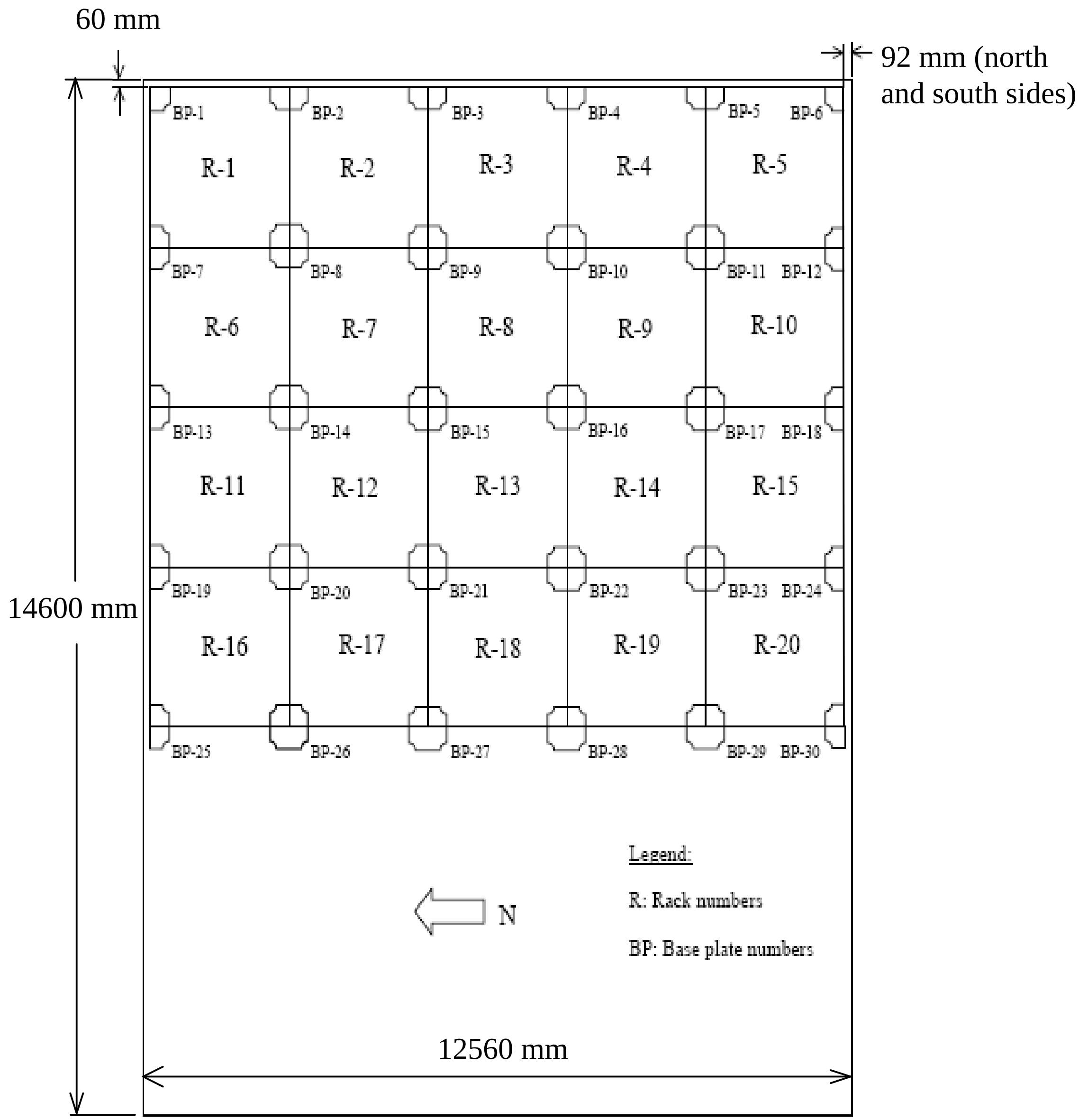
Fuel Storage Rack Layout – Spent Fuel Pool

- Pool dimensions are minimums. The tolerance for nominal pool dimensions is +300/-200 mm.

- There is sufficient space in the the west end of the pool to accommodate 20 years of spent fuel plus a full core offload.

- Rack displacement in the north/south direction is 44.5 mm.

- Rack displacement in the east/west direction is 51.6 mm.



GE HITACHI

Refueling Building Spent Fuel Rack Stress Results

Location	Stress (MPa)	Stress Limit (MPa)	Ratio
10 mm thick Enveloping Plate	226	292.8	22.8
10 mm thick Enveloping Plate Welds	163	198.6	17.9
7 mm thick Upper Level Plates	227	292.8	22.5
7 mm thick Upper Level Plate Welds	91	198.6	54.2
Fuel Support Base Plate	274	292.8	6.4
20 mm thick Base Plate Stiffener Plates	208	292.8	29.0
20 mm thick Base Plate Stiffener Plate Welds	136	198.6	31.5
Foot Cylindrical Nut	253	292.8	13.6
Foot Cylindrical Nut Welds	141	198.6	29.0
Nut Thread	107	198.6	46.1
Lower Links (Bearing Pad)	363	419.9	13.6
Upper links (Assembly Crossarm)	927	1049.7	11.7

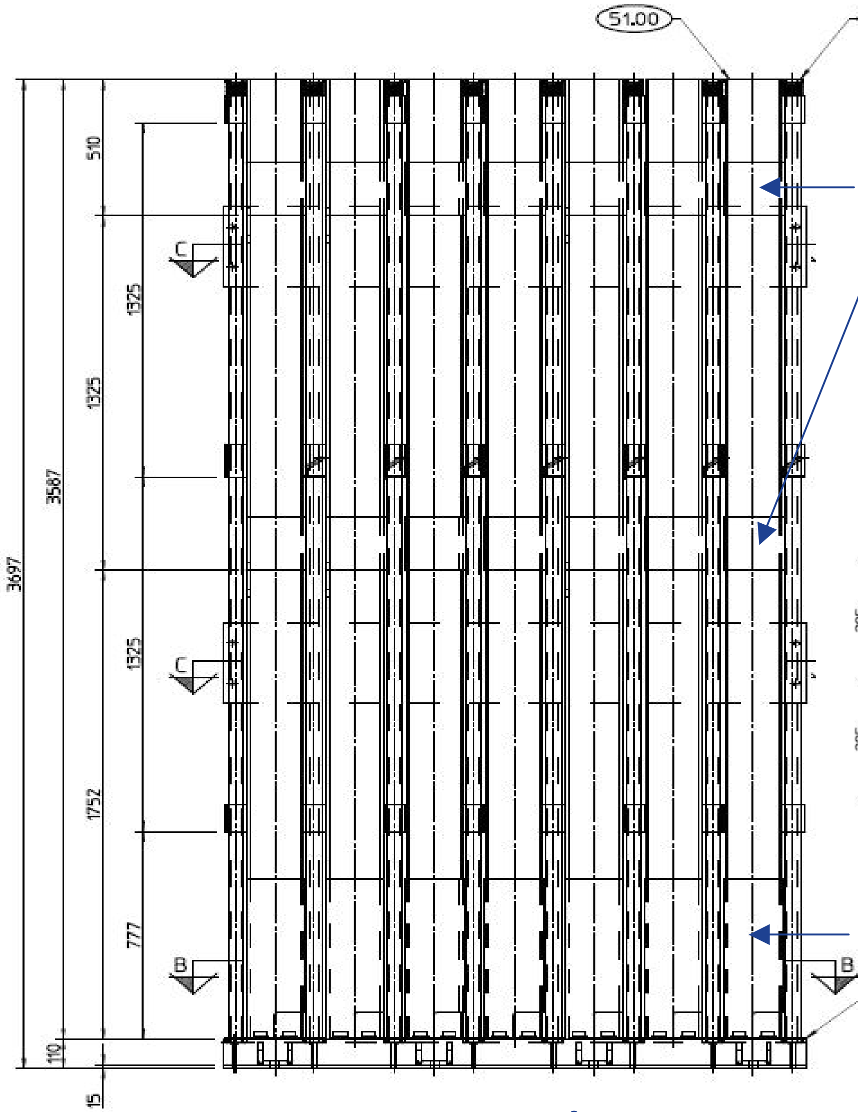
Buffer Pool Spent Fuel Rack Stress Results

Location	Calculated Stress (MPa)	Stress Limit (MPa)	Stress Margin
10 mm thick enveloping plate	131	292.8	55.3
10 mm thick enveloping plate welds	185.5	198.6	6.6
7 mm thick upper level plates	55.8	292.8	80.9
20 mm thick base plate	101	292.8	65.5
20 mm thick base plate stiffener plates	142	292.8	51.5
20 mm thick base plate stiffener plate welds	155.1	198.6	21.9
60 mm thick bolted support plates	174	292.8	40.6
M48x4 anchor bolts	0.87 (*)	1 (*)	13.0

* This is a stress ratio, not a stress value

HITACHI

New Fuel Side Entry Storage Racks

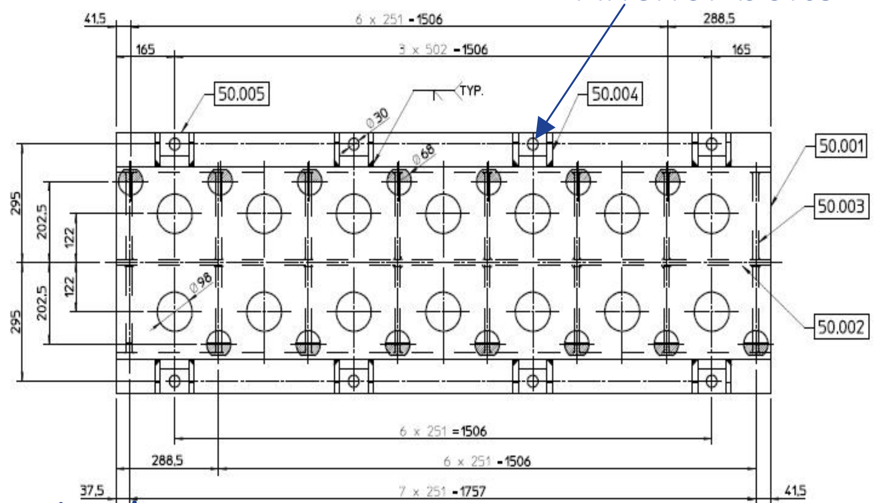


Fuel retainer plates that rotate with spring loaded rod

Fixed lower plate

Front Elevation View

Anchor bolts



Top View of base plate

HITACHI

New Fuel Storage Rack Stress Results

Location	Calculated Stress (MPa)	Stress Limit (MPa)	Stress Margin
8 mm thick channel plate	267	292.8	8.8
Channel to support-base welds	182	198.6	8.4
12 mm thick door plates	123	195.2	37.0
Assembly grid plate	52.5	195.2	73.1
Axis and hinge	130	195.2	33.4
15 mm thick support-base stiffeners	138	195.2	29.3
15 mm thick folded base plate	266	292.8	9.2
30 mm thick bolted support plates	124	292.8	57.7
M24x2 anchor bolts	0.91 (*)	1 (*)	9

* This is a stress ratio, not a stress value

HITACHI

Load-drop (Impact) analysis

- Summary of Results

Spent Fuel Storage Racks

- The most demanding impacts are those taking place against the top of the spent fuel racks from a 6.4 m drop onto a single rack plate with a slot located at the top of the plate
- In the worst case impact location, the dropped element is able to advance about 20 cm into the rack if it falls together with the handling tool and about 10 cm without it. In either case, the active fuel zone is not impacted.
- For impacts that take place at the intersection of cell walls, the deformations are considerably smaller and limited to 3 cm
- Impacts against the base plate of the spent fuel racks assuming a 1.8 m drop above the rack, results in strains that remain below the ductility limit of the material

New Fuel Storage Racks

- Impacts are insignificant due to the short assumed drop height (1 m)

Thermal-Hydraulic Analysis

Two Cases Analyzed by CFD

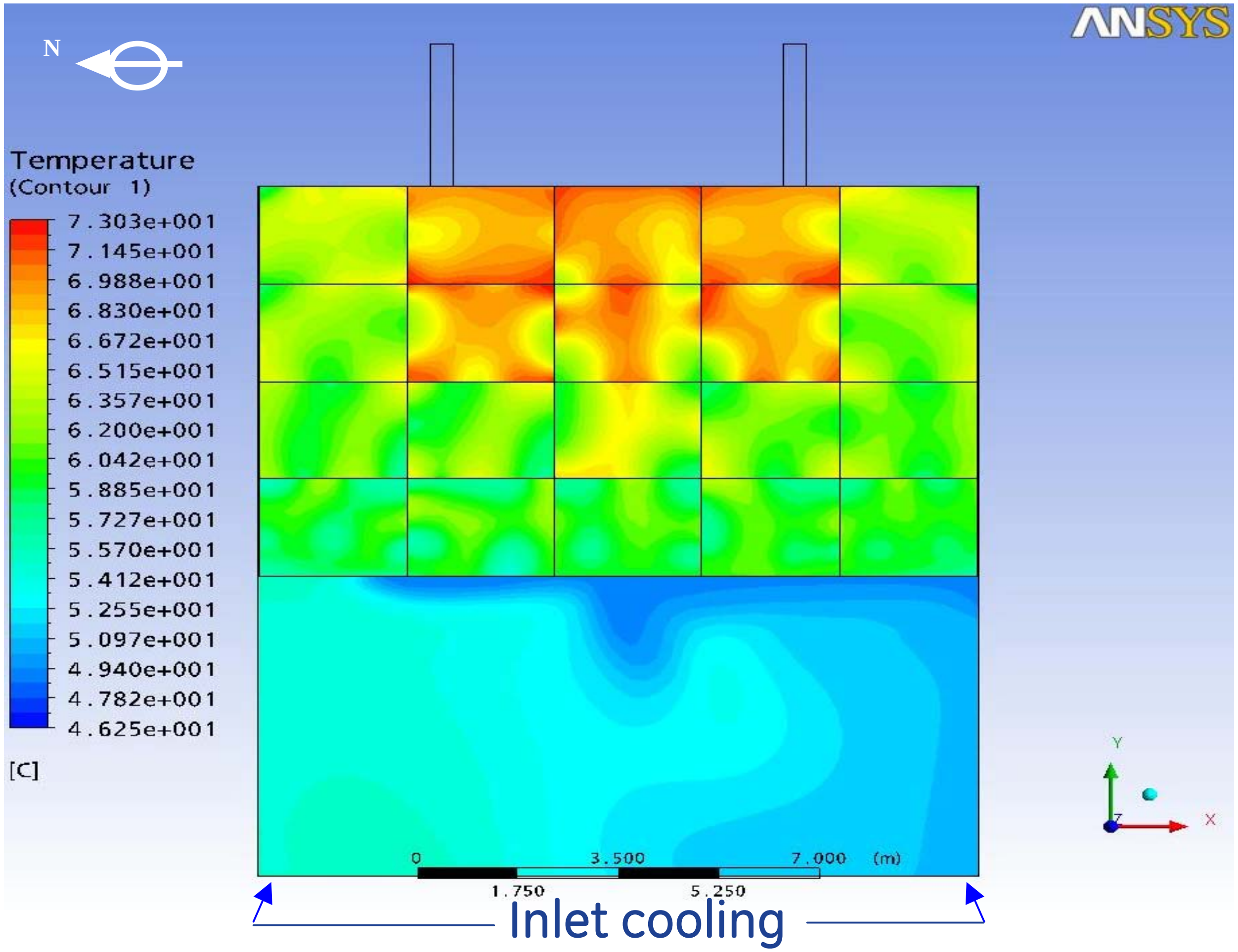
Normal Operation

- Heat Load = 10-Year spent fuel accumulation = 7.626 MW
- Maximum Pool Bulk Temp = 48.9°C
- Pool Cooling Rated Flow Rate = 545.1 m^3/hr (single train FAPCS operation)

Abnormal Operation

- Heat Load = 10-Year spent fuel accumulation + full core offload = 17.3 MW
- Maximum Pool Bulk Temp = 60°C
- Pool Cooling Rated Flow Rate = 1090.2 m^3/hr (two train FAPCS operation)

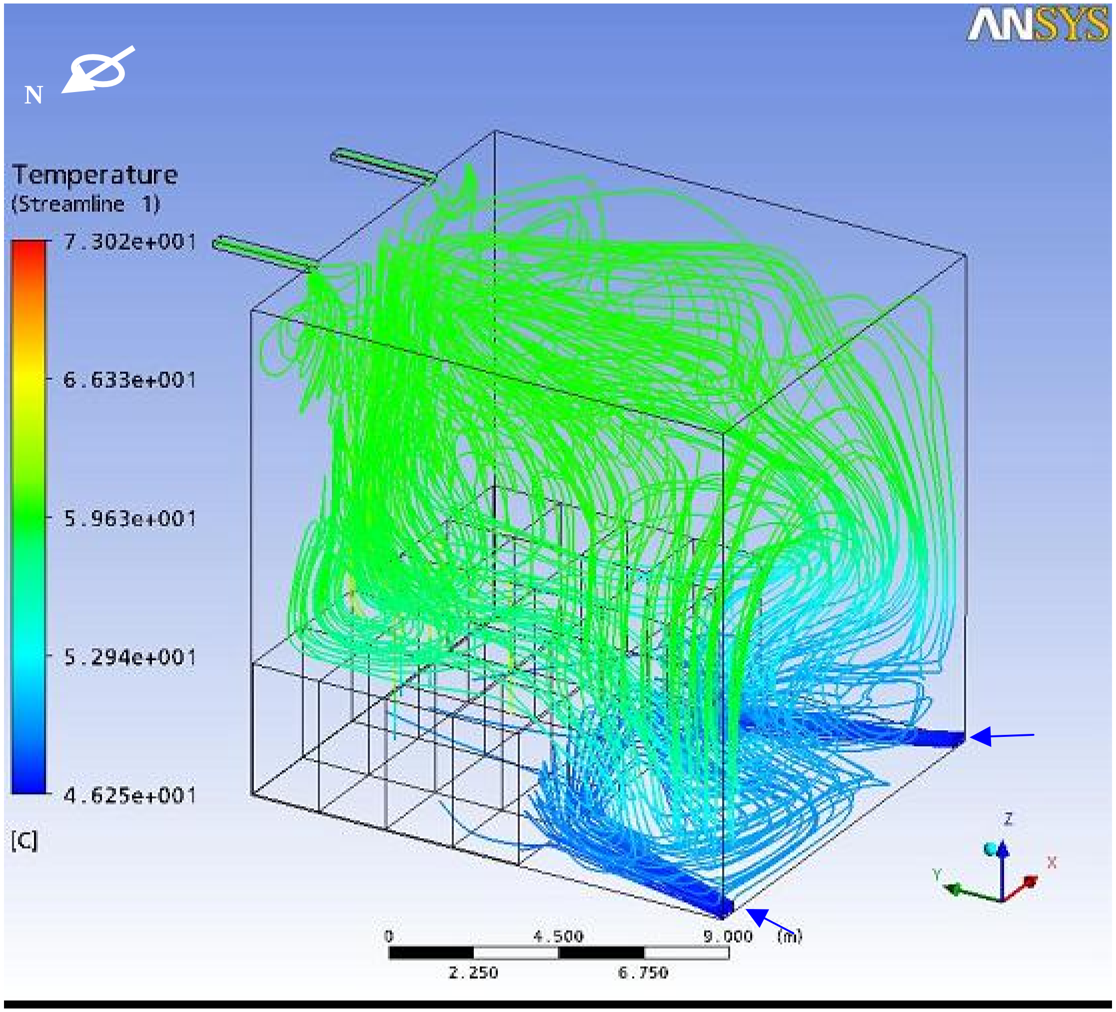
Limiting Thermal Condition (Abnormal Case)



maximum peak temperature = 73.03°C vs. maximum allowable temperature of 121°C.

HITACHI

Streamlines from Inlet to Outlet (Abnormal Condition)



HITACHI

Summary

- All structural stress results are within the ASME criteria
- The fuel drop analysis demonstrates that the active fuel zone will not be affected
- The thermal hydraulic analysis demonstrates that temperatures will be within the design limits

All fuel storage rack designs meet the required design criteria

HITACHI

Backup Slides

HITACHI

Load Combinations

Level A: $D + P_f$

Level D: $D + SSE + SRVD + LOCA + T_a$

Level D*: $D + SSE + T_a$

*Applicable only to analysis of freestanding racks in the Spent Fuel Pool.

HITACHI

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

Presentation to the ACRS Subcommittee

Staff Review of Dynamic and Load-Drop Analysis for ESBWR Fuel Racks (NEDO-33373)

Presented by

Jim Xu - NRO/DE/SEB

August 16, 2010

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

Background

- Rack structures were designated as ASME Class 3 plate type structures, and designed as ASME Section III, Division I, Subsection NF and Appendix F Class 3 plate and shell type supports
- Racks were analyzed for dynamic response to safe-shutdown earthquake (SSE), safety relieve valve discharge (SRVD), and Loss-of-coolant accident (LOCA) loads
- Racks were demonstrated to withstand operational and accidental load drops of fuel assemblies and handling tools
- Load combinations performed in accordance with SRP 3.8.4, Appendix D, Table 1

Regulatory Criteria

- 10 CFR 50.55a, “Codes and Standards,” as they relate to codes and standards
- GDC1, as it relates to racks being designed, fabricated, erected, constructed, and tested to quality standards commensurate with the importance of the safety function to be performed
- GDC 2, as it relates to racks being designed to withstand appropriate combinations of the effects of normal and accident conditions with the effects of earthquakes.
- GDC 4, as it relates to racks being appropriately protected against the dynamic effects of discharging fluids.

Staff Review Summary

- Staff reviewed the structural analyses based on guidance in SRP 3.8.4, Appendix D, "Guidance on Spent Fuel Pool Racks"
- Staff issued 33 RAIs since 2008
- NEDO has 4 revisions
- All RAI have been resolved

Key Review Findings

- Design temperature
  - Applicant used lower than accident temperature (121C) for the design of racks
  - Staff identified that ESBWR relies on FAPCS for spent fuel pool cooling which is a non-safety system and should not be relied on in an accident condition
  - Staff issued RAI 9.1-54, requesting justifications
  - In its response, applicant stated that reanalysis would be based on accident temperature and ASME material limits based on the accident temperature would be used for the design

Key Review Findings (cont'd)

- Service Level D combination
  - Service Level D requires SSE be combined with thermal load
  - Applicant credited FAPCS for spent fuel pool cooling, therefore neglecting induced thermal load
  - Staff identified that FAPCS is a non-safety system and should not be relied on in an SSE event
  - Staff issued RAI 9.1-144, requesting justifications
  - In its response, applicant stated that reanalysis would include thermal load in Service Level D load combination and the reanalysis also resulted in resizing the pool dimension to accommodate combined seismic and thermal effects

Key Review Findings (cont'd)

- Non-linear transient seismic model for spent fuel pool racks
  – 2-D non-linear models were used for SSE
  – Free-standing racks tied together exhibit 3-D motion which cannot captured by 2-D models, such as pivotal effect
  – Staff issued RAI 9.1-117, requesting justifications
  – In its response, applicant stated that reanalysis would be performed using a 3-D model of racks
  – Applicant also analyzed racks against sliding for lower bound of friction coefficient of 0.2, to ensure no impact of racks on liner

Conclusions

- The structural analysis and design of racks are consistent with ASME requirements for Class 3 plate and shell type supports
- Racks are analyzed as seismic Category I in accordance with guidance in Appendix D to SRP 3.8.4
- Staff review concludes that the structural analysis and design of racks meet applicable regulations.

Discussion/Committee Questions

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

Presentation to the ACRS Subcommittee

Staff Review of Thermal-Hydraulic Analysis for ESBWR Fuel Racks (NEDO-33373)

Presented by

James Gilmer - NRO/DSRA/SRSB

August 16, 2010

Regulatory Criteria

- 10 CFR 50 Appendix A, General Design Criterion 61 (Fuel Storage and Handling)
  - designed to assure adequate safety under normal and postulated accident conditions
  - with a residual heat removal capability having reliability and testability
- Standard Review Plan 9.1.2 (New and Spent Fuel Storage)

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

Staff Review Summary

- Rack and FAPCS design specifications*
- Normal and abnormal heat load calculations*
- Turbulence Model
- Flow loss/bounding ΔP
- Normal and abnormal definition
- CFD Code Qualification
- CFD Model Sensitivity

* by audit

Key Review Findings

- Significant margin in fuel and pool water temperature
- Adequate natural circulation
- Design meets GDC 61 requirements and SRP 9.1.2 guidance

Conclusions

- Rack design allows adequate natural circulation cooling of spent fuel
- Significant thermal margin will exist between the calculated fuel temperature and the design allowable temperature
- Staff review concludes that the thermal-hydraulic analyses and design of racks meets applicable GDC 61 requirements and SRP 9.1.2 guidance

Discussion/Committee Questions

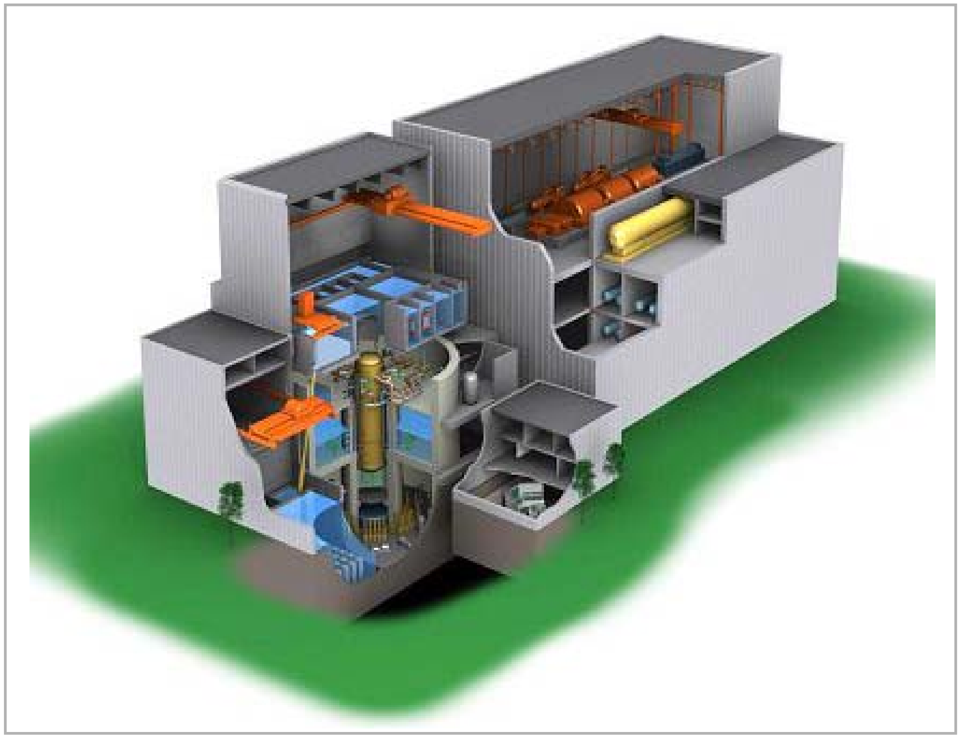
GE Hitachi Nuclear Energy

ESBWR Chapter 20: Generic Issues

Advisory Committee on Reactor Safeguards

David A. Hamon

August 16, 2010



Introduction

- Requirement to address generic issues and operating experience insights appears in 10 CFR 52.47.

(a) The application must contain a final safety analysis report (FSAR) that … must include the following information:

(8) The information necessary to demonstrate compliance with any technically relevant portions of the Three Mile Island requirements set forth in 10 CFR 50.34(f), except paragraphs (f)(1)(xii), (f)(2)(ix), and (f)(3)(v);

(21) Proposed technical resolutions of those Unresolved Safety Issues and medium- and high-priority generic safety issues which are identified in the version of NUREG–0933 current on the date up to 6 months before the docket date of the application and which are technically relevant to the design;

(22) The information necessary to demonstrate how operating experience insights have been incorporated into the plant design;

Introduction

- Further details about these requirements are provided in NUREG-0800, Standard Review Plan Section 1.0.
- Response to all RAIs related to Generic Issues have been submitted.

SRP 1.0, Section I.9

Generic Issues and Three Mile Island Requirements:

A table that identifies proposed technical resolutions for those Unresolved Safety Issues and medium- and high-priority generic safety issues which are identified in the version of NUREG-0933 current on the date up to 6 months before the submittal date of the application and which are technically relevant to the design and identifies FSAR section references where the resolutions are addressed is reviewed. The table also identifies Three Mile Island requirements set forth in 10 CFR 50.34(f).

Compliance:

GEH addressed these issues in DCD Tier 2 Tables 1.11-1 (Generic Issues) and 1A-1 (TMI Issues) based on NUREG-0933 and its supplements through Supplement 30, October 2006.

SRP 1.0, Section I.9

Operational Experience (Generic Communications):
Information from the applicant that demonstrates how operating experience insights from generic letters and bulletins issued after the most recent revision of the applicable standard review plan and 6 months before the docket date of the application, or comparable international operating experience, have been incorporated into the plant design is reviewed.

Compliance:
GEH addressed operational experience insights in DCD Tier 2 Tables 1C-1 (Generic Letters) and 1C-2 (Bulletins). List of GLs and BLs included in these tables was developed based on the ABWR DCD and Draft Regulatory Guide DG-1145 Section C.IV.8 dated September 2006.

Summary

- ESBWR DCD has addressed the requirements of 10 CFR 52.47 related to generic issues and operational experience insights.
- No Open RAIs

U.S.NRC
UNITED STATES NUCLEAR REGULATORY COMMISSION
Protecting People and the Environment

Presentation to the ACRS Subcommittee

ESBWR Design Certification Review
Chapter 20
“Generic Issues”

Leslie Perkins – Project Manager

August 17, 2010

ACRS Subcommittee Presentation
ESBWR Design Certification Review
Chapter 20

Applicable Regulations

- 10 CFR 52.47(a)(8) requires that DC applicants demonstrate compliance with technically relevant parts of TMI action plan requirements found in 10 CFR 50.34(f).
- 10 CRF 52.47(a)(21) requires the DC applicants to address resolution of USIs and medium and high priority GSI as define in NUREG -0933

ACRS Subcommittee Presentation
ESBWR Design Certification Review
Chapter 20

Applicable Regulations

- 10 CFR 52.47(a)(21) requires the applicant to include information necessary to demonstrate how operating experience insights have been incorporated into the plant design
    - Generic Letters
    - Bulletins

ACRS Subcommittee Presentation
ESBWR Design Certification Review
Chapter 20

Staff's Evaluation

- The Chapter 20 SER provides the staff's evaluation for certain generic issues
- Additional generic issues are discussed in other SER Chapters
  - Chapter 20 provides a pointer to applicable chapters and sections of the SER for the staff's evaluations

ACRS Subcommittee Presentation
ESBWR Design Certification Review
Chapter 20

- GEH addresses Generic issues and TMI Requirements in DCD Tier 2, Tables 1.11-1 and 1A-1

- Operational insights are addressed in DCD Tier 2 Tables 1C-1 and 1C-2

ACRS Subcommittee Presentation
ESBWR Design Certification Review
Chapter 20

- Issue A-17

- Issue A-17 Addresses concerns about adverse system interactions in nuclear power plants

- GEH addressed Issue A-17 in Tier 2, Table 1.11-1

- GEH analyzed specific features and actions that are design to prevent postulated adverse interactions

ACRS Subcommittee Presentation
ESBWR Design Certification Review
Chapter 20

Issue A-17:

- GEH submitted an assessment of significant adverse interactions

- Purpose of the assessment was to identify possible adverse interactions among safety-related passive systems and between safety and non-safety related active systems.

ACRS Subcommittee Presentation
ESBWR Design Certification Review
Chapter 20

Issue A-17

- GEH studied interaction of GDCS, ADS, ICS, SLCS and PCCS with other systems such as FAPCs, main steam, suppression pool, containment.

- The staff reviewed the study as part of their review for RTNSS in SER Section 22.5.5

ACRS Subcommittee Presentation
ESBWR Design Certification Review
Chapter 20

Issue A-17

- The staff concludes that GEH addressed issue A-17 for the ESBWR by completing an assessment of possible adverse system interactions and the potential consequences

ACRS Subcommittee Presentation
ESBWR Design Certification Review
Chapter 20

GL 92-04 and BL 93-03

- Resolution of issues related to reactor vessel water level instrumentation in BWRs

- GL 92-04 requested information regarding the adequacy of and corrective actions for BWR water level instrumentation with respect to non-condensable gases on system operations

ACRS Subcommittee Presentation
ESBWR Design Certification Review
Chapter 20

GL 92-04 and BL 93-03

- The staff's concern was that non-condensable gases may become dissolved in the reference leg of water level instrumentation and lead to false high level indication after a rapid depressurization

- Staff later issued BL 93-03, requesting hardware modifications for operating reactors

ACRS Subcommittee Presentation
ESBWR Design Certification Review
Chapter 20

GL 92-04 and BL 93-03

- GEH incorporated a backfill modification system that will constantly purge the reference leg with a very low flow rate of water supplied by the CRD system
- The staff finds that the ESBWR designs addresses the concerns identified in GL 92-04 and BL 93-03 because GEH incorporated the modifications recommended by the staff in the ESBWR RPV level instrumentation system design.

ACRS Subcommittee Presentation
ESBWR Design Certification Review
Chapter 20

Conclusion

- The staff concludes that GEH addressed applicable generic issues and demonstrated compliance with the requirements of 10 CFR 10 52.47(a)(8), 10 CFR 52.47(a)(21), and 10 CFR 52.47(a)(22)

ACRS Subcommittee Presentation
ESBWR Design Certification Review
Chapter 20

Discussion/Committee Questions