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ADVISORY COMMITTEE ON REACTOR SAFEGUARDS

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2 NUCLEAR REGULATORY COMMISSION

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4 ADVISORY COMMITTEE ON REACTOR SAFEGUARDS

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6 ESBWR SUBCOMMITTEE

7 + + + + +

8 OPEN SESSION

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10 TUESDAY

11 October 20, 2009

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13 ROCKVILLE, MARYLAND

14 The Subcommittee met in Room T2-B-3 at the
15 Nuclear Regulatory Commission Headquarters, Two White
16 Flint, North, 11545 Rockville Pike, at 8:30 a.m.,
17 Michael L. Corradini, Chairman, presiding.

18 SUBCOMMITTEE MEMBERS PRESENT:

19 MICHAEL L. CORRADINI, Chair

20 SANJOY BANERJEE

21 J. SAM ARMIJO

22 WILLIAM J. SHACK

23 SAID ABDEL-KHALIK

24

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CONSULTANTS TO THE SUBCOMMITTEE PRESENT:

THOMAS S. KRESS

GRAHAM B. WALLIS

DESIGNATED FEDERAL OFFICIAL:

CHRISTOPHER BROWN

NRC STAFF PRESENT:

KATHERINE WEAVER, Senior Engineer

AMY CUBBAGE, NRO

ALSO PRESENT:

GARY ANTHONY

GERALD DEAVER

ZAHIRA CRUZ

TUAN LE

RENEE LI

ENRICO BETTI

PATRICK SEKERAK

STEVEN HAMBRIC

JULES LINDAU

WAYNE MARQUINO

RICK WACHOWIAK

DAVID JENG

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

(9:00 a.m.)

MS. CUBBAGE: -- open items. We would like to discuss the progress that has been made on that issue. And steam dryers. Those were topics, of course, that had just recently been submitted at the time that we briefed the ACRS on Chapter 3. So this is the first run through on those topics.

So tomorrow morning I will give you a status of the topics we are going to discuss tomorrow and again on Thursday. But that sums up what you are going to hear about today. I would like to turn to Gerry Deaver, who is going to represent GE Hitachi this morning.

MR. DEAVER: Good morning. I would like to give you the presentation on the IC and PCCS reactor hardware with regard to sloshing. Let's see.

Okay the agenda is first review the RAI status on this topic, followed by a review of the configuration of the IC and PCCS condenser configuration. Then we will have a discussion about the reactor building dynamic loads evaluation. Then we will review the PCCS condenser structural analysis methods and the design report results, followed by some sloshing pressure results from the building model

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1 analysis. We will talk about the IC condenser
2 analysis and then conclusions.

3 Regarding RAIs, there was one RAI, 3.9-247
4 where the details of hydrodynamic loads and sloshing
5 loads were requested and a response was provided. And
6 at this time, the RAI is resolved.

7 CONSULTANT WALLIS: Does that mean we
8 can't ask questions about it?

9 CHAIRMAN CORRADINI: No, he is just giving
10 you the status. Now he is going to give you the
11 details.

12 CONSULTANT WALLIS: Oh, okay.

13 MR. DEEVER: So what I would like to show
14 you next is this is a 3D schematic of the two
15 condensers. On the left we have the ICS condenser and
16 on the right we have the a PCCS condenser.

17 CONSULTANT WALLIS: What I would need
18 would be a cross-section of them so I can see the
19 picture of the tubes and that kind of thing. Do you
20 have that somewhere?

21 MR. DEEVER: The next page will have those
22 coming up, the cross-sections.

23 CONSULTANT WALLIS: Now the other
24 question.

25 MR. DEEVER: The other question?

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1 CONSULTANT WALLIS: So I can see the
2 picture of the tubes.

3 MS. CRUZ: Excuse me.

4 CONSULTANT WALLIS: See it cutting through
5 the tubes.

6 CHAIRMAN CORRADINI: Well let's let him go
7 a little bit longer and then we will see --

8 MS. WEAVER: I can't hear. So I think he
9 is going to have to get closer to a mike.

10 CHAIRMAN CORRADINI: You mean for Gerry or
11 for Graham?

12 MS. CRUZ: Graham.

13 CHAIRMAN CORRADINI: Graham, I don't think
14 they can hear you exactly what you are saying.

15 CONSULTANT WALLIS: Why? There is a thing
16 here.

17 MS. CRUZ: Your mike might be covered.

18 CONSULTANT WALLIS: It was for a while.
19 Okay. Sorry.

20 CHAIRMAN CORRADINI: So keep on going. We
21 will stop you.

22 MR. DEEVER: Okay. So we have the inlet
23 steam pipe. This is the IC system. It is pressurized
24 during operation. And these are two header pipes that
25 tie in to the upper headers, followed by the tubes.

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1 There is a bank of tubes. You can see that there are
2 several tubes that span both sides and in towards the
3 middle. So there are several banks of tubes that tie
4 in here.

5 And then we have the lower header and then
6 we have the return line.

7 CONSULTANT WALLIS: Well that is just sort
8 of four layers of tubes and then there was another
9 layer of three.

10 CHAIRMAN CORRADINI: Oh you are looking
11 for, essentially the lattice structure. Is that what
12 you want to see?

13 CONSULTANT WALLIS: The lattice structure.

14 CHAIRMAN CORRADINI: Is it triangular
15 pitch?

16 MR. DEEVER: Triangular pitch.

17 CONSULTANT WALLIS: And how close are the
18 tubes? That is the sort of question I wanted to get
19 the answer to. Will you be going on to that later on
20 sometime?

21 MR. DEEVER: Okay, I didn't bring the
22 details but John Gallis is on the phone. He can give
23 us that kind of detail.

24 CHAIRMAN CORRADINI: Why don't we take
25 that under advisement and we will hear about it when

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1 we get to that.

2 MR. DEEVER: Okay. Similarly, the PCCS
3 condenser has similar components but it has the inlet
4 steamer pipe with the branch piping that ties into the
5 headers. There are similar tubes, a lower header, and
6 a return line at the base of the little header.

7 CONSULTANT WALLIS: It has more tubes. It
8 looks as if it has more tubes. Has it?

9 MR. DEEVER: It has the same basic pattern
10 but it happens to be longer.

11 CONSULTANT WALLIS: But the pattern looks
12 different in the figures. Maybe it is an illusion.

13 MR. DEEVER: Well this figure is too hard
14 to count tubes but I think they should be the same.

15 CONSULTANT WALLIS: Okay.

16 CHAIRMAN CORRADINI: So just to answer the
17 question on a general basis. So if you moved it up
18 higher you seem to just make it physically longer.

19 MR. DEEVER: Yes, that is true.

20 CHAIRMAN CORRADINI: Whereas the two bank
21 structure, at least from a design standpoint, will
22 have the same tube lattice structure and number of
23 tubes in a row.

24 MR. DEEVER: Exactly.

25 CHAIRMAN CORRADINI: So in other words, if

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1 it is five here, five here, it will five here, five
2 here, for either ICS or PCCS.

3 MR. DEAVER: That is true.

4 CONSULTANT WALLIS: But they are showing
5 they aren't the same in the cross-sections. There are
6 more tubes on the right than on the left.

7 MR. DEAVER: Okay.

8 CHAIRMAN CORRADINI: Correct.

9 MR. ANTHONY: The ICS is a thousand pound
10 machine and the PCCS is only --

11 CONSULTANT WALLIS: But there is more in a
12 cross direction, not just in the length. You will
13 sort that out.

14 PARTICIPANT: Why would go to two pipes
15 instead of four in PCCS?

16 MR. DEAVER: I don't know the total
17 history on this. This is a lower pressure system, as
18 opposed to PC. It operates at the full vessel design
19 pressure.

20 PARTICIPANT: That is probably the reason,
21 yes. Okay.

22 CHAIRMAN CORRADINI: Sam Armijo.

23 MEMBER ARMIJO: So remember we when we
24 were going to be talking about the gas and
25 condensables?

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1 MR. DEEVER: Yes.

2 MEMBER ARMIJO: And similarly in the DCD,
3 you mentioned that these systems were self-venting --

4 MR. DEEVER: Yes.

5 MEMBER ARMIJO: -- to get rid of non-
6 condensables. Is there anywhere in these pictures you
7 could show us where these vents are and how they
8 adapt?

9 MR. DEEVER: This figure shows a vent line
10 at the top of the header. It goes over here and joins
11 --

12 MS. CRUZ: Gerry, you might want to go to
13 your next slide.

14 MEMBER ARMIJO: Okay. I know this is a
15 sloshing thing but I just --

16 MS. CRUZ: Oh, no. I mean, I think the
17 figures on the next two slides might help you, maybe.

18 MR. DEEVER: Yes.

19 MEMBER ARMIJO: Okay.

20 MR. DEEVER: Okay, this is a cross-section
21 of the PCCS. Actually here you can see there is
22 actually eight tubes that tie in from this cross-
23 section.

24 And this shows the gas accumulation
25 function of this lower header here, where the gas

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1 accumulates in that part of the header. And then --

2 CONSULTANT WALLIS: Let's see that again.

3 Let me see that. That is an interesting point. The
4 gas accumulates down there?

5 MR. DEEVER: Yes. There is a, not shown
6 on this figure is, another pipe. There is a --

7 CONSULTANT WALLIS: What kind of gas is
8 there? This is connected to the RPV, isn't it?

9 MR. ANTHONY: No, this one is actually
10 connected to containment.

11 MR. DEEVER: This is containment.

12 CONSULTANT WALLIS: Oh, I'm sorry. This
13 is PCCS. It is the other one that is connected to the
14 RPV.

15 MR. DEEVER: Right.

16 CONSULTANT WALLIS: Will you show where
17 the gas is collected in the isolation condenser?

18 MR. DEEVER: That is the next figure.

19 CONSULTANT WALLIS: Show the detail.

20 CHAIRMAN CORRADINI: So just to clear up a
21 couple of things. These things are meant to be their
22 line drawings to be accurate? That is, at least in
23 these cross drawings, you essentially have an eight
24 tube -- eight tubes in a row --

25 MR. DEEVER: Yes.

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1 CHAIRMAN CORRADINI: -- in both cases.

2 And that is correct.

3 CONSULTANT WALLIS: -- and then seven. Is
4 that the way it goes? The drawing says four.

5 CHAIRMAN CORRADINI: I know. That is why
6 I am asking.

7 MR. DEEVER: If you look here, it is
8 showing the full tubes. Other ones are just shown as
9 lines.

10 CHAIRMAN CORRADINI: Yes. But all I guess
11 I am saying is there appear to be all this rendering
12 in the previous page and this was just more of, with
13 dimensions. We should pay attention to this as an
14 appropriate --

15 CONSULTANT WALLIS: Well look at the top,
16 Mike. If you look at the top on the left where it
17 joins the top header, it is sort of the second tube is
18 recessed from the first tube. Right? They are
19 showing two rows of tubes.

20 CHAIRMAN CORRADINI: Oh.

21 CONSULTANT WALLIS: So in fact it looks as
22 though it was something like five and four. It has
23 gotten anything like four and four or something. It
24 is just really a bit strange.

25 CHAIRMAN CORRADINI: Okay.

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1 CONSULTANT WALLIS: I don't think they did
2 the geometry right.

3 MR. DEEVER: Excuse me. I may have
4 misspoken earlier. These may be just rows. They are
5 not pitched.

6 CONSULTANT WALLIS: No, I think it shows
7 both a first row and a second row.

8 CHAIRMAN CORRADINI: Yes, I think they are
9 pitched and you are seeing two rows.

10 MR. DEEVER: Right.

11 CHAIRMAN CORRADINI: And they are
12 staggered.

13 MR. DEEVER: Yes.

14 CONSULTANT WALLIS: And he is going to
15 clarify that later?

16 CHAIRMAN CORRADINI: Yes, I wrote that
17 down. So why don't you go back to the profession that
18 we took you way from, which is how is the gas vented
19 from the lower header?

20 MR. ANTHONY: We will be able to give you
21 that on the break.

22 CONSULTANT WALLIS: Okay, thank you.

23 MS. CRUZ: Yes, and I certainly want to
24 the committee to get the questions answered but this
25 really is a completely different topic.

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1 So if we could proceed through the
2 sloshing and the seismic issue and then we can take
3 down any comments that you want addressed.

4 CHAIRMAN CORRADINI: That sounds fine.

5 MEMBER ARMIJO: The spacing they have to
6 do.

7 MS. CRUZ: Oh, the spacing might but the
8 venting.

9 CONSULTANT WALLIS: So while we look at
10 that figure, can we talk about this thing or is that
11 taboo?

12 CHAIRMAN CORRADINI: I would like to hold
13 that off if we could. We are supposed to have all
14 tomorrow for that.

15 Let's let him do what he came to do this
16 morning.

17 MEMBER ARMIJO: Mike, if this is the best
18 picture that shows how this venting is achieved, well,
19 I just ask GEH to make sure it is in the package when
20 we discuss the gases.

21 CHAIRMAN CORRADINI: Right. Okay.

22 MR. DEAVER: Okay, let me go back to the
23 prior slide.

24 CHAIRMAN CORRADINI: That will teach you
25 to show detail.

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1 MR. DEEVER: Anyway, I just wanted to
2 point out that the IC condenser is a Class D component
3 so it is designed to NC versus the PCCS condenser
4 which is part of containment, so it is an NC
5 component. So it is designed to different standards.

6 The PCCS Condenser, the support structure
7 is shown here. And the analysis report for this
8 structure and for the PCS condenser has been
9 completed. Basically, it is bolted to the floor.
10 There are saddles underneath the headers and then
11 there is supportive truss structure that also bolts to
12 the floor. The connection point is at the top header,
13 as you see at the top here, as where sloshing is
14 really a phenomenon at the top part of the pool and
15 the support structures provides adequate support to
16 resist any sloshing loads.

17 CHAIRMAN CORRADINI: Just one question now
18 about support. So is the support design for the PCCS
19 and the ICS identical and you show one with and one
20 without just for illustration purposes?

21 MR. DEEVER: We haven't finished or done
22 the design analysis for the support structure for the
23 IC system.

24 CHAIRMAN CORRADINI: I see.

25 MR. DEEVER: But we expect it to be very

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1 similar.

2 CHAIRMAN CORRADINI: Okay.

3 MR. DEEVER: Okay, moving forward. The
4 only point of this slide was to give you some relative
5 dimensions. Here the PCCS is fully submerged and the
6 primary component that would see sloshing loads is
7 this upper header because it has the most surface
8 area. And it is 1.58 meters below the water line. So
9 everything is submerged in this system.

10 Okay, moving forward. The IC is a little
11 different in that the water line, the upper piping is
12 actually out of the water and the water level for the
13 header is 1.38. So it is 0.2 meters shorter than the
14 PCCS is.

15 CHAIRMAN CORRADINI: Is there a particular
16 reason that they are different?

17 MR. DEEVER: I don't totally know the
18 background.

19 CHAIRMAN CORRADINI: Okay.

20 MR. DEEVER: These were designed in the
21 '90s and tested in the '90s.

22 CONSULTANT WALLIS: So this branch from
23 the upper header to the wall is correct in the drawing
24 before this one?

25 MR. DEEVER: Let me go back to that one.

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1 CONSULTANT WALLIS: The distance from the
2 wall is correct?

3 MR. DEEVER: This isn't meant to be an
4 accurate representation.

5 CONSULTANT WALLIS: It is not meant to be
6 an accurate representation?

7 MR. DEEVER: The pool width is five meters
8 and the PCCS is about four meters, as I remember. So
9 there is some clearance to the wall. Part of that
10 clearance is actually shown in this figure.

11 CHAIRMAN CORRADINI: So just to repeat, it
12 is about five meters tall and about five meters wide,
13 the PCCS. And the pool itself is a bit wider. And I
14 don't see any wider dimension here anyway.

15 MR. DEEVER: No but it is roughly five
16 meters is the --

17 CONSULTANT WALLIS: The reason I ask is
18 that when you shake something next to a wall, it is
19 not same thing as shaking it in --

20 MR. DEEVER: At least a half a meter.

21 CONSULTANT WALLIS: Well that is what you
22 say but until I see a drawing that is accurate, I
23 don't really know.

24 MR. DEEVER: okay.

25 CONSULTANT WALLIS: Can we get that?

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1 CHAIRMAN CORRADINI: We will get
2 verification.

3 MR. DEEVER: Okay.

4 MEMBER ABDEL-KHALIK: Now the ICS supply
5 pipe is outside the water. It runs hot. So the
6 inside surface temperature of the pipe is 550 or about
7 500.

8 MR. DEEVER: Yes.

9 MEMBER ABDEL-KHALIK: And if this thing
10 gets flooded, in other words, if there is uncertainty
11 in the level, the outside surface temperature of the
12 pipe would be pretty cold. What would be the thermal
13 stress in the wall if there is enough variability in
14 the level to cover the pipe for the ICS?

15 MR. DEEVER: Why don't you hold on to the
16 IC picture? Okay, you know, this is the closest.
17 There would be steam, a stagnant line but steam in it.
18 But we have a guard pipe here. It is an outer pipe.
19 This inner pipe comes in and joins near the top here.
20 So the guard pipe does act as a thermal shield. And
21 I believe one of the reasons the pipes are above water
22 is because of the temperature.

23 MEMBER ABDEL-KHALIK: Both of the pipes
24 are going to the header --

25 MR. DEEVER: Yes.

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1 MEMBER ABDEL-KHALIK: -- are not guarded.

2 Are they?

3 MR. DEEVER: No, they are not.

4 MEMBER ABDEL-KHALIK: So those are the
5 pipes I am concerned about. The inside temperature is
6 saturation of steam.

7 MR. DEEVER: Well, I think it will decay
8 out. You won't see the full temperature of the
9 vessel.

10 MEMBER ABDEL-KHALIK: But they can,
11 potentially.

12 MR. DEEVER: Yes.

13 MEMBER ABDEL-KHALIK: And if the outside
14 is flooded, the outside surface temperature would be a
15 lot colder.

16 MR. DEEVER: Yes.

17 MEMBER ABDEL-KHALIK: So what is the
18 maximum thermal stress that you would get if there is
19 uncertainty in the level?

20 MR. DEEVER: We haven't -- we have done
21 testing of this geometry so the sizing and materials
22 have been established. I am not sure if we have the
23 exact thermal stresses of those conditions.

24 CHAIRMAN CORRADINI: These are the
25 experiments that were done in Italy. Am I remembering

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1 correctly?

2 MR. DEEVER: Yes, Sardinia did the
3 testing, yes.

4 MEMBER ABDEL-KHALIK: This doesn't have
5 anything to do with testing. It is just the
6 structural integrity of this component.

7 MR. DEEVER: Yes. These are normal stick
8 type pipes. You will get some temperature variation
9 across the pipe but it will equalize itself out.

10 MEMBER ABDEL-KHALIK: I mean, if it is
11 outside the water, then it is primarily pressure
12 stress, --

13 MR. DEEVER: Yes.

14 MEMBER ABDEL-KHALIK: -- that you get from
15 the inside.

16 MR. DEEVER: That is correct.

17 MEMBER ABDEL-KHALIK: But if it gets
18 submerged, then you have to worry also about thermal
19 stress.

20 MR. DEEVER: Well, yes. You will see a
21 thermal gradient across the pipe because it will be
22 hotter inside the pipe than outside.

23 MEMBER ABDEL-KHALIK: Right. My question
24 is, how significant is that that we have to worry
25 about uncertainty in the level?

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1 MR. DEAVER: I don't believe it is all
2 that significant because the temperature by the time
3 it reaches this point will be quite a bit lower than
4 the vessel.

5 MR. WACHOWIAK: This is Rick Wachowiak. I
6 have a couple of clarifying questions. The condition
7 you are talking about, are you talking about during
8 normal operation of the plant or during some transient
9 condition? Because the conditions that are going on
10 are going to be different under those two situations.

11 Under normal operation of the plant, as
12 the plant starts out, this system will, within a few
13 hours of plant startup, become filled with water up to
14 the surface, so it will be cold. And there is a steam
15 bleed from the upper header back to that main steam
16 line. So high point vent just like others.

17 So there would be one thermal gradient
18 right at the top of the header and right where it
19 comes to the surface of the water. So that is one.

20 Then, the transient conditions, that is
21 when the drain and there is going to be hot steam on
22 the inside of the heat exchanger and cold water on the
23 outside. So that would be under a different set of
24 conditions.

25 So your question goes to both of those

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1 situations. What are the stresses during normal
2 operation and then what are the stresses during the
3 operation of the heat exchanger.

4 MEMBER ABDEL-KHALIK: I am just wondering
5 if one should be concerned about uncertainties in the
6 level that would cause the height to be covered,
7 resulting in a thermal stress if the inside of the
8 pipe is filled with steam at elevated temperature and
9 pressure.

10 MR. WACHOWIAK: Right. And the
11 uncertainty in the level is where I was little bit
12 confused by the question because the system is
13 designed to operate with the water, all the way up to
14 the top of the cross pipes. And then with water
15 slowly progressing down all the way to the mid point
16 of the tubes. So under all those situations, it needs
17 to perform.

18 CONSULTANT WALLIS: So what you are
19 saying, Rick, is that this figure is incorrect.

20 CHAIRMAN CORRADINI: No, he is saying that
21 water changes during the actuation.

22 MR. WACHOWIAK: During the actuation of
23 the system, the water level in that tank goes on
24 potentially to the mid point of the tube.

25 MEMBER ABDEL-KHALIK: But we were more

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1 concerned about the case when the supply tubes are
2 submerged, not when they are not covered.

3 MR. DEEVER: Well, this phase condition is
4 actual operation of the condenser. That is why we
5 have the actual steam coming in here and the water is
6 cold. So, that part we have tested.

7 CHAIRMAN CORRADINI: But I guess maybe we
8 should clarify the question and then we will leave it
9 so you can go on and do some investigation.

10 If there is various operational modes, as
11 you said, normal operation and various water levels
12 during the accident progression, I guess, getting
13 ready to answer Said's question is what is the worst
14 case situation and what are the stresses there, I
15 think. And then he asked the additional question
16 about an older flooding and a higher water level.

17 If you could just keep that in mind and
18 then we can come back to it. Does that make sense?

19 MR. WACHOWIAK: You are also concerned
20 when we refill the pools, as we talked about in some
21 of the previous subcommittee meetings, what happens
22 when we fill past the top of those cross pipes.

23 MEMBER ABDEL-KHALIK: You know you are in
24 a situation where not only do you have to worry about
25 pressure stress inside the pipe but you also have to

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1 worry about thermal stress if you sort of burst a pipe
2 in cold water when it is filled with steam at elevated
3 temperature and pressure.

4 MR. WACHOWIAK: I understand your question
5 now and the intent is for that pipe to be designed for
6 that condition. Now the question is, have the stress
7 calcs but done we are at the state we are at right now
8 to give you the answer.

9 But the answer is yes, it does need to
10 operate under that condition. That is a condition
11 required operation for the system.

12 MEMBER ABDEL-KHALIK: So if you would just
13 clarify that for us, that would be helpful.

14 CHAIRMAN CORRADINI: But he won't know the
15 stresses until he knows the prior design.

16 MEMBER SHACK: The prior design.

17 CHAIRMAN CORRADINI: You know, he has to
18 design that thing so that it accommodates those
19 stresses.

20 MR. WACHOWIAK: That needs to operate
21 under -- part of the tubes all the way to overflowing
22 in the compartment.

23 CONSULTANT WALLIS: So this is an ITAAC,
24 is it, that hasn't been designed yet?

25 CHAIRMAN CORRADINI: No, I'm sure this

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1 hasn't been designed in detail.

2 MR. DEEVER: The structure itself has been
3 designed. We have lines of this structure and we are
4 duplicating the test results.

5 CHAIRMAN CORRADINI: Right. But I think
6 just to make sure we close this, Rick's answer to Said
7 was that, unless I misunderstood it, normal operation
8 is the limiting mode. And then your question was, if
9 that is the limiting mode, what happens in the worst
10 case that I overfill. And your answer back is by
11 requirement it has to be able to take those pressure
12 stresses under various operational and overfill
13 condition.

14 MR. WACHOWIAK: Right.

15 CHAIRMAN CORRADINI: But we are not
16 expecting you have those stresses somewhere in a book
17 that in 20 minutes we are going to get --

18 MR. WACHOWIAK: You are not going to get
19 it in 20 minutes.

20 CHAIRMAN CORRADINI: That is what I
21 thought.

22 MS. CRUZ: This would be covered by ASME.
23 They would require ASME code reports to be available
24 for inspection prior to authorization to operate. And
25 there is an ITAAC for the stress report.

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1 MEMBER ABDEL-KHALIK: Gerry, where you
2 have a bolted or flanged cap at the top of the inlet
3 pipe on the isolation condenser and you don't have
4 that kind of arrangement on the lower pressure PCCS
5 condenser.

6 CONSULTANT WALLIS: This is a schematic
7 and this is one of these problems --

8 MEMBER ABDEL-KHALIK: The picture looks
9 pretty detailed.

10 MR. DEAVER: This bolted connection?

11 MEMBER ABDEL-KHALIK: Yes.

12 MR. DEAVER: That is to provide inspection
13 access to the top of the headers.

14 CHAIRMAN CORRADINI: Whereas you don't
15 think you guys need that for the PCCS?

16 MR. DEAVER: This system when it sits
17 there doesn't see any loads of pressures during
18 operation because it is connected to the containment,
19 whereas the IC system is pressurized during operation.

20 MEMBER ABDEL-KHALIK: Okay.

21 CHAIRMAN CORRADINI: And you are going to
22 use that probably more frequently during normal
23 startups and shut downs? I better ask the question.
24 Is that going to be exercised much more, I assume,
25 than the PCCS. I guess I am trying to --

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1 MR. WACHOWIAK: ICCS is normally used for
2 scrams.

3 CHAIRMAN CORRADINI: Oh.

4 MR. DEEVER: Yes, you would expect IC to
5 operate some number of upstream right to the plant.

6 MEMBER ABDEL-KHALIK: Just getting at the
7 issue if that thing leaked up there when you needed
8 it, it would not be good news.

9 MR. ANTHONY: Well, we also had both the
10 connections on the headers and so forth also for
11 inspection and safety purposes. So we have a variety
12 of bumper connections.

13 CONSULTANT WALLIS: Do you have a drawing
14 of the ICS like the PCCS which is more detailed that
15 we could look at?

16 This one here, the one in the previous
17 slide you show more detail than you do in this. And I
18 grant that schematics often depict the skeletons. So
19 I would like to see the real scale of the ICS with
20 details.

21 CHAIRMAN CORRADINI: We will get to that,
22 though.

23 CONSULTANT WALLIS: Well I would like to
24 see one of ISC if you have one.

25 MR. DEEVER: Okay, why don't we hold all

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1 the questions and move on.

2 CONSULTANT WALLIS: There haven't been any
3 questions yet.

4 CHAIRMAN CORRADINI: We want it in dribs
5 and drabs. So we got our first drib. Keep on going.

6 MR. DEAVER: Okay. Next what I will talk
7 about is the modeling of the pool under seismic
8 conditions. It is traditional to model the sloshing
9 as a convective spring mass in the system. And the
10 impulsive rigid components are modeled as a solid
11 connection because they are rigid. So this is typical
12 in pool design.

13 CHAIRMAN CORRADINI: And then just to
14 remind everybody because we kind of went over this
15 with you guys in an exercise you did before. You
16 actually went back to an original reference. This is
17 a typical accepted practice to essentially break up
18 the loads as one essentially, I will call it, spring
19 mass and one a rigid connection --

20 MR. DEAVER: Yes.

21 CHAIRMAN CORRADINI: -- that has been done
22 historically.

23 MR. DEAVER: Right.

24 CHAIRMAN CORRADINI: They are empirically
25 based. It is not theoretically based. If I remember

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1 correctly, the paper you guys went back to and showed
2 us was showed based on some experiments there was an
3 empirical basis for this.

4 MR. DEEVER: Right. And there are
5 equations that calculate these.

6 CHAIRMAN CORRADINI: Okay.

7 MR. DEEVER: Okay, the next figure just
8 shows the overall model of the reactor building in the
9 back with each of the pools are separately modeled.
10 And it is a finite element model. And that is pretty
11 much I had to say about the actual model itself.

12 In modeling the pool water in the building
13 itself, typically the sloshing component is a very low
14 frequency at 0.5 Hz. And none of our structural
15 components have natural frequencies down in that
16 range. So there is no amplification due to sloshing.

17 MEMBER ABDEL-KHALIK: On the previous
18 figure, is this the actual modelization they use in
19 the finite element analysis?

20 MR. DEEVER: I believe it is.

21 MEMBER ABDEL-KHALIK: And is that
22 sufficiently detailed to capture what is actually
23 going on?

24 MR. DEEVER: Well this is a building model
25 but they do model water in it also. So this is

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1 primarily to analyze the building structure. So that
2 is a civil question.

3 CHAIRMAN CORRADINI: Let me ask the
4 question differently because I think I know where Said
5 is going with this.

6 If you guys have a concern, do you then go
7 in and do some more detailed modeling or is this the
8 level of detail that you are looking at? That is like
9 another area that I think that he is getting at. If
10 something concerns you, what do you do relative to
11 additional analysis?

12 MR. DEEVER: Well obviously if we have
13 something that looks high stress, then we would refine
14 the mesh and rerun the model.

15 CHAIRMAN CORRADINI: And so the same thing
16 here relative to these pool structures, I guess is --

17 MR. DEEVER: Sure. I think the pool
18 structures would be a similar situation.

19 CHAIRMAN CORRADINI: Okay.

20 MEMBER ABDEL-KHALIK: But that was not the
21 case here.

22 MR. DEEVER: No, I don't believe they had
23 to do any of that. That is a whole different topic.

24 We have, I am sure we have somebody on the
25 line that could answer that, either Shaulai Lu or

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1 Sirjan. Do you want to see if they are on the line?

2 CHAIRMAN CORRADINI: Can somebody allow
3 them to speak, please, in the control room back there?

4 Can somebody turn on the bridge line, please? Hang
5 on a second.

6 MR. DEAVER: Okay.

7 CHAIRMAN CORRADINI: I think, I knew
8 somebody was on your bridge line. Let me cut them on.

9 Are you guys -- can you guys speak now?

10 TELEPHONE PARTICIPANT: Can you hear us?

11 CHAIRMAN CORRADINI: Yes.

12 TELEPHONE PARTICIPANT: We just went out
13 of the room real quick to get food.

14 CHAIRMAN CORRADINI: Okay. So did you
15 hear the question or do you want -- why don't we
16 repeat the question?

17 MEMBER ABDEL-KHALIK: Well my concern is
18 about the resolution of the mesh. I mean, this seems
19 like a very course mesh. And the question is whether
20 or not you actually checked whether the resolution of
21 the mesh is adequate.

22 CHAIRMAN CORRADINI: Have you got the
23 question?

24 TELEPHONE PARTICIPANT: Yes, we are
25 waiting for Sirjan.

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1 CHAIRMAN CORRADINI: Okay, that is fine.

2 MEMBER SHACK: Well I guess I have another
3 one in the same sort of thing. I am looking at this
4 table and it says summary of seismic analysis method
5 and it says 3D mass stick coupled with soil springs.
6 So I was expecting a stick lump mass model.

7 MR. DEEVER: It is all pressure.

8 MEMBER SHACK: Well you don't get dynamic
9 loads from that and then you go back and do a stress
10 analysis from those. So which model am I looking at
11 here?

12 TELEPHONE PARTICIPANT: Okay, he is here.

13 Go ahead.

14 CHAIRMAN CORRADINI: Why don't you start
15 with Bill's question and then go to Said's about mesh
16 refinement. Can you ask your question?

17 MEMBER SHACK: Yes. It is just you are
18 showing a finite element model here of the building
19 but when I look at the table, it says the seismic
20 analysis is done with a lump mass stick, coupled with
21 soil springs. So do you do the lump mass stick to get
22 the dynamic load and then the finite element analysis
23 is for the stress analysis? Am I looking at a second
24 stage here?

25 TELEPHONE PARTICIPANT: No. What we need

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1 is the mass of the water to the wall and onto the
2 floor.

3 CHAIRMAN CORRADINI: I think now we are
4 talking about your overall methodologies. So Bill is
5 asking, what do you start with and then how do you
6 refine it? Which leads to Said's question about at
7 what level do you know the refinement is adequate.

8 TELEPHONE PARTICIPANT: I don't have that
9 answer. I can get back to you and give you that
10 answer.

11 CHAIRMAN CORRADINI: Well just let Bill
12 ask the question again. Because I thought we had
13 already gone over this before. But can you ask your
14 question again?

15 MEMBER SHACK: It is just I am looking at
16 it says it is done with a lump mass stick model and I
17 am wondering what the relation to that lump mass stick
18 model is to this finite element picture we are looking
19 at.

20 CHAIRMAN CORRADINI: Do you have the
21 picture we are looking at?

22 MS. CRUZ: We have someone from the staff
23 here, a structural reviewer. If you want to step to
24 the other side, there is a microphone.

25 CHAIRMAN CORRADINI: Identify yourself,

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1 please.

2 MR. JENG: My name is Davie Jeng NRC
3 staff, Mechanical Engineering. I think basically what
4 we are doing is there are two sticks. For the seismic
5 analysis, we used the mass model. And some time I
6 will present it. I can produce it. The seismic stick
7 with the masses and they are connected.

8 That is primarily for the analysis of
9 seismic response. But then you realize that your
10 structural elements is subject to the seismic walls.
11 So that work has to be completed in a finite element
12 model to get to that stress level of each element.

13 CHAIRMAN CORRADINI: So if I can just
14 summarize, then. Your point is the stick model
15 provides the boundary conditions for a more resolved
16 detailed analysis --

17 MEMBER ABDEL-KHALIK: Well it provides the
18 loads.

19 CHAIRMAN CORRADINI: -- provides the
20 loads.

21 MR. JENG: Provides the loads, primarily.
22 And that could input to other roads. And that gives
23 input to each of these other loads. And that gives
24 you a more defined dynamic finite element model that
25 we are looking at.

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1 CHAIRMAN CORRADINI: Okay.

2 MR. JENG: As to the question how do you
3 know how refined should be adequate? I think the
4 program is nearly built yet we check the convergence.

5 Okay? If they want to try and see that they converge
6 in a solution. If they don't converge, that means we
7 have to move on so we cut the size to half inch and
8 adjust until such a time your response is stable.
9 That defines how refined this mortar should be. It is
10 a basic technique available in that code technology.

11 MEMBER ABDEL-KHALIK: This is a quasi-
12 static model. Right? He just does -- he will tie
13 that in with the dynamic loads put on as though they
14 were loads.

15 MR. JENG: Yes. They are completely
16 static.

17 MEMBER ABDEL-KHALIK: Now what does it
18 mean what the gentleman said before, that they added
19 the mass for water for the floor and the walls?

20 MR. JENG: Okay, I will explain. The
21 water has sink in the upper level. A huge mass of
22 water which was in use massive natural wave and which
23 is accounted for in the design of the subject. I
24 think it has a tank.

25 So they took the mass, and then they use

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1 that equivalent mass of the water and tie it to the
2 adjacent lumped mass in the same place that the
3 increased mass could sink as an earthquake is applied
4 to both of them.

5 So this is the equivalent here of a effect
6 of certain water in the tank an to complete adequate
7 conservative loads for the design of the structures.

8 MEMBER ABDEL-KHALIK: The gentleman from
9 GE will get back to us on the adequacy of the mesh
10 resolution?

11 TELEPHONE PARTICIPANT: Yes, could you
12 please repeat the question again so that I can write
13 it down?

14 MEMBER ABDEL-KHALIK: We were just
15 wondering how do you decide whether or not the
16 resolution of this mesh is adequate to resolve
17 whatever you are trying to calculate.

18 TELEPHONE PARTICIPANT: Other than that?
19 Well, all right. We will get back to you.

20 CHAIRMAN CORRADINI: Okay.

21 MS. CRUZ: I believe David spoke to that
22 some in his discussion.

23 MEMBER ABDEL-KHALIK: I understand.

24 MS. CRUZ: Okay.

25 MR. DEAVER: Okay, I think we were on the

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1 second bullet.

2 The impulsive component responds in unison
3 to the pool because it is treated as a rigid
4 structure.

5 CONSULTANT WALLIS: And the component we
6 are talking about here is the boundaries of the
7 coolant. Right?

8 MR. DEEVER: Right.

9 CONSULTANT WALLIS: It is nothing to do
10 with the structure that is in the pool like the PCCS
11 itself.

12 MR. DEEVER: Right. In the building
13 analysis --

14 CONSULTANT WALLIS: So don't you have the
15 mass of the -- what do you do about the mass of the
16 steel that is in there that is shaking, too? Does it
17 move with the water in some way?

18 MR. DEEVER: In the structural analysis of
19 the building, no components were modeled in the pool.

20 CONSULTANT WALLIS: They do have mass and
21 they do move. Right?

22 MR. DEEVER: Well they do but they are
23 anchored on the floor.

24 CONSULTANT WALLIS: So they move with the
25 building.

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1 MR. DEAVER: Yes.

2 CONSULTANT WALLIS: So they are mass added
3 to the building?

4 MR. DEAVER: I know they accounted for the
5 water weight.

6 CONSULTANT WALLIS: That is right but how
7 do you account for the steel weight?

8 CHAIRMAN CORRADINI: Sinjee are you still
9 there?

10 MS. CRUZ: No.

11 MR. DEAVER: Are they still connected?

12 CHAIRMAN CORRADINI: We may need to leave
13 them on for a while?

14 CONSULTANT WALLIS: And the support, rigid
15 or not, that the whole things moves in place with the
16 building. Is that what --

17 CHAIRMAN CORRADINI: Well let me just try
18 what I remember they said from last time, Graham.
19 Based on this empirical thing, they take part of it
20 being out of phase and part of it in phase. That is
21 why we showed the original model as a --

22 CONSULTANT WALLIS: But you have a
23 structure made of steel?

24 CHAIRMAN CORRADINI: The water, there is
25 both an in phase and out of phase. The structure,

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1 there still ought to be --

2 MR. DEEVER: Actually without a structure
3 in the pool, the loads on the water would be higher
4 because you are taking up mass by having a structure
5 in the pool.

6 CONSULTANT WALLIS: But that is a steel
7 mass.

8 MR. DEEVER: But that doesn't apply load
9 to the wall.

10 CONSULTANT WALLIS: It applies your load
11 to the floor.

12 MR. DEEVER: Correct. Exactly.

13 CHAIRMAN CORRADINI: Yes, it actually acts
14 as a resistance to the water and adds more load to the
15 wall -- to the floor.

16 MR. DEEVER: To the pool itself.

17 CHAIRMAN CORRADINI: Do we have anybody on
18 the bridge line?

19 TELEPHONE PARTICIPANTS: Yes, we are here.

20 CHAIRMAN CORRADINI: Okay. So did you
21 hear the question about are the PCCS and the ICS
22 structural steel added to the layer to the floor?

23 TELEPHONE PARTICIPANT: They are added to
24 the floor, yes.

25 CHAIRMAN CORRADINI: Okay.

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1 CONSULTANT WALLIS: They are within phase
2 with the floor.

3 MR. DEAVER: No, not necessarily. The IC
4 and PCCS components are individually analyzed with the
5 floor response factor.

6 CONSULTANT WALLIS: So if they are not in
7 phase with the floor, they must be doing something to
8 the walls.

9 MR. DEAVER: Well, like I mentioned
10 before, the worst case is to assume that there is no
11 equipment in the pool because the water mass is --

12 CONSULTANT WALLIS: Well if you suppose
13 they were very weakly attached to the floor, then all
14 their motion would have to be somehow transmitted to
15 the walls because there is no where else to transmit
16 it to, presumably.

17 MR. DEAVER: Well, it is the floor that
18 holds the structure.

19 CHAIRMAN CORRADINI: Well I think Graham
20 is asking just a very simple question. He is saying
21 the two extremes are they are not connected. So the
22 would add to the mass of the water that is wiggling in
23 the lateral direction.

24 The other extreme is they are totally
25 rigidly connected, which means you have got to count

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1 they are really downward. And therefore, as you said,
2 it minimizes the sideward.

3 So I think he is asking the question since
4 they are connected but they are not exactly literally
5 connected, do you properly account for the consistency
6 from how it wiggles from side to side versus the
7 connection at the bottom.

8 Do I have it?

9 CONSULTANT WALLIS: That is correct. That
10 is about what I said.

11 MR. DEEVER: Well it really doesn't move
12 structurally very much. Movement is very actually
13 small.

14 CONSULTANT WALLIS: How can it move very
15 much in this seismic model?

16 MR. DEEVER: We are comparing that to
17 loads being generated on the side --

18 CONSULTANT WALLIS: If they can't give me
19 a technical answer.

20 CHAIRMAN CORRADINI: Are the people on the
21 bridge line understanding the question?

22 TELEPHONE PARTICIPANT: No. We did not
23 understand the question. Could you please repeat
24 that?

25 CHAIRMAN CORRADINI: Graham, do you want

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1 to give it a shot again?

2 CONSULTANT WALLIS: The steel structure of
3 the heat exchanger moves. If it is rigidly attached
4 to the floor and really rigidly attached to the floor,
5 then presumably its mass is added to the mass of the
6 floor when you consider motion. If it is very
7 flexibly attached to the floor, then its motion
8 somehow is transmitted to the side walls.

9 And I want to know how you split the mass
10 of the structure, the steel, and do you add it to the
11 floor or the walls or some to one and some to the
12 other?

13 MR. WACHOWIAK: This is Rick Wachowiak
14 again. So what they are asking about is in Section
15 3(g)15415 of the DCD where we discuss the ANSYS model
16 of the PCCS heat exchangers and how it is attached to
17 the containment.

18 Now, what I believe they are asking you,
19 is the PCCS heat exchanger analyzed along with the
20 containment in the single finite element model that
21 calculates the stresses on both the floor, the walls,
22 and the individual components of the PCCS or is it
23 combined in some sort of a piece meal way such that we
24 would have to worry about how we partition out the
25 different loads?

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1 From reading the DCD, it appears to me
2 that this all analyzed as an integral unit with the
3 hand calculation that was performed to evaluate the
4 effect of the sloshing on this beam and shell model.

5 TELEPHONE PARTICIPANT: No, this is what
6 we did. We didn't evaluate values for the of the
7 building for the operating under dynamic mode because
8 of the response of the building. Between that, we
9 added mass of the model. The mass of the model was
10 added to the wall and also to the floor.

11 MR. WACHOWIAK: Okay but you don't take
12 account of the mass of the heat exchanger when you are
13 calculating the building response, then.

14 TELEPHONE PARTICIPANT: I will get back to
15 that to you because I do not have it right in front of
16 me. I do not know what that. We did account for
17 equipment roll on the floor but I don't know
18 specifically if we had accounted for the heat
19 exchanger. But I will get back to that to you.

20 But this is how we did that. So once you
21 get to response of the building then we did
22 qualification, the high quality data out of the
23 chamber. So we derived a response to the heat
24 exchanger and we found out that this depends on the
25 forces and the models. And that is how we qualified

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1 the heat exchanger.

2 CHAIRMAN CORRADINI: So if I might just
3 ask the final point. So how do you consistently
4 account for any heat exchanger weight in the lateral
5 direction, in the horizontal direction adding to the
6 sloshing effect?

7 TELEPHONE PARTICIPANT: Okay, this is what
8 we did. We had mass of heat exchanger, which is steel
9 that were inside of that heat exchanger, which is why
10 we added the weight of the water. And then we account
11 to the sloshing effect, we added a mass.

12 Then we analyzed the heat exchanger. Does
13 that answer your question?

14 CHAIRMAN CORRADINI: I think I understood
15 what you said. Does this answer your question,
16 Graham?

17 CONSULTANT WALLIS: No but now he has
18 raised another question. When you talked about
19 sloshing --

20 TELEPHONE PARTICIPANT: All right.

21 CONSULTANT WALLIS: Now sloshing I
22 understand is a low frequency so a motion of water but
23 there is a impulsive component due to the water, too.

24 TELEPHONE PARTICIPANT: Right.

25 CONSULTANT WALLIS: And that is the one I

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1 was really talking about. Once the sloshing happens
2 and the whole structure sways in the sloshing, I think
3 that is a different analysis.

4 I was really looking at the impulsive
5 component of this thing.

6 TELEPHONE PARTICIPANT: Right. The
7 sloshing can go for very, very long.

8 CONSULTANT WALLIS: That is right.

9 TELEPHONE PARTICIPANT: And then when we
10 did the calculations with that we found - I found it
11 reached 417 Helmholtz.

12 CONSULTANT WALLIS: Now, I think the
13 sloshing is not so much my concern. But when you do
14 your stuff, you have to somehow couple this structure,
15 the weight of the heat exchanger itself, into the
16 various other things that are moving. In other words
17 do something with it in you dynamic analysis.

18 Then you are going to do a full analysis
19 of the PCCS, which you are getting to later, the
20 actual motion of the heat exchanger itself. Somewhere
21 in there, is the interaction between it and the floor,
22 which must feed back to the other analysis in a
23 consistent way.

24 Do you see what I mean? Maybe you say
25 well, assume it is rigid and it moves with the floor.

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1 And then you did the analysis of the thing itself
2 later on and we see how good that assumption was.

3 TELEPHONE PARTICIPANT: Okay.

4 (Off-mic comment.)

5 CONSULTANT WALLIS: So there is no water
6 in there at all and you move the floor.

7 TELEPHONE PARTICIPANT: Right.

8 CONSULTANT WALLIS: The heat exchanger
9 doesn't necessarily follow the floor. The floor may
10 move out of phase with the --

11 TELEPHONE PARTICIPANT: Yes, it could.

12 CONSULTANT WALLIS: So how you treat that
13 mass is probably could be important.

14 TELEPHONE PARTICIPANT: Correct.

15 CONSULTANT WALLIS: All right. Well you
16 don't know how you treated it until you look back at
17 the paperwork.

18 Well, I don't want to keep going over
19 this. This is something we need to follow up on,
20 perhaps.

21 (Off-mic comment.)

22 CONSULTANT WALLIS: Oh it is a separate
23 component in the seismic analysis?

24 PARTICIPANT: It is a system analysis of
25 which is supported to a --

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1 CONSULTANT WALLIS: In the stick analysis,
2 it is one of the sticks?

3 PARTICIPANT: Yes, and then you apply the
4 floor seismic motion to give that, this number.

5 CONSULTANT WALLIS: But is that what they
6 actually do?

7 CHAIRMAN CORRADINI: We are still coming
8 back. We are trying to get the floor response first.
9 You are not looking at the heat exchanger. You have
10 got the floor response first.

11 I am guessing that you treat the heat
12 exchanger as an impulsive load. You just add that
13 mass.

14 CONSULTANT WALLIS: I guessed that, too.

15 CHAIRMAN CORRADINI: I'm guessing that.

16 PARTICIPANT: Don't guess. I know how it
17 is done.

18 CHAIRMAN CORRADINI: Okay.

19 PARTICIPANT: Based on the heat exchanger
20 is the basically all the mass that is supporting
21 frames like a base.

22 CONSULTANT WALLIS: In the stick analysis.

23 PARTICIPANT: In the stick analysis.
24 Okay. So we use in a model.

25 CONSULTANT WALLIS: Well so you added

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1 seismic mass to that?

2 PARTICIPANT: You take the motion at the
3 floor, which comes with the other analysis. Okay.

4 CONSULTANT WALLIS: And you put the added
5 mass to that then?

6 PARTICIPANT: Right. And when you apply
7 that, it could affect the water and the equipment.
8 And you just do the analysis of that single developing
9 system with the forces. And forces should be
10 transmitted through the floor to the tank. And that
11 is another factor of structural analysis.

12 CHAIRMAN CORRADINI: Okay. So you
13 estimated it with the forces. So the next question
14 would be you then apply those forces both to the pool
15 and to the structure, to the PCCS structure. Is that
16 correct?

17 PARTICIPANT: Right. Correct.

18 CHAIRMAN CORRADINI: So at least I think I
19 understand that part. At least I think I do.

20 So then the final thing that Graham is
21 asking that I guess I am still not clear on is how do
22 you consistently then put in the effect of the water,
23 both its impulsive part and its in phase and its out
24 of phase part, and how does the structural mass add
25 into that? Because if it is going to be totally

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1 rigid, we are going to have nothing. If it was
2 totally loose, it would have had everything. But it
3 is somewhere in the middle. How do you consistently
4 do that? That is what I am still not clear about.

5 PARTICIPANT: Okay. In a more bigger
6 situation, it is literally there in that. It costs
7 more to do that in doing a refined analysis. But in
8 this case, what we did was use an equivalent analysis.

9 We used a single mass to represent that equipment.
10 And also used that amount of water displaced by this
11 equipment and its equivalent water mass into the
12 coupled equipment mass and did more rough analysis to
13 get the effect of that sourcing equipment. And that
14 would be a reaction to that floor and the effect is a
15 seismic force by this seismic analysis performance.

16 So it is harder in a more rigid, simpler
17 way. But it is --

18 CONSULTANT WALLIS: Okay. But until we
19 see your equations, I don't think we know really what
20 was done. But I think this discussion is helpful.

21 But until I see the equation, I don't
22 really know how what you said was incorporated into
23 the analysis. Do you have some kind of analysis which
24 is written down that we can look at?

25 PARTICIPANT: Yes it is written down the

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1 equations how it is done, the handling of the mass.

2 CONSULTANT WALLIS: Are they GEH's equations?

3 CHAIRMAN CORRADINI: I am sure they are
4 GEH's.

5 CONSULTANT WALLIS: Okay. So are they
6 available somewhere?

7 CHAIRMAN CORRADINI: So why don't we leave
8 this as an item just for clarification? But I think
9 this helped a bit in terms of discussion. But can we
10 leave it with the folks on the bridge line that we
11 are at least looking for clarification on the
12 approach?

13 TELEPHONE PARTICIPANT: Yes.

14 CHAIRMAN CORRADINI: Okay.

15 MR. DEAVER: Well, I did bring with me an
16 appendix of the building model stress analysis which
17 addresses sloshing.

18 CHAIRMAN CORRADINI: What page is that? I
19 am trying to find it myself.

20 MR. DEAVER: This is a GE document.

21 CHAIRMAN CORRADINI: Oh, this is not in
22 the DCD?

23 MR. DEAVER: No, it is not.

24 CHAIRMAN CORRADINI: Okay.

25 MR. DEAVER: In here, there is empirical

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1 equations that were developed based on testing
2 calculating both the impulsive and the sloshing modes.

3 And those are added to the building.

4 My understanding is that those are
5 separately added to the other stresses to calculate
6 the total stresses on the building structure, such as
7 the walls.

8 CHAIRMAN CORRADINI: Okay. So, why don't
9 we leave it this way. So you have something that has
10 already been part of the RAI response or is this an
11 internal GE?

12 MR. DEEVER: No, this is just an internal
13 GE document.

14 CHAIRMAN CORRADINI: Okay. So to the
15 extent that I will let staff work with you on that.
16 If we are asking to at least get more clarification,
17 you can decide if you want to use that as a way to
18 clarify it. Okay?

19 MR. DEEVER: Okay.

20 CHAIRMAN CORRADINI: Why don't you move
21 on?

22 MR. DEEVER: Okay. Back to the slide.
23 The next bullet talks about the sum of the masses
24 associated with each component is equal to the total
25 water mass in the pool. So this is basically

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1 describing that all the water mass is accounted for
2 either in the side walls or the floor of the model
3 itself.

4 Okay and then for conservatism, the entire
5 water mass of each pool is considered as impulsive
6 mass rigidly attached to the structural nodes in the
7 seismic stick model for predicting overall pressures
8 of the building structure.

9 And all pools are included in the model,
10 thus the effect of the pool interactions are accounted
11 for. And pool to pool, since these are a series of
12 pools.

13 The next slide talks about the seismic
14 loads. Our goal to determine for shear movement an
15 accelerations. Then there are local loads in the form
16 of hydrodynamic pressure loads due to convective and
17 impulsive modes of the pool. That is basically the
18 water calculation that has been done for the pool
19 walls.

20 So those are then combined with other
21 loads and compared against the design to go to the
22 acceptance criteria.

23 Okay. One other sensitivity that was done
24 was to look at the sloshing effect to see if it had
25 any effect on the building's natural frequency. So,

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1 what was done was to basically exclude the mass of the
2 sloshing water from the total mass. And we are
3 looking at just the elevation where the pools are, to
4 the floor of the pools and there to the base of the
5 pool.

6 And so in calculating just the mass
7 reduction, there was a mass reduction of four percent
8 in that local section of the building. And that
9 equates to a frequency variation of two percent at the
10 pool elevation itself.

11 Since the response factor has been
12 broadened to plus or minus 15 percent, it was
13 concluded that the two percent variation due to
14 sloshing effects will not have any impact on the
15 analysis itself.

16 So this was just a check to see if a
17 sloshing affect was going to affect the building
18 natural frequency.

19 MEMBER ABDEL-KHALIK: What is the building
20 natural frequency?

21 MR. DEEVER: Seejay are there?

22 TELEPHONE PARTICIPANT: Yes, I am here. I
23 don't recall that number.

24 CHAIRMAN CORRADINI: All engineers should
25 own numbers. I figured this was your number. Don't

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1 you own this number?

2 TELEPHONE PARTICIPANT: Yes, I do own this
3 number. Yes.

4 CHAIRMAN CORRADINI: Could you get back to
5 us? Because you have to look it up.

6 TELEPHONE PARTICIPANT: But you are saying
7 that when we did the analysis of the building, we -

8 (Off-mic comment.)

9 MEMBER ABDEL-KHALIK: We can read the
10 slide. I am just asking about what the natural
11 frequency is.

12 TELEPHONE PARTICIPANT: I can't tell you
13 from the memory. Can I get back to you on that?

14 MEMBER ABDEL-KHALIK: That would be good.
15 That would be good. Thank you.

16 TELEPHONE PARTICIPANT: Yes, sure. Yes.

17 MR. DEEVER: Okay, so in summary, on the
18 building dynamic analysis, the building analysis
19 included the pool water but not the internal
20 structures. The actual building stressors were
21 determined. And then the building seismic models
22 included all pool water as impulsive mass.

23 CONSULTANT WALLIS: I still don't
24 understand. What do you mean by sloshing?

25 MR. DEEVER: Sloshing is --

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1 CONSULTANT WALLIS: What is the difference
2 between the impulsive motion where things move and
3 things move very, very quickly, and sloshing?

4 Sloshing to me means like a bath tub that
5 goes --

6 MR. DEEVER: Exactly.

7 CONSULTANT WALLIS: -- up one side and
8 that is driven by gravity.

9 MR. DEEVER: Exactly.

10 CONSULTANT WALLIS: That is what you mean
11 by sloshing?

12 MR. DEEVER: Yes. Impulsive and rigid
13 mean --

14 CONSULTANT WALLIS: But the sloshing, it
15 goes off and then gravity brings it back again.

16 MR. DEEVER: Right.

17 CONSULTANT WALLIS: The restoring force is
18 gravity.

19 In the quick motion, the restoring force
20 is elasticity of things.

21 MR. DEEVER: Typically, --

22 CONSULTANT WALLIS: It is mechanical.

23 MR. DEEVER: -- at the bottom of the pool,
24 there is no sloshing effect at the bottom because --

25 CONSULTANT WALLIS: Is that what you mean?

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1 You mean gravity is the restoring force in sloshing?

2 MR. DEEVER: Yes.

3 CONSULTANT WALLIS: Are you serious?

4 Okay, thank you.

5 MR. DEEVER: Okay.

6 CHAIRMAN CORRADINI: I thought he was
7 trying to answer your question by saying that for the
8 deep pools -- I just want to make sure he answered
9 your question. I am not sure if this was your
10 question but what he was answering was --

11 CONSULTANT WALLIS: -- has no effect on
12 seismic. Right? Is that your argument?

13 MR. DEEVER: Yes.

14 CONSULTANT WALLIS: So let's forget it and
15 let's talk about the very quick and impulsive
16 response. That is what matters. You keep bringing
17 this word sloshing into the conversation.

18 CHAIRMAN CORRADINI: That was their action
19 item. Last time we did a little portion about
20 sloshing. So they went away and analyzed sloshing.

21 MEMBER ABDEL-KHALIK: But the impulsive
22 mode, they just included it in the model. All the
23 mass.

24 MR. DEEVER: All the mass, yes.

25 CONSULTANT WALLIS: Except the mass of the

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1 steel when we get to the next slide.

2 You see there is no structures. This
3 means that none of the steel structure was counted.
4 Right?

5 MR. DEEVER: The one we did the stick
6 model part it was but not in the actual building.

7 CONSULTANT WALLIS: This first bullet
8 here, --

9 MR. DEEVER: Yes.

10 CONSULTANT WALLIS: -- says that no
11 internal structures were included.

12 MR. DEEVER: In the finite element
13 analysis of the building.

14 CONSULTANT WALLIS: The dynamic analysis,
15 not the finite element. In the stick model. The
16 stick model was what you --

17 MR. DEEVER: The stick model did include
18 the masses. But the finite element analysis of the
19 building structures --

20 CONSULTANT WALLIS: Well then you had
21 better be clear about what you mean here. This you
22 are talking about finite element part and it just says
23 dynamic analysis. To me, it only means the stick
24 model. How do things move, dynamics. And you mean
25 the stress analysis.

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1 MR. DEEVER: Yes, I am referring to stress
2 analysis.

3 CONSULTANT WALLIS: Are you sure?

4 MR. DEEVER: That is what I believe.

5 CONSULTANT WALLIS: Did you prepare the
6 slide or did somebody else?

7 TELEPHONE PARTICIPANT: I was discussing
8 something else. Could you please repeat that? MR.
9 WACHOWIAK: Well on the slide they say that in the
10 building dynamic analysis included pool water but not
11 the internal structures.

12 TELEPHONE PARTICIPANT: That was something
13 we discussed before and I mentioned that I would get
14 back to you whether the equipment load is added to the
15 floor.

16 MR. WACHOWIAK: Okay but when you say
17 building dynamic analysis, we mean the mass stick
18 model. Right?

19 TELEPHONE PARTICIPANT: Stick model,
20 right. Yes.

21 CONSULTANT WALLIS: You do. Right.

22 MR. WACHOWIAK: The thing is you make it -
23 -

24 TELEPHONE PARTICIPANT: I said this
25 before. In the stick model, the mass includes the

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1 building and also the water weight. And he asked if
2 there were another equipment weight added to that.
3 And I will get back to that.

4 CONSULTANT WALLIS: But clearly with this
5 slide, you did not.

6 CHAIRMAN CORRADINI: You know, it might be
7 reasonable if overall the mass is a fairly small
8 contribution.

9 MR. DEEVER: It is, in actuality.

10 In the next slide, I actually show the
11 masses on the slide.

12 I am turning my attention to the actual
13 structural analysis of the PCCS condenser. We
14 performed a finite element analysis and in the finite
15 element analysis, we included hydrodynamic mass to
16 account for the displaced water.

17 CONSULTANT WALLIS: That is a question.
18 You say you added the displaced water mass.

19 MR. DEEVER: Yes.

20 CONSULTANT WALLIS: Then what you were
21 seeing it was moving sideways and the added mass
22 coefficient was one.

23 MR. DEEVER: What we did was we adjusted
24 the density of the structure itself. We added in the
25 mass of internal water plus all of the displaced mass.

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1 CONSULTANT WALLIS: No but
2 hydrodynamically, there is an added mass coefficient
3 when you move a body in water. And for assume it were
4 moving sideways in a large massive flow, it is now a
5 displaced mass.

6 When you said that there isn't an array,
7 the added mass coefficient is different than one.

8 MR. DEEVER: In this analysis, we simply
9 added mass to the structure.

10 CONSULTANT WALLIS: Yes but you have to
11 know how much mass to add. And you add by taking an
12 added mass coefficient times the -- you take the
13 building or the structure, take a coefficient,
14 multiply it by the density of water. In this case,
15 you have the added mass.

16 If you have cylinders side by side and
17 touching, moving like this, the other mass coefficient
18 is infinite because the water can't get through.

19 So you know, it really changes the added
20 mass. And I just want to know what you did about
21 that. And when you add a wall, the wall restricts the
22 motion of the water and the added mass coefficient
23 goes up when it is moving towards the wall and away
24 from it. When it gets close to the wall, it has no
25 added mass. I just want to know what you did about

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1 those factors.

2 MR. DEEVER: As we discussed earlier,
3 there is some distance between the structure and the
4 wall. Okay?

5 CONSULTANT WALLIS: And you can calculate
6 the effect. And if it is small, then you get that.

7 MR. DEEVER: Okay. What was simply done
8 in this case was to take the three rates, the mass of
9 the structure, the mass of the internal water, and
10 then the whole displaced mass of the structure.

11 CONSULTANT WALLIS: Yes. So the added
12 mass is 16,295 pounds.

13 MR. DEEVER: Right.

14 CONSULTANT WALLIS: And you add that to
15 27,575. Right?

16 MR. DEEVER: Right.

17 CONSULTANT WALLIS: And you get the total
18 mass, which is shaking.

19 MR. DEEVER: We also have the internal --

20 CONSULTANT WALLIS: Yes, but that is the
21 common state inside. It is the water inside the
22 tubes.

23 MR. DEEVER: Yes.

24 CONSULTANT WALLIS: Right. I am not sure
25 that moves with the tubes but anyway.

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1 So if you have mass coefficient with two
2 and not one, you would be adding 32,600 pounds, which
3 would be more than the mass of the steel, wouldn't it?

4 If you added twice the displaced water mass because
5 the outer most coefficient was two and not one. You
6 have something significant. I just want to know what
7 the other mass coefficient is for this array, which is
8 why I asked what the array looked like.

9 MR. DEEVER: It is a steady flow, not an
10 accelerated flow.

11 CONSULTANT WALLIS: No, there is not a
12 nice and steady flow. It is all a dynamic effect. We
13 worked on this problem.

14 MR. DEEVER: Okay.

15 CONSULTANT WALLIS: I just want to know
16 what you did. It seems to me someone said oh, we only
17 have a mass for one so we will add one. They didn't
18 consider the effect of the neighboring tubes on the
19 other mass. It may not be important.

20 CHAIRMAN CORRADINI: He is talking about,
21 that is why we started the whole question about -- he
22 was leading us down a primrose path, with all due
23 respect. That is why he was asking the spacing of the
24 tubes in terms of the array. Because if you cut
25 through it and you look at the array of tubes, if they

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1 are tightly packed, they behave as he said and you
2 drive up essentially the equivalent amount of mass.
3 But if they are relatively openly spaced like a very
4 sparse forest, it essentially goes back to essentially
5 what he was talking about as one.

6 CONSULTANT WALLIS: Think about it. If
7 you are moving a tube, it takes mass with it. So you
8 have to put the water around. And if you move that,
9 when it blocks, it is all added mass.

10 So if you have some of them side by side,
11 moving like this, and they touch, then they are
12 behaving like a bear. Then there is enormous added
13 mass. If they are in line then there is sort of the
14 slip stream effect decreases the added mass.

15 So when you have an array, you have to
16 consider all those effects. I don't know how big are
17 your tubes and I think you ought to know. That's all.

18 MR. DEAVER: Well as far as sloshing is
19 concerned --

20 CONSULTANT WALLIS: Well it is not
21 sloshing I am concerned about. I am just wondering
22 about the inertia. When you move these things, the
23 question is how much water moves when the things shift
24 quickly in very small displacements.

25 And it may not be important. I just say

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1 you ought to consider it. And probably because of all
2 the factors of safety, it doesn't matter. But I don't
3 know that until you do the analysis.

4 MR. DEEVER: Okay. All I am reporting is
5 the very simplistic approach that was used to
6 consider the mass.

7 CONSULTANT WALLIS: That's right.

8 CHAIRMAN CORRADINI: So let's let you go
9 on but let's just take at least as an action item. Do
10 you understand now the point he was asking about the
11 impulsive loads so you can at least do a check on
12 that?

13 MR. DEEVER: Yes.

14 CHAIRMAN CORRADINI: Okay?

15 MR. DEEVER: Right.

16 CONSULTANT WALLIS: The added mass.

17 CHAIRMAN CORRADINI: The added mass to the
18 impulsive load.

19 MR. DEEVER: Okay.

20 CONSULTANT WALLIS: I didn't know how much
21 water was in the tank. When you use the mass of a
22 steel that is small compared with the overall water,
23 that was for the previous slide, do you have any idea
24 how much water is in the tank completely?

25 MR. DEEVER: Inside the condenser?

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1 CONSULTANT WALLIS: No, in the tank.

2 MR. DEEVER: In the tank.

3 CONSULTANT WALLIS: In the pool.

4 MR. DEEVER: In the pool.

5 CONSULTANT WALLIS: So maybe this mass of
6 steel is very small compared to --

7 MR. DEEVER: It is, yes.

8 CONSULTANT WALLIS: How much water is in
9 the pool?

10 MR. DEEVER: We could calculate it. It is
11 basically a five meter by five meter by 4.8 meter high
12 pool.

13 CONSULTANT WALLIS: So it is a hundred
14 cubic meters?

15 CHAIRMAN CORRADINI: Six hundred and
16 twenty five tons. Five times five times five. I'm
17 sorry. One hundred and twenty five tons.

18 TELEPHONE PARTICIPANT: One hundred twenty
19 cubic meter.

20 CHAIRMAN CORRADINI: One hundred five
21 metric tons.

22 TELEPHONE PARTICIPANT: Right.

23 CONSULTANT WALLIS: And we have got how
24 many tons of steel here?

25 MR. DEEVER: Six.

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1 CONSULTANT WALLIS: Twelve. So it is ten
2 times. Okay.

3 MR. DEAVER: Okay. So we took no credit
4 for the dampening effects in water. And the pool
5 response spectra at the floor was applied to the
6 model, on the building model.

7 CHAIRMAN CORRADINI: Keep on going.

8 MR. DEAVER: Okay. The next slide shows
9 the results of the structural design report of the
10 PCCS condenser. As mentioned earlier, the first mode
11 natural frequency was 14.7. For the limiting design
12 condition, which would be the seismic event, I
13 summarized the stresses and allowable stresses and
14 their margins for the different components. At this
15 point, the connecting pipes would be the limiting
16 component. This would be the connection of the pipe
17 into the top header pipe right at that junction.

18 So our conclusion from this is that we
19 have large structural margins in this structure
20 because of the low pressures and so forth.

21 The next slide shows the results of an
22 analysis that was done for the actual sloshing force
23 at different elevations in the pool starting with at
24 the very surface going to the bottom of the pool.

25 CONSULTANT WALLIS: And this is a

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1 sloshing? This is really due to the -- it is not
2 sloshing. Now we are talking about you have a 14.7 Hz
3 response. It is not sloshing at all.

4 MR. DEAVER: This is going back to the
5 building dynamic.

6 CONSULTANT WALLIS: No I think you are
7 using sloshing for two different meanings. When you
8 get this high frequency, the thing shakes very
9 rapidly. Gravity is irrelevant. There is no sloshing
10 going on at all. It is all the impulsive modes that
11 matter and sloshing shouldn't appear in these slides
12 at all because you are not talking about sloshing.
13 You are talking about the motion of the water in
14 response to the impulsive loads. That is what we are
15 talking about.

16 CHAIRMAN CORRADINI: He was getting back
17 to the building now.

18 CONSULTANT WALLIS: Oh you are back now to
19 the sloshing?

20 MR. DEAVER: Yes.

21 CONSULTANT WALLIS: Or were you talking
22 about the previous slide? You just analyzed the
23 motion. What you ought to do is take the motion you
24 just analyzed for that PCCS structure and go back and
25 figure out what effect that has on the figure and see

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1 how much it changes the impulsive mode. I thought
2 that was what you were going to do. Now all of a
3 sudden you are talk about sloshing, which is a low
4 frequency thing. Is that what you are talking about?

5 MR. DEEVER: Well that was the topic that
6 I thought we were addressing today.

7 CHAIRMAN CORRADINI: Just for
8 clarification, Graham, I think they have now gone back
9 to the building.

10 CONSULTANT WALLIS: Gone back to sloshing?

11 CHAIRMAN CORRADINI: So this slide is not
12 connected to the previous slide.

13 CONSULTANT WALLIS: It is. It is because
14 what the impulsive loads are on this structure effects
15 the building and the coupling between them. That is
16 what I am looking for in the next slide and now you
17 are going -- okay, you have gone back to something
18 else.

19 MR. DEEVER: Yes.

20 CONSULTANT WALLIS: Which is gravity
21 driven sloshing?

22 MR. DEEVER: Yes. What I am trying to do
23 is given appreciation for what type of loads sloshing
24 creates on the walls in the structure itself.

25 CONSULTANT WALLIS: Well what type of

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1 loads does this previous 14.7 Hz shaking of the
2 structure impose on the walls? That is more
3 interesting to me. That is the one that matters.

4 CHAIRMAN CORRADINI: But let's just take a
5 step back, just real quick. So let him at least go
6 through this. And so what you are asking for is once
7 we know this effect, you want to compare it on a
8 relative basis to the dynamics --

9 CONSULTANT WALLIS: Well he could reshapes
10 a structure in a water pool, it effects the rest of
11 it. Sloshing has nothing to do with -- I mean gravity
12 has nothing to do with that.

13 If you lit a bomb off in a swimming pool,
14 you might knock the walls off. Right? It's like an
15 extreme case. If you get something shaking in the
16 pool.

17 So I don't understand the sloshing -- well
18 okay. Go ahead.

19 MR. DEEVER: At any rate, this gives you
20 an appreciation for the sloshing loads that were
21 calculated on the pool wall itself.

22 CONSULTANT WALLIS: By sloshing you mean -
23 - no, I am serious.

24 MR. DEEVER: That effect, yes. Not the
25 impulsive rigid --

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1 CONSULTANT WALLIS: For the it going up by
2 4.2? Gravity force goes up by 1.39 psi?

3 MS. CRUZ: I think the --

4 MEMBER SHACK: These are stresses.

5 MR. DEEVER: These are pressure forces.

6 CONSULTANT WALLIS: But they are driven by
7 gravity and pressure must lift the water that is
8 sloshing.

9 MR. DEEVER: That is the side load onto
10 the wall.

11 CONSULTANT WALLIS: But that is tied into
12 it all because of hydrostatics. I mean just -- it is
13 a sloshing mode but psi is going to lift the wall
14 because --

15 MR. DEEVER: That is the component but
16 this is the effect of the horizontal sloshing.

17 CONSULTANT WALLIS: It is tied together
18 because gravity is driving what is happening. You
19 can't have one without the other.

20 I wonder if you really are analyzing
21 sloshing as driven by gravity.

22 CHAIRMAN CORRADINI: But you can't slosh
23 without inertia.

24 CONSULTANT WALLIS: Yes but the inertia
25 because of that because they are tied together. When

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1 it stops, it is not moving. So it really goes up a
2 foot or two, this sloshing stuff?

3 MR. DEAVER: This is only accounting for
4 the zero location, which is the --

5 CHAIRMAN CORRADINI: Gerri, let me just, I
6 think I know where he is going so let me just say it
7 back to you to make sure we are on the same page and
8 then we have to go on.

9 I think Graham's point is near the surface
10 you are predicting a pressure of about 1.4 psi.

11 MR. DEAVER: Yes.

12 CHAIRMAN CORRADINI: A tenth of a ball,
13 which means the water rose a meter.

14 CONSULTANT WALLIS: That is right because
15 he says the distance below the water level is zero on
16 the left side here.

17 CHAIRMAN CORRADINI: But does it Graham?
18 In some sense, I mean, I look at the gradient of this
19 and it is actually a very steep gradient. So you are
20 down to less than maybe ten or 15 centimeters of
21 movement down deep into the pool.

22 CONSULTANT WALLIS: That is what happens
23 with water waves.

24 CHAIRMAN CORRADINI: So I think he is just
25 observing the fact that --

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1 CONSULTANT WALLIS: But I have difficulty
2 believing that the level goes up three feet or
3 something on the top. Does it?

4 MEMBER SHACK: Didn't we actually see that
5 and solve a seismic event?

6 CONSULTANT WALLIS: So there is evidence.
7 Okay. Thank you. So it did go up.

8 MR. DEAVER: Yes.

9 CONSULTANT WALLIS: Okay, thank you. So
10 we are talking about sloshing.

11 MR. DEAVER: Yes. I said that we
12 calculated that the elevations with the centerline of
13 the headers were at the elevation of 1.38 and 1.58 to
14 see what the pressure of sloshing force would be at
15 that elevation. And the value is quite small compared
16 to other loads that are going to be applied to the
17 structure.

18 And particularly in dynamic analysis where
19 we use some SRSS methods to take different components,
20 when you look at the magnitude of the other
21 components, such as the best impulsive load and the
22 structural loads, then the sloshing effects, in
23 essence, are very, very small and a minor effect on
24 the actual structure itself.

25 CONSULTANT WALLIS: But let me go back to

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1 the previous question here. When you have an array of
2 tubes near the wall and they are oscillating, they
3 move water with them. So there is water at the wall
4 as they move to and fro. So there is a load on the
5 wall due to the moving of a structure near the wall.
6 That is what I was looking for.

7 So now you have done this analysis of the
8 added mass and all that and there is no numbers on
9 these slides but when you are talking about structural
10 design, headers, calculated stress, allowed stress,
11 whatever that is, number four here, now I see you
12 having done that, what is the effect on the wall?

13 CHAIRMAN CORRADINI: Gerry, just to make
14 sure I am clear, Graham's point, I think is, that he
15 feels comfortable there is no sloshing but now he is
16 back with the impulsive load and he wants to do some
17 sort of comparison quantitatively between what that
18 layer is and what the --

19 CONSULTANT WALLIS: I think you will find
20 the load is bigger than the sloshing load if you --

21 CHAIRMAN CORRADINI: Right.

22 MR. DEAVER: Yes. Well, what we were
23 trying to address today was sloshing.

24 CONSULTANT WALLIS: ACRS used the word
25 sloshing?

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1 CHAIRMAN CORRADINI: It is our fault. We
2 asked for it.

3 MS. CRUZ: Well it has been a long time
4 since we had the subcommittee meeting. So I think too
5 many memories are fading away. But at that time, I
6 believe the committee was satisfied with the response
7 of the water impacting on the structure. And the
8 remaining concern was the effect of the water on the
9 components themselves and what is that factored in.

10 And so that was the point of this
11 presentation. I do know that there are some lingering
12 concerns perhaps with the material that was presented
13 before. GE was not prepared to discuss that in detail
14 today. So we need to get some guidance from the
15 committee on if you want more information we can ask.

16 CHAIRMAN CORRADINI: Before we give you an
17 action item that may or may not be necessary, I guess
18 the only observation is I see a few open items that
19 you guys want to clarify but I will wait until you are
20 finished and just to review them so we are on the same
21 page.

22 MR. DEAVER: Okay, the next slide. As I
23 mentioned earlier, we have not analyze the IC
24 condenser structure, performed that structural
25 analysis. So our plan is to complete the analysis as

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1 part of the detailed design of the plant.

2 The sizing of the condenser already
3 considers the normal operating condition loads and use
4 Alloy 600 materials to provide a stronger material
5 response to the higher stresses.

6 Dynamics can be readily taken care of by
7 the support structure by fixturing and support similar
8 to the PCCS support structure. And then added loads
9 can be taken care of by the structure itself.

10 We expect the sloshing loads to be very
11 close to the PCCS condenser loads. It is closer to
12 the water surface but it is also shorter. So the
13 actual surface area times the pressure comes out with
14 a similar load. And the PCCS condenser will be
15 analyzed using the same analysis methods as the PCCS
16 condenser. And we are not anticipating any problem
17 with the actual analysis when it is performed.

18 And as far as conclusions, we considered
19 the effects of sloshing on the PCCS and ICS condensers
20 but we haven't separately analyzed them due to the
21 conservative hydrodynamic analysis methods that were
22 used.

23 The effects of sloshing are expected to be
24 very small compared to the other dynamic loads.

25 And based on the large structural margins,

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1 we don't see any problems with the IC calculation that
2 will be performed.

3 So that is our prepared material.

4 CHAIRMAN CORRADINI: Okay, let me at least
5 review. Thank you very much. Let me just ask for
6 questions from the committee. Let me just at least
7 review what I had written down because you guys wanted
8 to check a few items of information.

9 One was the question about the lattice
10 arrangement. And I think that couples back to
11 Graham's question about the impulsive loading. The
12 guess is that the lattice arrangement is such that the
13 added mass approach you are taking may be appropriate,
14 it is just a matter of getting clarity.

15 Also, Professor Abdel-Khalik was asking
16 the question about relative to the header arrangement,
17 the isolation condenser, since it is out of the water
18 and what are the thermal stresses. We left that to
19 mean that the pressure and thermal stresses are
20 essentially going to have to be calculated when the
21 detailed design is done. So at this point, it remains
22 an ITAAC that has got to meet ASME code levels.

23 And then the last one that I have down
24 here is that there was a question about what the
25 natural frequency was and one of your colleague was

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1 going to check on that and get back to us. More
2 information on all of these cases.

3 MR. DEAVER: Right.

4 TELEPHONE PARTICIPANT: And that is our
5 duty.

6 CHAIRMAN CORRADINI: Excuse me?

7 TELEPHONE PARTICIPANT: And that is our
8 other duty.

9 CHAIRMAN CORRADINI: Correct, yes.

10 MR. DEAVER: So as a follow-up, I have the
11 drawing the lattice.

12 CHAIRMAN CORRADINI: Okay.

13 MR. DEAVER: It is here. Pass this around
14 but we have someone coming up, driving up today, and
15 he is going to bring the drawings but if you want to
16 talk a look at it on the two-inch screen, I have got
17 a version of it here.

18 CHAIRMAN CORRADINI: Now you know the
19 virtual mass coefficient for that lattice.

20 CONSULTANT WALLIS: Mr. Chairman?

21 CHAIRMAN CORRADINI: Yes, sir.

22 CONSULTANT WALLIS: When we are talking
23 about the stresses in the structure, you have got
24 stresses of 100 megapascal. A big stress. And then
25 the sloshing of course they are talking about

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1 kilopascal. For something that is 10,000 times bigger
2 on the pipes, now I don't know what it is on the
3 walls, but if I can set up 100 megapascals in the
4 pipes, even if it is attenuated by a factor of 100 to
5 one, it is still a megapascal in the walls, which is
6 100 times bigger than what you are worried about in
7 the sloshing. So, I think I have reason to be
8 interested in the coupling between the motion of the
9 structure and the wall.

10 The numbers are so much bigger. I mean,
11 so much bigger. And then when you do this, and you
12 take, naturally, if you put in some kind of a forcing
13 function like seismology and you worry about, do you
14 worry about some sort of resonance at the structure?

15 MR. DEAVER: The structure with respect to
16 the --

17 CONSULTANT WALLIS: You put in the
18 frequency from the seismic. There is no resonance
19 frequency in the seismic itself. It is just the whole
20 spectrum of stuff. But the response is particularly
21 at the resonance frequency. Is that why we are
22 getting this high stress because there is a component
23 of 14.7 Hz in the seismic driving force?

24 MR. DEAVER: Which slide are you talking
25 about?

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1 CHAIRMAN CORRADINI: I think he is on the
2 slide, can you go back three slides?

3 CONSULTANT WALLIS: Right here where you
4 say you have a margin of 38 percent. Now if you
5 multiply the other mass by a factor of two, this might
6 be significant in changing that stress.

7 MR. DEAVER: Well that would only add
8 another 48 percent.

9 CONSULTANT WALLIS: Well I don't know how
10 much it adds but if it adds 48 percent, that is more
11 than your margin of 38. So it seems to me you ought
12 to do this again.

13 CHAIRMAN CORRADINI: So why don't we just
14 summarize. So this is the peak stresses near the
15 natural frequency based on the seismic input. And
16 Graham's question is just to be clear with the
17 impulsive load making sure the added mass is
18 appropriate. Otherwise if it is missing it, you might
19 be closer to the margin you first suspect.

20 CONSULTANT WALLIS: And what effect does
21 it have on the wall? If it can produce these very
22 large stresses in the pipes, does it have some effect
23 on the wall?

24 MR. DEAVER: The location where the higher
25 stress is, it is also supported well.

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1 CONSULTANT WALLIS: Is it at the bottom or
2 the top?

3 MR. DEEVER: This is at the top. The
4 connecting pipe is at the top connection to the top
5 header pipe.

6 CONSULTANT WALLIS: Oh these things are
7 coming across the top.

8 MR. DEEVER: Yes.

9 CONSULTANT WALLIS: Okay because the other
10 pipes are trying to move --

11 MR. DEEVER: Right.

12 CONSULTANT WALLIS: -- and that is
13 restrained in the middle that connecting pipe.

14 MR. DEEVER: Right.

15 CONSULTANT WALLIS: Okay. Maybe you ought
16 to not restrain it in the middle and you would be
17 okay.

18 CHAIRMAN CORRADINI: We are not going to
19 design it for him.

20 CONSULTANT WALLIS: Okay.

21 CHAIRMAN CORRADINI: We just observe.

22 CONSULTANT WALLIS: Okay, thank you.

23 CHAIRMAN CORRADINI: Okay. Other
24 questions.

25 MEMBER SHACK: Yes, I had a question on

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1 the choice of materials for the isolation condenser.
2 Now you said you are going to use Alloy 600 because it
3 is stronger.

4 MR. DEAVER: Yes.

5 MEMBER SHACK: Is that driven by this
6 concern about sloshing or just other factors?

7 MR. DEAVER: The combined situation.

8 MEMBER SHACK: Because it is a higher
9 pressure system?

10 MR. DEAVER: Right.

11 MR. ANTHONY: Actually, it is a heat
12 driven thing. That is one thing -- I mean, a heat
13 transfer, you want the walls thin. And so you want to
14 use a higher strength material to deal with it, get
15 the heat transfer.

16 MEMBER SHACK: Okay. And the big headers
17 and all of that is in canal?

18 MR. ANTHONY: All canal, yes.

19 MEMBER SHACK: Okay, that is a very pricey
20 thing.

21 MEMBER SHACK: Okay, the other thing is
22 just my recollection of when we started this was
23 concern that the sloshing would put loads that hadn't
24 been taken into account onto the walls. Well my
25 concern was that sloshing that put loads on the

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1 component, the condensers themselves, where they are
2 supported at the base and basically damage the
3 component in a seismic event so they wouldn't be
4 available to do their job if you had an accident.

5 So somehow I think we got, at least I got
6 confused that we got that answer. Are these
7 components going to be, have a lot of margin at their
8 structural supports, the component itself, the tubes,
9 attachments to the header? Is that analysis yet to be
10 done?

11 MR. DEAVER: On the IC system, yes.

12 MEMBER SHACK: And but the PCCS you feel
13 you demonstrated that you got margin?

14 MR. DEAVER: We have done the analysis and
15 have the results.

16 MEMBER SHACK: Okay. I think you need a
17 little bit more.

18 CHAIRMAN CORRADINI: Well can I just
19 rephrase what you just said? At least I heard
20 differently when you first said it to Sam. My
21 understanding is that they have done the structural
22 support for the PCCS. They have analyzed it. They
23 see a lot of margin relative to our original question
24 about sloshing. And they have yet to do it with the
25 isolation condenser. But going forward, they will use

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1 the same design approach so they expect the same
2 result.

3 MR. DEEVER: Yes.

4 MEMBER SHACK: And my question was the
5 Alloy 600 selection had nothing to do with sloshing.

6 MR. DEEVER: No. It was driven by the
7 heat transfer.

8 CHAIRMAN CORRADINI: Okay. Other
9 questions? Thank you very much.

10 Staff is going to join us up here.

11 CONSULTANT WALLIS: One thing occurs to
12 me. When you did these in Switzerland or something on
13 the PCC condenser, did anybody shake it and see what
14 its frequency was?

15 MR. DEEVER: No, this was a performance
16 test. It wasn't a --

17 CONSULTANT WALLIS: No one has shaken the
18 condenser yet?

19 MR. DEEVER: No.

20 CONSULTANT WALLIS: Thank you.

21 MR. LE: Hello. My name Tuan Le. I am
22 the lead technical review for the SRP section 3.9.3.
23 This section for my technical review consider is
24 condenser, concentrate on component, component support
25 and core support structures.

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1 I am really taking the responsibility for
2 3.9.3 for technical review and awareness of review
3 2.4.7, regarding the structural effects of the seismic
4 analysis.

5 I would like to review here a little bit
6 the background and the RAIs and the result of the
7 review, the RAI. Back then, the previous issue, the
8 seismically induced dynamic loads could affect the
9 structure, effecting basic changes, submersing the
10 loads in the water pool.

11 Then this committee reviewed and asked
12 additional question needed to demonstrate the dynamic
13 loads forced and the seismic event could affect loads
14 in the analysis of the heat exchanger such as the
15 reactor, ICS condenser and ICS and the containment
16 coding system in the PCCS heat exchanger. This
17 equipment is submerged into a large water pool.

18 In response to that response, generally an
19 RAI, the staff asked GEH to demonstrate how dynamic
20 forces from seismic events treat it in the nozzle of
21 the heat exchanger submerged in the elevated water
22 pool.

23 They responded with a letter and as part
24 of their response, it was disclosed in the product
25 2008.

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1 This response was reviewed. The GEH
2 responded to RAI and we had discussion in the telecoms
3 and prior to their responding to the RAI in the
4 22,000 words.

5 In addition to that meeting, telecom, and
6 the meeting on October 14 of this year, the staff
7 noticed that two items. One is the PCCS submerged
8 changes support and the seismic is complete but the
9 ICS submerged changes support is not completed.

10 Therefore, in the supplement of this RAI,
11 the staff preferred that the applicant provide DCD
12 changes. The staff asked the applicant to provide
13 these changes to describe the methodology of the sum
14 of the masses with the sloshing effect asked in
15 previous presentation from the application regarding
16 to these methods.

17 And secondly, the staff would like to have
18 the method to compare the ICS and the PCCS heat
19 exchangers' support design to follow up and make a
20 comparison. This has been completed.

21 That is all I have for today.

22 CONSULTANT WALLIS: So you don't have any
23 of the kind of questions that I was asking?

24 MR. LE: No.

25 CHAIRMAN CORRADINI: Did you hear his

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1 question?

2 MR. LE: I'm sorry?

3 CONSULTANT WALLIS: Did you hear the
4 questions I was asking GEH when they were up there? I
5 just wondered if you asked any of the same kind of
6 questions.

7 MR. LE: Well the discussion on the 10/14
8 meeting last week, we asked about the pressure
9 regarding the mass methodology. What happened was my
10 question was asking them what method that they applied
11 through the PCCS system and the stress location is
12 where is it located on the pipe wall or on the wall of
13 the pipe, pipe connection to heat exchanger on the
14 support system. But it lead to the ICS system has not
15 been completely designed for the support here.

16 What I will see is that the stress would
17 be in the system wall or the piping itself because it
18 is a pressure retaining component.

19 CONSULTANT WALLIS: But you didn't ask the
20 questions about the affect of the array or the walls
21 on the added mass of the structure.

22 MR. LE: No.

23 CONSULTANT WALLIS: You didn't ask any of
24 those. Okay. So I have to be very explicit in my
25 report.

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1 MEMBER SHACK: Did your review address the
2 loads on the PCCS structure where it is bolted or
3 attached to the floor? Did you address? Because it
4 would seem to me if there are sloshing loads, you have
5 a big moment at the very top of the equipment, which
6 is transmitted down to where it is connected to the
7 floor. And that, you put stresses there and then you
8 have got your vertical component as the water changes.
9 Buoyancy tends to let things up.

10 So did you go to that level of detail in
11 your review?

12 MR. LE: As far as that level of detail
13 has not been provided to the staff until now because
14 the detail of that would be in the design report. The
15 staff hasn't looked at that because it is not
16 available at the time that I took responsibility for
17 review.

18 MEMBER SHACK: So that is not taken into
19 account in this analysis?

20 MR. LE: The analysis was based on the
21 previous discussion and also when we discussed with
22 them, as described to the applicant earlier, taking
23 the effect of the stick model where they had the
24 spectrum and the load. And you got load in the header
25 model to generate the stresses there.

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1 And you have got a sloshing effect at the
2 top a little more challenging for the stick model to
3 simulate the force loading condition combination with
4 the mass of the equipment, the mass of the water.

5 MEMBER SHACK: Yes. Well just my concern
6 is more that this equipment could basically, unless it
7 is anchored properly and analyzed very carefully, that
8 that is where the weak link is, is the loads that are
9 transmitted to that support structure while it is
10 anchored.

11 And apparently, I don't know if GEH has
12 done that analysis to size the bolting or whatever
13 arrangement they have to make sure that that doesn't
14 happen.

15 CHAIRMAN CORRADINI: So let me take a -- I
16 guess -- well, I didn't want to interrupt the staff.
17 You go ahead and finish answering his question. I'm
18 sorry. Go ahead.

19 MR. LE: It doesn't --

20 MEMBER SHACK: Yes, it is very simple. If
21 there was no water in those pools, this would just be
22 a plain dynamic seismic analysis. Okay, you get your
23 modes and stresses and you could do it.

24 But since you have got water and it is
25 moving, it is a backed up effect, it is putting big

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1 loads at the top of those structures. Those
2 structures are very stiff. Those load stresses are
3 transmitted down to where it is rigidly attached to
4 the floor. And the question is, has that been
5 analyzed enough so that you know it is going to stay
6 there and not break physically.

7 MR. LE: In that detail, I haven't had
8 that stress indication. Also the how the method used
9 result in that stress that transmitted materially in
10 the structure.

11 MEMBER SHACK: Okay.

12 MR. LE: No, I didn't work on that.

13 MEMBER SHACK: Well maybe GEH has done
14 that. Maybe I am totally off base but is that a
15 really significant concern to GEH?

16 MR. LE: Does anybody want to answer that
17 question? Did it stress the support of the piping as
18 it changes?

19 CHAIRMAN CORRADINI: GEH, did you hear the
20 question?

21 MR. WACHOWIAK: Yes, this is Rick
22 Wachowiak. The question was, have we analyzed the
23 forces on the component itself being translated down
24 into the anchorage on the floor. And that is a to be
25 done analysis.

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1 We have the forces on the component and it
2 looks reasonable that we will be able to design the
3 support structure to support that and not break that
4 support. But that specific calculation has not been
5 done yet.

6 MEMBER SHACK: Okay. I hope somebody does
7 it.

8 CHAIR CORRADINI: So let me just roll back.
9 Do you understand the question that Dr. Wallis was
10 asking about the impulsive load not the sloshing load?

11 We kind of did a bait and switch with GEH. So we are
12 going to do the same thing with you.

13 Have you looked at the analysis they have
14 done relative to the PCCS, since that is the
15 structural support? They looked at the PCCS
16 structure and then the associated pool and you are
17 satisfied with what they have done?

18 MR. LE: I think that the methodology, we
19 are satisfied with the response to the RAI. Although
20 we see other methods that used the code generally the
21 seismic effect and all the impulse.

22 CHAIRMAN CORRADINI: Great.

23 MR. LE: But this method the staff RAI
24 respond seriously but then the authority is to send it
25 back and respond for the staff review. For me, I

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1 discussed with them recently and I have no objection
2 to their method.

3 CHAIRMAN CORRADINI: Okay. So, but just
4 let me be clear and then we will leave it at that.

5 In some sense, at least personally, I
6 don't disagree with what you are saying. I think they
7 answered the RAI. I understand their response. I
8 understand your position. And I am not worried about
9 what we originally brought up.

10 But in the conversation we had today the
11 concern was raised, or at least the check was
12 questions -- the question was raised that the
13 impulsive loads depend upon an assumption relative to
14 essentially the added mass. And is that added mass
15 appropriately computed? So I think that is just kind
16 of a check that we want to be clear about. At least
17 that is --

18 So I just wanted to make sure you
19 understand what our question was.

20 MR. LE: Yes, Mr. Chairman, I understand
21 that question.

22 CHAIRMAN CORRADINI: Okay.

23 MEMBER BANERJEE: What is the volume --

24 CHAIRMAN CORRADINI: Good morning Dr.
25 Banerjee.

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1 MEMBER BANERJEE: Good morning. What is
2 the volume of water within the bundle or the mass of
3 water? Because added mass obviously relates to that.
4 Right?

5 MR. LE: I understand --

6 MEMBER BANERJEE: My assumption would be -
7 -

8 CHAIRMAN CORRADINI: Well if you had been
9 here, it is in the slide number 11. I'm sorry. I had
10 to do that to you. I'm sorry. That is inappropriate.

11 MEMBER SHACK: It will all be covered,
12 2,779 kilograms.

13 MEMBER BANERJEE: Okay. And the mass of
14 the -- so all of this mass is taken into added mass.

15 CHAIRMAN CORRADINI: Right. We will catch
16 you up on this. But basically the question was they
17 assumed an added mass factor that depends upon the
18 details of the header design -- not the header design
19 -- the tube design and we still want to be clear about
20 what that tube design was so that what they assumed
21 and what the tube design are consistent.

22 CONSULTANT WALLIS: They just assumed an
23 added mass coefficient of one.

24 CHAIRMAN CORRADINI: Yes.

25 CONSULTANT WALLIS: Irrespective of the

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1 tube design or the proximity of the wall, all these
2 other things.

3 MEMBER BANERJEE: Well, the coefficient is
4 one but the amount was --

5 CONSULTANT WALLIS: No, the coefficient is
6 not one.

7 MEMBER BANERJEE: No but the amount of
8 material in that --

9 CHAIRMAN CORRADINI: That we know.

10 MEMBER BANERJEE: All the interstitial
11 liquid. Right?

12 CONSULTANT WALLIS: No, they don't do
13 that. They take the water displaced by a tube.

14 CONSULTANT WALLIS: Well, we can talk
15 about it since we have been through this.

16 CHAIRMAN CORRADINI: Okay. So we will
17 catch you up. We will catch you up.

18 MEMBER BANERJEE: All right.

19 CHAIRMAN CORRADINI: Other questions for
20 Mr. Le?

21 MEMBER ARMIJO: I have a quick questions,
22 as long as we have all of the sloshing experts here.

23 In the analysis, how high were the seismic
24 events that you were treat? How high up the wall does
25 this sloshing occur? And are you sure that you can

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1 retain all of the water, that it always stays in the
2 pool or can it slosh out of the pool?

3 Do you have an answer to that?

4 MR. ANTHONY: There is a cover on the
5 compartment.

6 MEMBER ARMIJO: So it never gets -- it
7 just puts loads on the top and sloshes right back.

8 MS. CRUZ: Is the concern a flooding
9 concern?

10 MEMBER ARMIJO: No, I just thought -- I
11 didn't know.

12 CHAIRMAN CORRADINI: He was worried about
13 losing inventory.

14 MEMBER ARMIJO: Losing water, yes, that it
15 stays put.

16 CONSULTANT WALLIS: What is the force on
17 the cover?

18 MS. CRUZ: I guess we are talking
19 posturally in a seismic event and them needing the
20 equipment for a LOCA.

21 MEMBER ARMIJO: Yes.

22 MS. CRUZ: Okay.

23 CHAIRMAN CORRADINI: Okay, other questions
24 for Mr. Le?

25 Thank you very much.

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MS. CRUZ: Should we take a break now?

CHAIRMAN CORRADINI: Well, I think this would be the most logical thing to do at this point. Why don't we take a break until about 20 of and we will go into closed session. We will shut down the bridge line and we are going to come back together.

(Whereupon, the foregoing matter went off the record at 10:23 a.m., ending the open session, and resumed at 10:42 a.m. to the closed session.)

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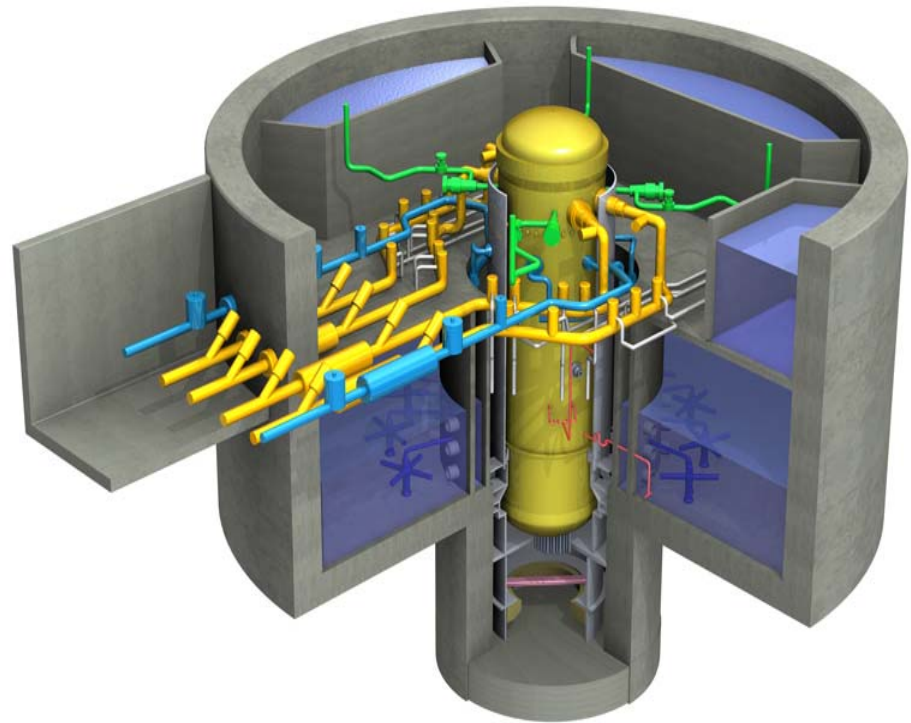
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ESBWR DCD

Seismic Design of PCCS & ICS Reactor Hardware (impact of sloshing water)

Advisory Committee
on Reactor Safeguard

October 20, 2009
GE Hitachi Nuclear Energy



Agenda

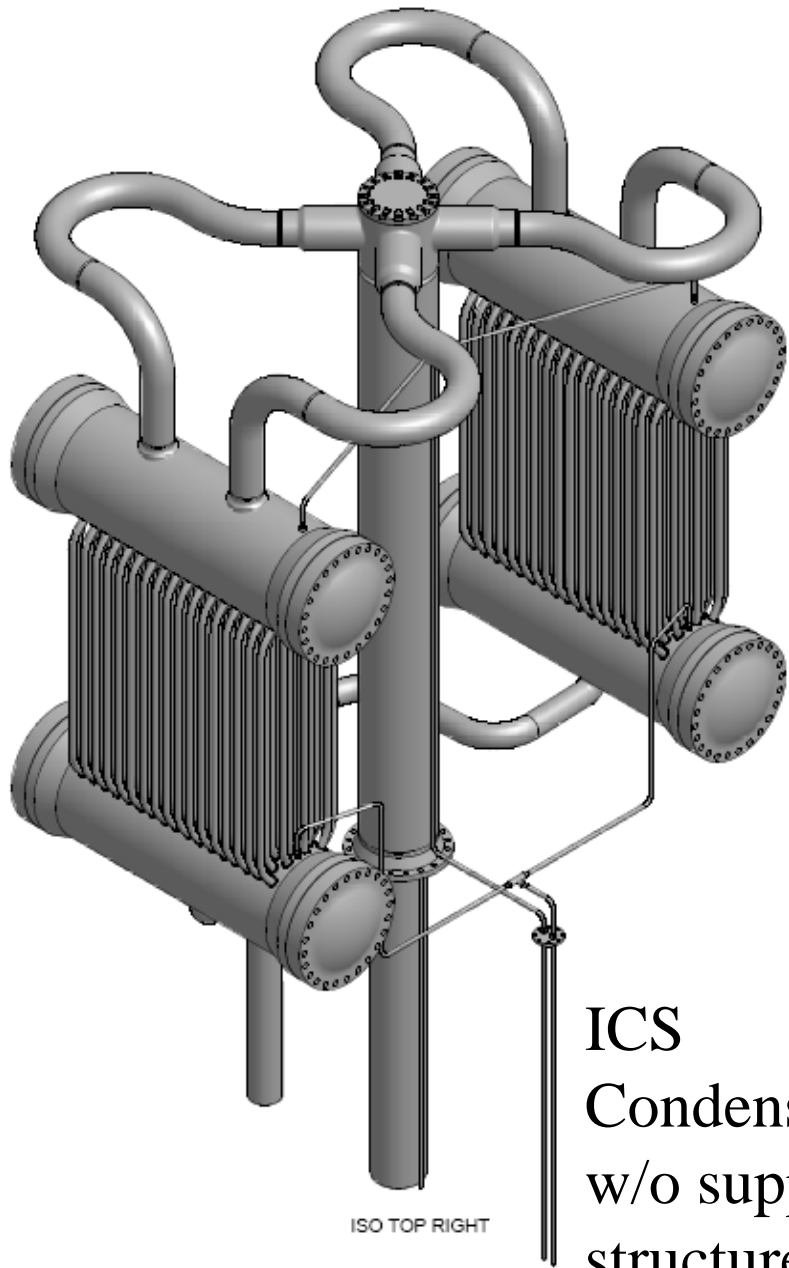
- RAI Status
- Review of IC & PCCS Condenser Configuration
- Review of Reactor Building dynamic load evaluation
- Review of the PCCS Condenser structural analysis methods
- Results from PCCS Condenser Design Report
- Sloshing Pressure Results
- IC Condenser Analysis
- Conclusions

RAI Status

- RAI 3.9-247

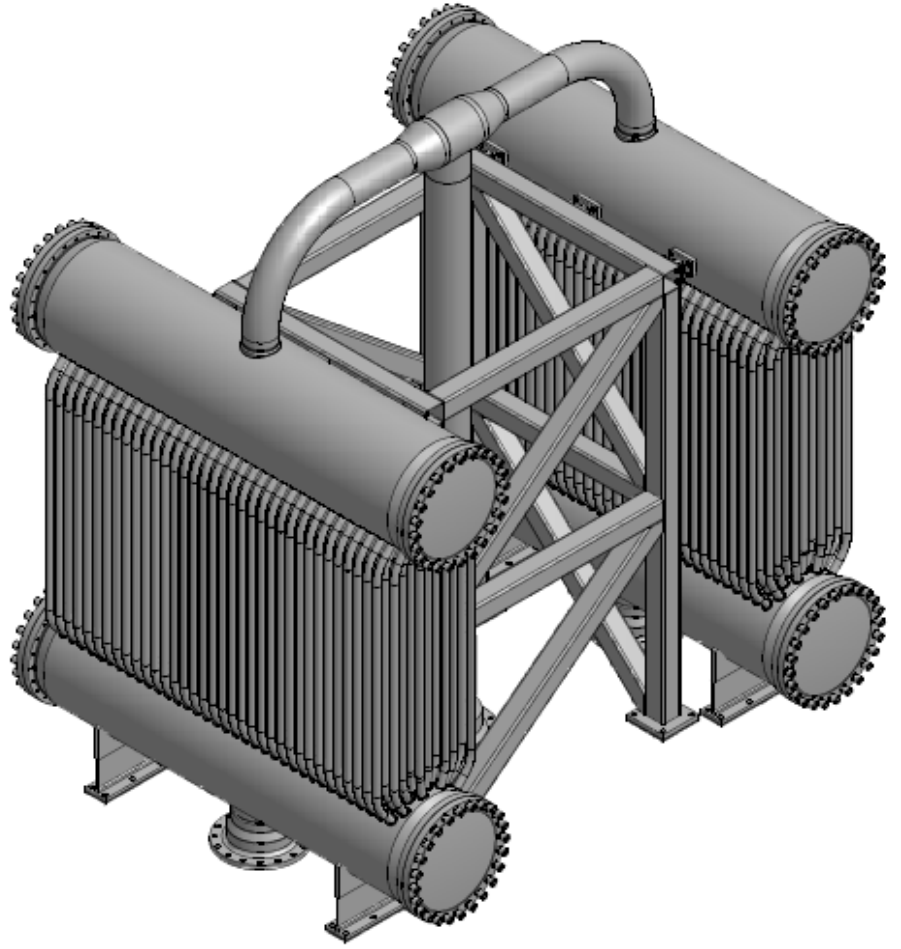
Requested details on how hydrodynamic including sloshing loads on the IC and PCC Condensers are addressed

- This RAI has been Resolved



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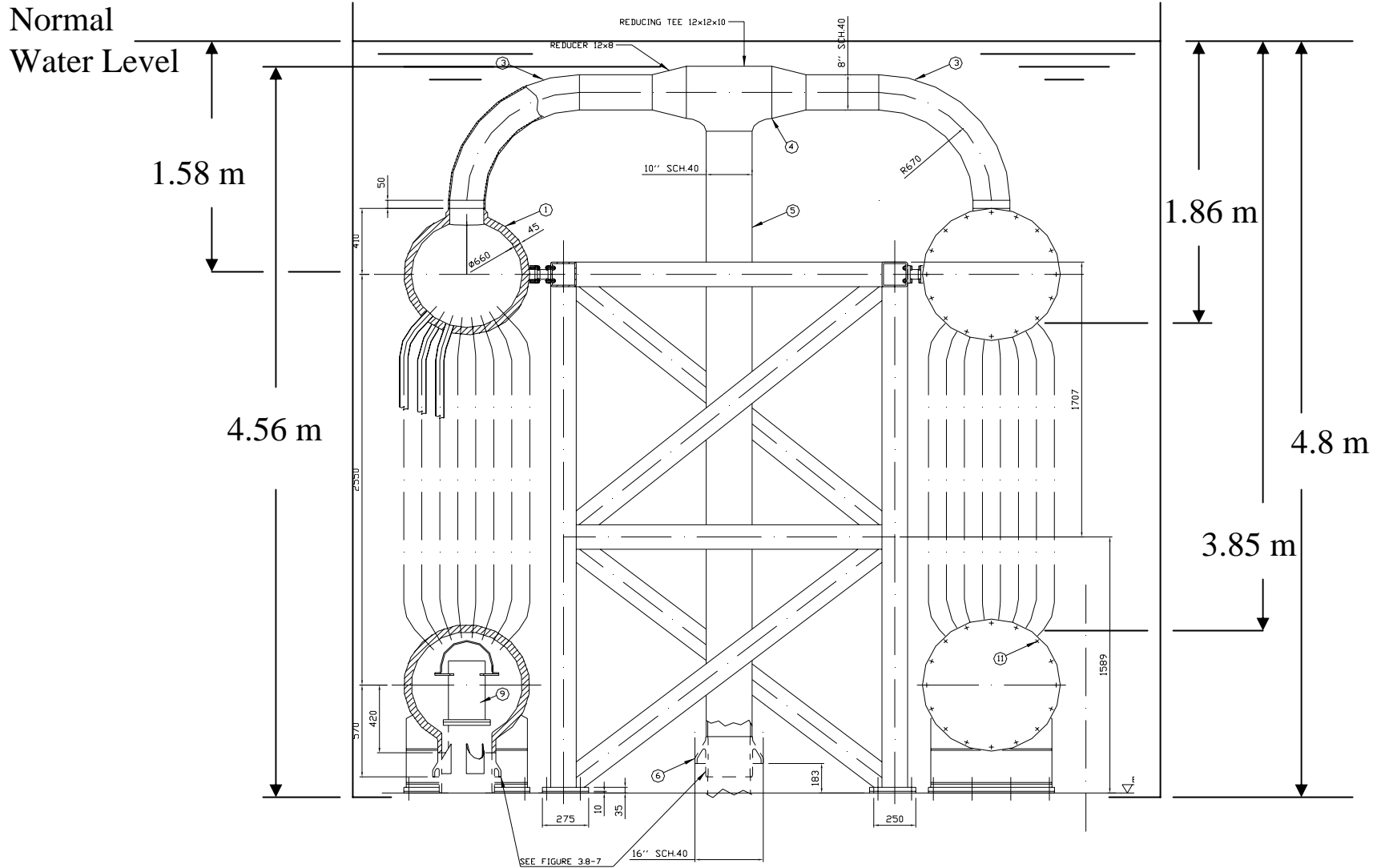
ICS
Condenser
w/o support
structure



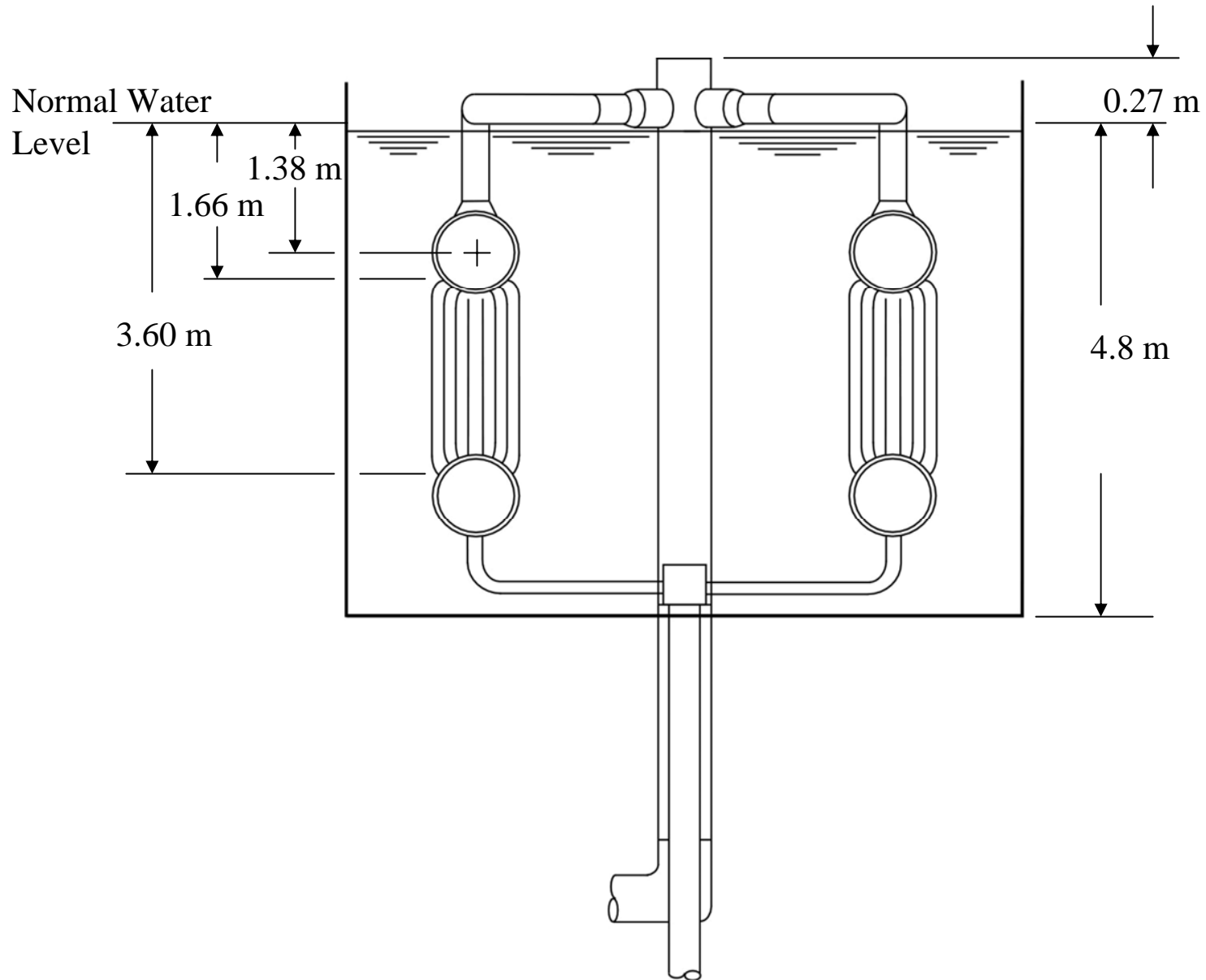
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PCCS Condenser with
support structure

PCCS Condenser

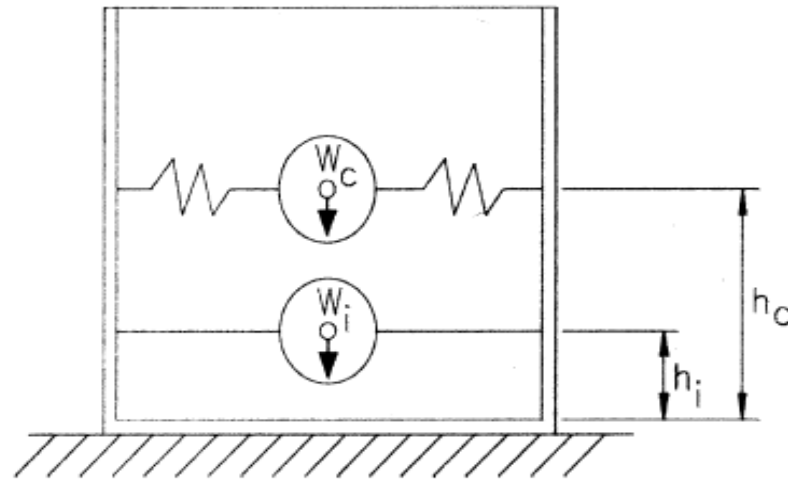


Isolation Condenser Schematic



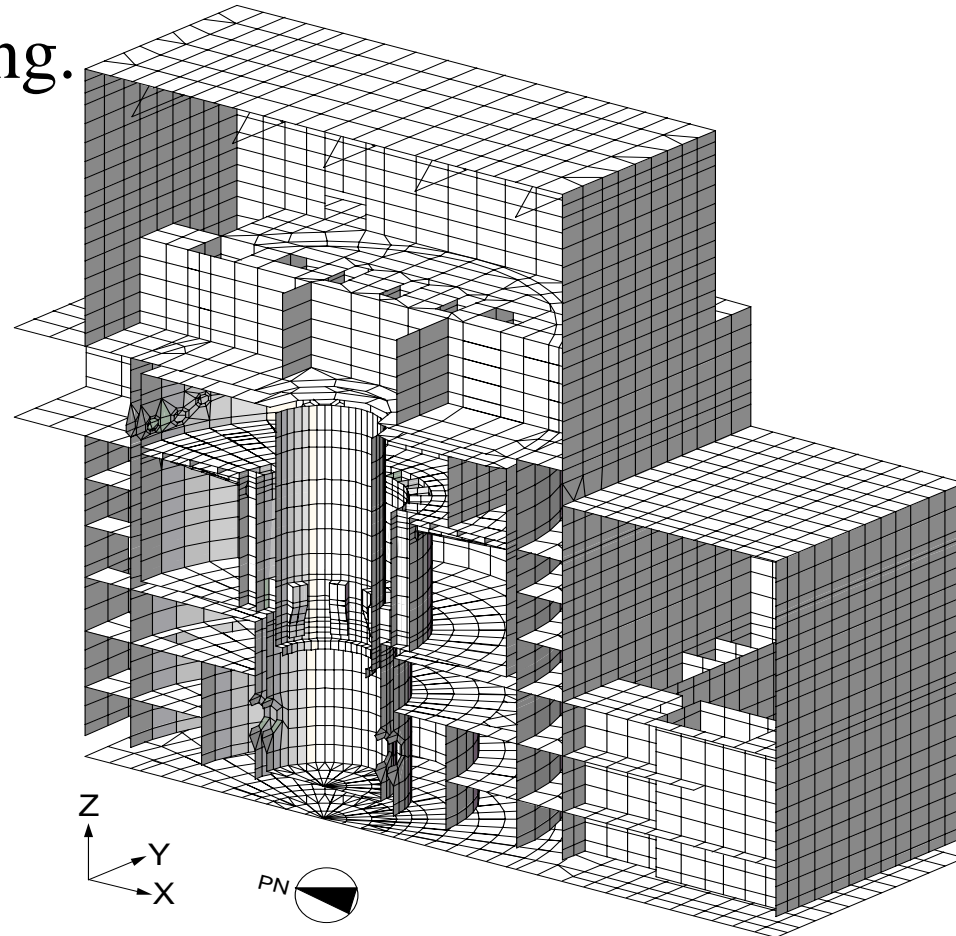
Modeling of Pool Water under Seismic Conditions

- Fluids contained in pools are commonly modeled as mass-spring system made of convective (sloshing) and impulsive (rigid) components.



Stress Analysis of Pool Structures

- Each pool structure is explicitly modeled and included in the overall finite element model of the building.



Modeling of Pool Water in Reactor

Building Seismic Analysis

- Sloshing component responds in very low frequencies (typically <0.5 Hz) where no structural modes of vibration exist
- Impulsive component responds in unison with the pool structure and its effect is treated as added mass
- The sum of masses associated with each component is equal to the the total water mass in the pool
- For conservatism, the entire water mass of each pool is considered as impulsive mass rigidly attached to structural nodes in the seismic stick model for predicting overall response of the building structure
- All pools are included in the model, thus the effect of pool interaction is accounted for

Stress Analysis of Pool Structures

- Input seismic loads consist of
 - Global loads in the form of maximum shear, moment and accelerations calculated from the seismic response analysis.
 - Local loads in the form of hydrodynamic pressures due to convective and impulsive modes on the pool boundaries.
- Resulting stresses are combined with others per required load combinations to meet design code acceptance criteria.

Sloshing Sensitivity Evaluation

- An assessment was completed to determine whether sloshing could cause a local variation in the Reactor Building structure frequency
- Conservatively excluding the sloshing mass resulted in a total mass reduction of 4% for the RB, and a frequency variation of $< 2\%$ at the pool elevation
- This is well within the $\pm 15\%$ broadening range for design floor response spectra

Summary of Reactor Building Dynamic Analysis

- For the PCCS/ICS pools, the building dynamic analysis included the pool water but no internal structures
- The reactor building seismic model included all pool water mass as impulsive (rigid)
- A separate sloshing sensitivity evaluation concluded that any local building frequency shift would be insignificant
- A separate analysis has been performed, using standard equations, to calculate sloshing pressure loads on the pool wall structures

PCCS Condenser Structural Analysis Methods

- A Finite Element Model (FEM) was prepared for the condenser and support structure
 - FEM included hydrodynamic mass to account for the displaced water mass of the Condenser
 - The analytical process of adding displaced water mass to the structure conservatively accounts for all the hydraulic effects including sloshing [7,390 kg (16,295 lbs) of external water mass was added to the FEM = 48% mass increase]
 - The Condenser steel mass is 12,510 kg (27,585 lbs) and the internal water mass is 2,779 kg (6,128 lbs)
- No credit was taken for the damping effects of the water in the model
- The pool floor response spectra from the reactor building dynamic analysis were used to input the dynamic effects into the base of the condenser and support structure FEM

Results of PCCS Condenser Structural Design Report

- First mode natural frequency was 14.7 Hz
- Limiting Service Level C/D Stress Results (MPa)

	Calculated Stress	Allowable Stress	Margin %
- Headers	47.8	137.9	65
- Tubes	66.4	180.7	63
- Connecting Pipes	112.9	180.7	38
- Head Cover	92.0	180.7	49
- Head Bolts	70.3	220.2	68

Large Structural Margins Exist

Reactor Building IC/PCCS Pool Wall Sloshing Pressure Results

<u>Distance below water</u>	<u>Sloshing Force</u>	<u>Sloshing Force</u>
meters	kN/m ²	psi
0	9.56	1.39
0.96	5.40	0.78
1.38	4.25	0.62
1.58	3.81	0.55
1.92	3.19	0.46
2.88	2.14	0.31
3.84	1.87	0.27

CL of IC Upper Header
CL of PCCS Upper Header

- Actual Sloshing Loads applied to the condensers will be less (water mass is decreased due to displaced mass from condenser, condenser dampens sloshing)
- Since dynamic loads are combined by SRSS (not phase coherent), any stress increase from sloshing becomes negligible

The effect of a sloshing load is very small compared to
Impulsive Water and Seismic Structural loads

IC Condenser Structural Analysis

- Analysis will be completed during the detail design of the plant
- The sizing of the condenser already considers the loads caused by normal operating conditions, and the design uses higher strength materials (Alloy 600) for the Condenser
- Dynamic loads can be readily taken care of by the support structure that is expected to be similar to the PCCS support structure
- Sloshing loads on the IC Condenser that are very close to the PCCS Condenser loads are considered negligible
- The ICS Condenser will be analyzed using the same conservative analytical methods as the PCCS Condenser
- No problems are anticipated with the ICS Condenser based on the large structural margins of the PCCS Condenser

Conclusions

- The effect of water sloshing in the PCCS and ICS Condensers have been considered, but are not separately analyzed due to the conservative hydrodynamic analytical methods that are used
- The effects of sloshing are expected to be very small compared to other dynamic loads and the support structure placement is ideally located to react such loads
- Based on the large structural margins calculated for the PCCS Condenser, there will be no problems in completing the IC Condenser design analysis



Presentation to the ACRS Subcommittee

ESBWR Design Certification Review

Topic of Interest:

Seismic Design of PCCS and ICS RH (impact of sloshing water)

October 20, 2009

**ACRS Subcommittee Presentation
ESBWR Design Certification Review
Topic of Interest
Seismic Design of PCCS and ICS RH (impact
of sloshing water)**

Review Team

- Lead PM
 - Amy Cubbage
- Lead Technical Reviewers
 - Tuan Le (SRP 3.9.3)
 - David Jeng (SRP 3.7.2)

RAI Issued

RAI 3.9-247: Staff requested GEH to demonstrate how dynamic forces from seismic events are treated in the analysis of heat exchangers immersed in elevated water pools.

RAI Status

- RAI response in GEH letter MFN 08-743 (ML0821406820)
- RAI was closed in October 2008

RAI Response Review Results

- GEH'S RESPONSE OF THE RAI IS SATISFACTORY.
- PCCS SUBMERGED HEAT EXCHANGER SUPPORT DESIGN AND SEISMIC ANALYSIS IS COMPLETED.
- ICS SUBMERGED HEAT EXCHANGER DESIGN IS NOT COMPLETED.
- DCD CHANGE TO DESCRIBE THE METHODOLOGY OF SEISMIC ANALYSIS WITH SLOSHING EFFECT ON ICS AND PCCS HEAT EXCHANGER. ADD ITAAC TO CONFIRM THE ICS AND PCCS HEAT EXCHANGER SUPPORT DESIGN.

**ACRS Subcommittee Presentation
ESBWR Design Certification Review
Topic of Interest
Seismic Design of PCCS and ICS RH (impact of
sloshing water)**

Discussion/Committee Questions