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COMMITTEE ON REACTOR SAFEGUARDS

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Official Transcript of Proceedings

NUCLEAR REGULATORY COMMISSION

Title: Advisory Committee on Reactor Safeguards
 ESBWR Subcommittee: OPEN SESSION

Docket Number: (n/a)

Location: Rockville, Maryland

Date: Wednesday, October 21, 2009

Work Order No.: NRC-3161

Pages 1-137

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UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

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ADVISORY COMMITTEE ON REACTOR SAFEGUARD
(ACRS)

+ + + + +

SUBCOMMITTEE ON ESBWR

+ + + + +

OPEN SESSION

+ + + + +

WEDNESDAY

OCTOBER 21, 2009

+ + + + +

ROCKVILLE, MARYLAND

+ + + + +

The Subcommittee convened at the Nuclear
Regulatory Commission, Two White Flint North, Room
T2B3, 11545 Rockville Pike, at 8:30 a.m., Dr. Michael
Corradini, Chairman, presiding.

SUBCOMMITTEE MEMBERS PRESENT:

MICHAEL CORRADINI, Chairman

SAID ABDEL-KHALIK, Member

J. SAM ARMIJO, Member

SANJOY BANERJEE, Member

WILLIAM J. SHACK, Member

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CONSULTANTS TO THE SUBCOMMITTEE:

THOMAS S. KRESS

GRAHAM B. WALLIS

NRC STAFF PRESENT:

CHRISTOPHER BROWN, Cognizant Staff Engineer

KATHY D. WEAVER, Cognizant Staff Engineer

AMY CUBBAGE

BRUCE BAVOL

TOM SCARBROUGH

GEORGE THOMAS

JOE DONOGHUE

ALSO PRESENT:

JESUS DIAZ-QUIROZ

WAYNE MARQUINO

RICK WACHOWIAK

JERRY DEEVER

MD ALAMGIR (via telephone)

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

8:45 a.m.

CHAIR CORRADINI: (presiding) Okay.

Let's come into session.

I will not read the whole thing. Let's just come to order.

This is a meeting of the Advisory Committee on Reactor Safeguards, the ESBWR Subcommittee. We are in our second day of meetings.

My name is Mike Corradini, Chair of the Subcommittee.

We think we have the current members in attendance. We know we have Said Abdel-Khalik, Sam Armijo, Bill Shack, maybe Sanjoy Banerjee, and our consultants Tom Kress and Graham Wallis.

I will just remind everybody the purpose of the meeting is to review resolution of certain issues related to reactor systems, mechanical systems, and INC for the ESBWR design certification.

We are in the middle of hearing presentations and holding discussions with representatives of the staff and GEH regarding these matters.

Christopher Brown and Kathy Weaver of the

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1 ACRS staff are the Designated Federal Officials for
2 this meeting.

3 Let me just remind everybody the rules of
4 participation have been published in The Federal
5 Register. A transcript is being kept and will be made
6 available, as stated in the Register.

7 It is requested that speakers first
8 identify themselves and speak with sufficient clarity
9 and volume so they can be readily heard.

10 Please turn off your cell phones or put
11 them in the vibrate mode.

12 We have not received any requests from
13 members of the public to make oral statements.

14 Just, again, to remind everybody, probably
15 the most important thing, we are going to start off in
16 open session, then we are going to go into break, and
17 we will go into closed session and throw out all the
18 observers that aren't staff or GEH, and primarily
19 because this information is protected as proprietary
20 by GEH pursuant to 5 USC or security-related
21 information.

22 Should I turn to Amy? Do you want to kick
23 us off, Amy, about what we are planning to hear today?

24 MS. CUBBAGE: Great. This Amy Cubbage on
25 the staff, the Project Manager on the ESBWR.

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1 You are going to hear about a variety of
2 topics today, mostly related to the reactor systems
3 area. You are going to hear from GE Hitachi and also
4 staff from NRO, NRR, and our Office of Research, who
5 have been providing outstanding support during this
6 review.

7 I am just going to run through the agenda
8 very quickly to give you some background on why we are
9 going to be discussing these topics.

10 The first two issues, open issues,
11 regarding non-condensable gas in the GDCS line and the
12 design of GDCS check valves were issues that were
13 identified by the ACRS as topics of interest during
14 the SER with open items discussions. So we wanted to
15 brief the Committee on the RAIs that resulted and the
16 resolution of those issues.

17 The next item, TRACE confirmatory
18 calculations on anticipated operational occurrences.
19 That was an item that we were not prepared to discuss
20 when we met about a year and a half ago. Those
21 calculations are available now for presentation.

22 The next topic, on the initial core
23 design, that is a topical report review that we have
24 completed our safety evaluation report, and it was
25 provided to the Committee.

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1 The next item, CPR correlation
2 applicability. That item was partially briefed during
3 the SER with open items phase, but additional
4 information came in about the time of that meeting,
5 providing additional information where GE did testing
6 on the GE14E fuel, and we will hear about that today.

7 Feedwater temperature operating domain,
8 when we last met on that topic, GE had just recently
9 or was about to submit that topical report. They gave
10 you a preview. At this time, the staff has completed
11 its review and there are no open items. So we are
12 going to discuss our review of that topical report.

13 And lastly, stability and chimney open
14 items. Those were issues that were of ACRS interest
15 at the SER with open items phase. We are going to
16 discuss the resolution of those issues.

17 There are no open issues remaining for any
18 other topics that we are going to discuss today.

19 So, with that, I would like to turn it
20 over to -- Wayne, who is starting?

21 CHAIR CORRADINI: Is Wayne going to start?

22 MR. MARQUINO: I am going to start.

23 CHAIR CORRADINI: So, just to remind the
24 members, there's a little bit of a difference. In the
25 agenda it shows that we are going to talk about non-

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1 condensable gases and then check valve. As I
2 understand it, GEH is going to discuss both first, and
3 then we will turn to the staff to have that
4 discussion.

5 So, Jesus, do you want to start it off,
6 please?

7 MR. DIAZ-QUIROZ: Sure. Good morning.

8 My name is Jesus Diaz-Quiroz. I am with
9 GEH.

10 This morning I will be covering the topic
11 of non-condensable gases in the GDCS line and,
12 thereafter, the check valve itself and its branch
13 lines.

14 Final items pertaining to this particular
15 topic, GEH has responded to RAI 21.6-12, which was on
16 the presentation agenda here. I will be covering GDCS
17 operation during LOCA, GDCS injection, line
18 integration, in-service testing of GDCS injection
19 lines, sources of non-condensable gases in those lines
20 and, actually, the calculations for GDCS flow. I will
21 summarize at the end there.

22 Just looking at how the GDCS operates, of
23 course, a LOCA would ensue. Eventually, level 1 is
24 reached. After level is reached, there is a confirmed
25 level 1, where ADS and GDCS/SLC timers are started.

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1 Fifty seconds later, DPV actuation occurs. So, at
2 that point, the reactor pressure vessel begins to
3 depressurize. About a hundred seconds later, you have
4 that GDCS squib valves are actuated.

5 Of course, at this time, the reactor
6 pressure vessel is higher than the GDCS injection
7 pressure. So then you have a reverse flow in the
8 line, in each branch line. The GDCS check valves
9 close. Then, thereafter, pressure --

10 CONSULTANT WALLIS: I take it they were
11 open before?

12 MR. DIAZ-QUIROZ: Yes, they were open
13 before, right.

14 CONSULTANT WALLIS: Do they dangle or
15 something? Do they dangle? Gravity holds them open?

16 MR. DIAZ-QUIROZ: No. No, these
17 particular valves won't dangle. They are not swing-
18 type check valves.

19 CONSULTANT WALLIS: Okay.

20 MR. DIAZ-QUIROZ: That's not what we are
21 looking at.

22 MR. WACHOWIAK: We will cover that in
23 about 40 minutes.

24 CONSULTANT WALLIS: Okay.

25 MR. DIAZ-QUIROZ: Okay.

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1 CHAIR CORRADINI: Thank you. Go ahead.

2 MR. DIAZ-QUIROZ: All right. So, as the
3 reactor pressure continues to depressurize, the
4 pressure in the vessel drops below the injection
5 pressure, and then the check valves open, and then, at
6 that point, of course, GDCS flow begins. It gradually
7 increases to its maximum. Of course, it's tank
8 draining. The rate of flow will drop off as the level
9 drops.

10 During this time, of course, you have that
11 reactor pressure vessel communicates with the drywell
12 because of the DPVs being open. They are permanently
13 open. Once they are open, they cannot be closed.
14 Depending on where the break is at, if it is above the
15 waterline, of course, that as well will communicate
16 with the drywell.

17 At the same time, the GDCS pool airspace
18 communicates with that same volume, the drywell
19 volume, because there's a gap between the GDCS pool
20 wall, the top of the pool wall, and the top of the
21 drywall slope. So we have this communication that
22 occurs for the same volume.

23 Just shown here, a 3D depiction of one
24 GDCS injection line. If you look at the left side
25 slide there, you see --

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1 CONSULTANT WALLIS: So these are
2 connected, but the DPVs are open. There is still a
3 pressure drop across the DPVs?

4 MR. DIAZ-QUIROZ: Right.

5 CONSULTANT WALLIS: It is pressurizing the
6 RPV side?

7 MR. DIAZ-QUIROZ: Right. The DPVs are
8 open. So what ends up happening is, of course, you
9 are dumping into the drywell; you are pressurizing the
10 drywell. So the GDCS pool itself communicates with
11 the --

12 CONSULTANT WALLIS: But you do provide a
13 resistance to the draining of the tank, but it's
14 small?

15 MR. DIAZ-QUIROZ: Right. Right. And that
16 is why the vessel continues to depressurize. At some
17 point, the injection pressure exceeds the reactor
18 pressure.

19 So, again, looking at the left side, you
20 have one GDCS injection line only shown here. You see
21 where you have the 5.9 meter. You see the GDCS pool
22 inlet there on the left side.

23 MEMBER SHACK: Can you use the mouse?

24 MR. DIAZ-QUIROZ: I'm sorry?

25 MEMBER SHACK: Use the mouse?

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1 MR. DIAZ-QUIROZ: Okay. All right. Thank
2 you. I will just point to the GDCS pool inlet.

3 That is where that inlet is in the pool
4 itself, and then you have that 5.9 meters. Above that
5 is the minimum water level for the pool. Then that
6 line runs down, and that's an NH nominal line. It
7 runs down, branches off in this case here, and then
8 you go from 8- to 6-inch reducers for each branch
9 line. Then you have a check valve, here shown in
10 vertical orientation.

11 Then the next valve, the next valve there,
12 the squib valve and then the maintenance. Then, of
13 course, it rises up, and then turns around to go back
14 into the vessel through the nozzle.

15 CHAIR CORRADINI: You guys once gave us an
16 isometric. Just a quick reminder, there's about 6
17 meters from the minimum water level to the first
18 quasi-horizontal run. Then the H, the height from
19 there down to the branch is what, another 10 meters?

20 MR. DIAZ-QUIROZ: Yes. What happens is,
21 from the top of that inlet to the nozzle itself, if
22 you go down to the side elevations here on the
23 slides --

24 CHAIR CORRADINI: Oh, okay, never mind.
25 If it's there already --

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1 MR. DIAZ-QUIROZ: Okay. All right. Well,
2 we'll discuss it.

3 CHAIR CORRADINI: That's fine. Thank you.

4 CONSULTANT WALLIS: We will get to the
5 system in the next couple of slides?

6 MR. DIAZ-QUIROZ: Right.

7 So there you have pretty much what you
8 call, some people would call the U-shape, but you have
9 the highest point being the nozzle on one end,
10 downstream, the squib valve, which is normally closed.

11 Then you have the pool inlet, which is the highest
12 point upstream of the squib valve.

13 MEMBER BANERJEE: But the check valve, of
14 course, only works if you've got flow going from the
15 GDSCS to the vessel.

16 MR. DIAZ-QUIROZ: The check valve, right,
17 it is normally in an open position.

18 MEMBER BANERJEE: It's normally in an open
19 position?

20 MR. DIAZ-QUIROZ: Right, right. So, when
21 it closes, when you have the RPV pressure is greater
22 than the injection level pressure, that is when you
23 have that quick impulse to close. That protects
24 the upstream --

25 MEMBER BANERJEE: So it prevents backflow?

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1 MR. DIAZ-QUIROZ: Yes, it does.

2 MEMBER BANERJEE: But it is normally open?

3 MR. DIAZ-QUIROZ: Normally open, yes.

4 That is the requirement.

5 MEMBER BANERJEE: It closes if there was a
6 flow backward?

7 MR. DIAZ-QUIROZ: Yes.

8 CHAIR CORRADINI: Any pressurization.

9 MR. DIAZ-QUIROZ: Any pressurization,
10 right, flow, right.

11 CHAIR CORRADINI: You may not have been in
12 the room. They are going to get the check valve
13 design in the next set of presentations, the next set.

14 MEMBER BANERJEE: But it impacts this
15 presentation.

16 CHAIR CORRADINI: Correct.

17 MR. DIAZ-QUIROZ: Right.

18 CHAIR CORRADINI: But I will limit your
19 questions about geometry.

20 MEMBER BANERJEE: But not about flow?

21 CHAIR CORRADINI: No.

22 MR. DIAZ-QUIROZ: Okay. Again, the two
23 highest points being, downstream of the squib valve,
24 the nozzles; upstream of the squib valve, the pool
25 inlet side.

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1 MR. WACHOWIAK: And the lowest point --

2 MR. DIAZ-QUIROZ: The lowest point being
3 the GDCS squib valve, which is normally closed, and,
4 of course, you have sloping up toward each of those
5 high points away from that squib valve.

6 MEMBER BANERJEE: That block valve is
7 normally closed, right?

8 MR. DIAZ-QUIROZ: That block valve, no, is
9 not normally closed, although there are maintenance
10 valves that will be used to flush the lines and do
11 repairs on those valves, on the squib valves and the
12 check valves.

13 MEMBER BANERJEE: The block valve is
14 normally open?

15 MR. DIAZ-QUIROZ: Our block valves are
16 normally open, and these lines are locked open during
17 standby mode, of course. Otherwise, there's no way to
18 actuate them. So they are normally open.

19 Again, I will just quickly go through the
20 piping here.

21 MEMBER ABDEL-KHALIK: Is there an
22 indication in the control room of the status of that
23 block valve?

24 MR. DIAZ-QUIROZ: Yes. Every one of those
25 valves on that line has status indication, in addition

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1 to the squib valve and the check valve itself.

2 Just to quickly go over the GDCS injection
3 line, the piping, there's four 8-inch injection lines.

4 Each of those, the 8-inch lines are about 18 meters
5 long, which then drop. So you have this run of 8-
6 inch, then it drops down, branches off into two 6-inch
7 branch lines. Then, of course, I just went over the
8 components in those branch lines. Check valve, squib
9 valve, lowest point, maintenance valve, and then it
10 rises up again to go to the nozzle.

11 Then, sloping of those horizontal lines,
12 of course, as I mentioned, it is toward each of the
13 high points, away from the squib valve. So you have
14 venting to either side.

15 MEMBER BANERJEE: Can you go back to the
16 figure and show the sloping?

17 MR. DIAZ-QUIROZ: Yes.

18 CHAIR CORRADINI: I don't think it shows
19 it, Sanjoy, the way you want it. We an isometric in
20 our package.

21 MEMBER BANERJEE: I have the isometric,
22 but it is still not clear to me how it slopes.

23 MR. DIAZ-QUIROZ: Right, just go ahead to
24 that slide.

25 So, here, of course, since this is a

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1 depiction, a 3D depiction, it is difficult to show
2 sloping, but the triangles here show the way. There's
3 the squib valve. Sloping is away from the squib
4 valve. So it is up. Of course, the vertical run, and
5 then, since this is downstream of the squib valve, you
6 have sloping up toward the nozzle.

7 Then, if you go back again to the squib
8 valve, away from the squib valve, upstream, sloping up
9 toward that vertical run, the check valves then; of
10 course, vertical run, sloping up toward the main
11 injection line, 8-inch line. Then it is vertical,
12 sloped up toward -- vertical, and then this long run,
13 of course, is sloped up toward the pool itself.

14 MEMBER BANERJEE: Is there an indication
15 whether the check valve is open or closed?

16 MR. DIAZ-QUIROZ: Yes, there is. There's
17 a position indication that is required for that check
18 valve to show open or closed.

19 CHAIR CORRADINI: And even though we are
20 getting into your next presentation, have you guys yet
21 determined the detail as to at what point it says open
22 versus percent open? Do you know what I am asking?

23 MR. DIAZ-QUIROZ: Right.

24 CHAIR CORRADINI: Is that still in design.

25 MR. DIAZ-QUIROZ: Well, it depends on the

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1 flow coefficient that we are going to use, but,
2 really, we are looking at -- we have talked to several
3 vendors, and one valve candidate is a nozzle-type
4 check valve where the disc itself would actually fully
5 seat. So that would be full open.

6 CHAIR CORRADINI: Okay. All right. Thank
7 you.

8 MR. DIAZ-QUIROZ: So, in-service testing
9 of the --

10 MEMBER BANERJEE: So, in summary,
11 everything is open except the squib valve?

12 MR. DIAZ-QUIROZ: Right. There is only
13 one valve that is closed, right. You're right. The
14 squib valve, of course, which you might call a
15 hermetically-sealed valve, which is a cap that is
16 basically sheared by the squibs themselves, the
17 booster charge.

18 CHAIR CORRADINI: Okay, thank you.

19 MEMBER BANERJEE: Are there any vents in
20 the line?

21 MR. DIAZ-QUIROZ: Vents? No. No, there
22 are no vents in the line. The configuration itself
23 provides the venting.

24 MR. MARQUINO: It depends on how you want
25 to look at it. I would say there are two high-point

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1 vents in the line that are always open.

2 MR. DIAZ-QUIROZ: Right.

3 MR. MARQUINO: One is the pipe connection
4 to the GDCS pool, and the other is the pipe connection
5 to the vessel.

6 MR. DIAZ-QUIROZ: So, within the line
7 itself, the high points do not exist other than what
8 you see. Because, due to the sloping, you do get the
9 high points at the nozzle end and the pool --

10 MEMBER BANERJEE: What is the slope?

11 MR. DIAZ-QUIROZ: The slope? Well, I
12 mean, you are looking at anywhere from one-third, 100
13 millimeters to 300 millimeters, or so.

14 Of course, there is an ITAAC --

15 MEMBER BANERJEE: What is the angle,
16 roughly?

17 MR. DIAZ-QUIROZ: The angle? Sorry, I
18 don't have that quickly.

19 MEMBER BANERJEE: Give me the height over
20 the length.

21 MR. DIAZ-QUIROZ: Right. The height being
22 100 millimeters over 300 millimeters, so one over
23 three.

24 CHAIR CORRADINI: Twenty-five degrees.

25 MR. DIAZ-QUIROZ: Right. So, at that

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1 point, that's something --

2 MEMBER BANERJEE: That is a pretty big
3 slope here.

4 MR. DIAZ-QUIROZ: Right, it is a big
5 slope.

6 MEMBER BANERJEE: A hundred millimeters
7 over 300?

8 CHAIR CORRADINI: Is it a quarter inch
9 over --

10 CONSULTANT WALLIS: That doesn't sound
11 right.

12 MR. DIAZ-QUIROZ: Four inches over 12
13 inches. So the same number. It is a large number
14 and, of course --

15 MEMBER BANERJEE: It is like that.

16 MR. DIAZ-QUIROZ: Right.

17 CONSULTANT WALLIS: It doesn't show that
18 in the figure. I don't think that is correct.

19 MR. DIAZ-QUIROZ: No. No, it doesn't.
20 The figure doesn't show it.

21 There is an ITAAC requirement that the
22 lines --

23 CHAIR CORRADINI: So 19.5 degrees.

24 MR. DIAZ-QUIROZ: Okay. All right.

25 CHAIR CORRADINI: Approximately.

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1 MR. DIAZ-QUIROZ: That is something that
2 has been discussed, the isometric. The final routing
3 has not been done. There is an ITAAC for this final
4 routing to self-vent. So that sloping will have to be
5 revisited at that time as well.

6 MEMBER BANERJEE: So the squib valve is
7 like that.

8 MR. DIAZ-QUIROZ: Well, if you want to
9 make sure that the squib valve operates correctly, you
10 don't want to make a "V" shape like you said.

11 MEMBER BANERJEE: Right. Let's say around
12 the squib valve, how is it sloped?

13 MR. DIAZ-QUIROZ: I threw out a number, is
14 basically what I did. The final sloping will be
15 dictated by the final routing and how much room is
16 left between the annulus and the reactor pressure
17 vessel, and how much is required for thermal
18 expansion.

19 So the ITAAC that I mentioned will require
20 self-venting. But, yes, if a lesser slope can be
21 done, well, then that is what we will be using.

22 MEMBER BANERJEE: Let's go to that figure
23 there.

24 MR. DIAZ-QUIROZ: This one?

25 MEMBER BANERJEE: Yes. The one that

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1 you --

2 MR. DIAZ-QUIROZ: Okay.

3 MEMBER BANERJEE: Between the squib valve
4 and the elbow, what is the length there?

5 MR. DIAZ-QUIROZ: The squib valve and this
6 elbow?

7 MEMBER BANERJEE: Yes.

8 MR. DIAZ-QUIROZ: The rough length here?
9 You're looking at about a meter between the squib
10 valve and that elbow, and on the other side of it, it
11 is about 1.2 meters.

12 MEMBER BANERJEE: Okay. And the
13 difference in the elevation between the squib valve
14 and the elbow is how much?

15 MR. DIAZ-QUIROZ: It is about here to
16 here.

17 MEMBER BANERJEE: The difference in
18 elevation between the elbow and --

19 CHAIR CORRADINI: Well, if it is 3-to-1,
20 if they can actually realize 3-to-1, you could just do
21 it.

22 MEMBER BANERJEE: So that would be 30
23 centimeters?

24 CHAIR CORRADINI: Yes, yes.

25 MEMBER BANERJEE: And 30 centimeters on

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1 the other side? So the squib valve is in a "V"?

2 MR. DIAZ-QUIROZ: It could be. It could
3 be in a V-shape, but, of course, that is extreme.
4 Again, if the lesser slope can self-vent, as the ITAAC
5 requires --

6 MEMBER BANERJEE: How do you determine
7 what can self-vent or not? Are you going to do some
8 experiments?

9 MR. DIAZ-QUIROZ: Experiments? Well, I
10 mean, do you have --

11 MEMBER BANERJEE: What is the difference
12 between 30 and 15 or between 15 and 10 and between 10
13 and 5?

14 CONSULTANT WALLIS: Or zero. Zero self-
15 vents pretty well.

16 MEMBER BANERJEE: Zero?

17 MR. DIAZ-QUIROZ: Right. This is just to
18 assure that's --

19 MR. MARQUINO: This is not different from
20 other process plants. So we have applied line slope
21 requirements on other BWRs and will apply similar line
22 slope requirements in --

23 CONSULTANT WALLIS: This slope requirement
24 seems absolutely extreme.

25 MR. DIAZ-QUIROZ: Right, it is extreme.

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1 That would be the maximum.

2 CONSULTANT WALLIS: If it is so big, you
3 should really show it on the figure, because it is
4 misleading to show it --

5 MR. DIAZ-QUIROZ: Right.

6 CONSULTANT WALLIS: It's such an extreme
7 slope.

8 MR. DIAZ-QUIROZ: True.

9 MEMBER BANERJEE: Then we have a different
10 set of problems. The squib valve is down in the
11 trough. Then, depending on what happens, you've got
12 a trough there, which is sort of a crude place to trap
13 gas if it gets in there.

14 CHAIR CORRADINI: Again? I'm sorry?

15 MEMBER BANERJEE: Well, it is always nice
16 to have -- if you have a flow and you get some gas by
17 some means in a trough, it gets trapped in the trough.

18 CHAIR CORRADINI: Right.

19 CONSULTANT WALLIS: That gets trapped in
20 the trough.

21 MEMBER BANERJEE: Yes. It is like a
22 little loop seal.

23 Anyway, carry on.

24 At least we've got an idea roughly. That
25 is an extreme slope.

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1 MR. DIAZ-QUIROZ: Right.

2 MEMBER BANERJEE: I thought it was like 1
3 degree or so.

4 MR. DIAZ-QUIROZ: Right, right. It's an
5 extreme slope, and that would be in the extreme case.

6 CONSULTANT WALLIS: Apart from that, the
7 only way you can non-condensables stuck in this thing
8 is for the upper block valve to be closed, so they
9 don't vent to the pool.

10 MR. DIAZ-QUIROZ: Right.

11 CONSULTANT WALLIS: That's the only way.
12 That's the only thing you have to consider, it seems
13 to me. If someone did some maintenance and left that
14 block valve closed, the squib valve pops, and the
15 operator says, "Gee whiz, I've got no flow. Ah, the
16 block valve was closed." It's just like TMI when they
17 opened.

18 MR. DIAZ-QUIROZ: Right.

19 MEMBER BANERJEE: And then what happens?

20 CONSULTANT WALLIS: Then it goes, "Ump,
21 ump, ump, ump," and the various things happen.

22 MR. MARQUINO: Okay, but the block valve
23 is inside containment. It is not accessible in a
24 LOCA. That is why we have procedural requirements to
25 make sure the block valves are open, to make the

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1 ECCS --

2 CONSULTANT WALLIS: But I'm just saying,
3 the only way you could get non-condensables in there
4 is for this happen.

5 MR. MARQUINO: Yes, we agree. Okay.

6 CHAIR CORRADINI: So just one other
7 clarification, since I have stuff written down, but I
8 don't have it with me. So I need one of the eight --
9 is it one of the eight lines or two of the eights to
10 provide the appropriate flow for makeup?

11 MR. DIAZ-QUIROZ: Well, if you track --
12 two sensitivities have been conducted to show that,
13 once some of the flow, if you really lined that up,
14 it would be, of course, one line, one branch line.

15 CHAIR CORRADINI: But I just want to make
16 sure, from a success criteria approach, what is the
17 minimum that I need to --

18 MR. MARQUINO: We have slides on that.

19 CHAIR CORRADINI: Later?

20 MR. MARQUINO: Later, from a success
21 criteria approach.

22 CHAIR CORRADINI: But just remind me,
23 what's the answer right now?

24 MR. MARQUINO: Well, in licensing basis
25 space, we assume one valve fails as part of the

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1 single-failure criteria. Actually, we only need one-
2 seventh of the flow to make up for decay heat at the
3 time the system injects. So we feel we have a robust
4 design here.

5 CHAIR CORRADINI: No, I'm not trying to
6 judge. I just wanted to remember the number. So it
7 is one-seventh?

8 MR. MARQUINO: Yes.

9 CHAIR CORRADINI: Okay. Thank you.

10 MR. MARQUINO: Right.

11 MEMBER BANERJEE: You have how many GDSC
12 lines which get split in two?

13 MR. DIAZ-QUIROZ: There's a total of four
14 that get split into two. So you have the total of
15 eight branch lines, so eight nozzles.

16 CONSULTANT WALLIS: From three pools?

17 MR. DIAZ-QUIROZ: From three pools, right.
18 So there are two lines share one of the larger pools,
19 yes.

20 MEMBER BANERJEE: And the block valve is
21 located after the split or before the split?

22 MR. DIAZ-QUIROZ: There is a block valve
23 after the split. There is a block valve here, not
24 shown, upstream of the check valve.

25 MR. WACHOWIAK: It is shown.

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1 MR. DIAZ-QUIROZ: It's shown? Okay.

2 MEMBER BANERJEE: Ah, okay, so there is a
3 valve before --

4 MR. DIAZ-QUIROZ: Right, right. For
5 isolation, maintenance.

6 MR. WACHOWIAK: In the PRA, we looked at
7 the inadvertent closure of these valves, not
8 inadvertent closure, but remaining closed following an
9 outage, and identified that it is requiring the
10 indication in the control room, and also something
11 that is required to be addressed by the HFE program as
12 an insight for the plants. So it is important that
13 these valves are open.

14 MEMBER BANERJEE: And there is a position
15 indicator, actually?

16 MR. DIAZ-QUIROZ: Right, if they are
17 blocked.

18 MR. WACHOWIAK: At this point in time,
19 it's specified as position indication. When the HFE
20 program goes through all of the machinations that they
21 have to go through, we will decide whether a stem
22 indication is sufficient or some other indication may
23 be needed on top of that. But that is a part of the
24 HFE program where we decide, the Human Factors
25 Engineering Program.

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1 MR. DIAZ-QUIROZ: Next slide.

2 In-service testing program is required by
3 technical specifications. There you have that, during
4 every refueling outage, you would flush lines and you
5 would test the check valve itself for open and closed.

6 CHAIR CORRADINI: And then, just since I
7 guess I want to get to the checking part of this, so
8 when you do the flushing, once again, from the venting
9 standpoint, the way Wayne described it, you are
10 essentially going to then use, if you were to do
11 maintenance on this line and reopen the line, you
12 would expect to essentially then have the venting
13 through backup, through the GDCS pool?

14 MR. DIAZ-QUIROZ: Right. That would
15 occur, and, in addition, you would have flushing. Of
16 course, the connections are at the low point.
17 Flush --

18 CHAIR CORRADINI: Right.

19 MR. DIAZ-QUIROZ: So any gas would rise,
20 you're right, to the high points that would exist,
21 which is the pool and the nozzles. The flushing, of
22 course, to assure that nothing is in the lines
23 themselves as well.

24 CHAIR CORRADINI: Thank you.

25 MEMBER ABDEL-KHALIK: Now the squibs would

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1 not be fired?

2 MR. DIAZ-QUIROZ: No, the squibs have a
3 different testing criteria where every refueling
4 outage, a certain percentage of them are pulled out,
5 and they are fired, of course, offline. Then, based
6 on that, of course, you develop an experience, and
7 then maybe change that percentage.

8 CONSULTANT WALLIS: Now the squibs are
9 fired by an explosion, which makes gas.

10 MR. DIAZ-QUIROZ: Right.

11 CONSULTANT WALLIS: And if something went
12 wrong with the squib valve, you could get gas from the
13 explosion injection. It seems very far-fetched, but
14 that is a source of gas.

15 MR. DIAZ-QUIROZ: Right, it could be a
16 source of -- what happens is you have a piston; you
17 would have a piston that would, the gas expansion
18 would propel that to shear the cab.

19 MR. MARQUINO: The explosive chamber is
20 separated from the primary system.

21 CONSULTANT WALLIS: There is no path to
22 it.

23 MR. MARQUINO: There's no path to it. If
24 a path opened up, you would have, basically, a second
25 LOCA with water draining out of that point. So that

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1 is not --

2 CONSULTANT WALLIS: But assuming that the
3 thing is sealed and the explosion happens, and for
4 some reason there's a leak into the --

5 CHAIR CORRADINI: But I think his point
6 is, Graham, though, there are two separate systems.
7 To have what you want, you would create a LOCA. I
8 think that is what Wayne's --

9 MR. MARQUINO: It is a bad thing to
10 happen, but it is not --

11 CONSULTANT WALLIS: It wouldn't create a
12 LOCA. It wouldn't create a LOCA because it still
13 enclosed in the piston. It is just it leaks into the
14 valve.

15 MR. DIAZ-QUIROZ: The pressure
16 requirements, the class requirements, the boundary --

17 CONSULTANT WALLIS: We would have to look
18 at the details of the valve.

19 MEMBER BANERJEE: But maybe when you show
20 us the valve details, you can show us a sketch of
21 this.

22 MR. DIAZ-QUIROZ: Right. Well, here I
23 won't be covering the squib valve, but I could
24 probably --

25 CHAIR CORRADINI: Well, let's just hold it

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1 until we get to the check valve.

2 MR. DIAZ-QUIROZ: Okay.

3 CHAIR CORRADINI: But I think we want to
4 clarify that because we went through that in one
5 January. I don't know which January. I thought we
6 were satisfied that they were separated such that, the
7 way you described it, at least at the time in my
8 mind, there was no chance of essentially passage
9 through, unless you then have reverse passage of water
10 back out.

11 Let's hold that until the check valve
12 discussion. Okay?

13 MEMBER ABDEL-KHALIK: So what kind of
14 debris, or whatever, you would expect to clear during
15 this flushing?

16 MR. DIAZ-QUIROZ: Well, it's to assure
17 flushing -- water will be in the line for a period of
18 two years. So you would want to at least cycle the
19 water. Of course, you wouldn't expect any debris
20 because in the pools themselves, they sit, the well
21 itself sits about 6 meters above the diaphragm floor.

22 There's plates that cover up, there's slosh guards
23 that cover up that gap. So you wouldn't expect
24 debris.

25 CONSULTANT WALLIS: The debris would come

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1 from some maintenance mistake.

2 MR. DIAZ-QUIROZ: Right.

3 CONSULTANT WALLIS: Someone left something
4 there.

5 MR. DIAZ-QUIROZ: Right.

6 MR. MARQUINO: So the flushing is
7 primarily to make sure that the line is full. It is
8 part of starting up after maintenance on this line to
9 make sure that it is full of liquid.

10 MR. DIAZ-QUIROZ: Right. Part of that
11 cycle of water.

12 MEMBER ARMIJO: You never flow water
13 through that whole line as long as you've got that
14 squib valve there.

15 MR. DIAZ-QUIROZ: Right. So the upstream
16 -- downstream of the squib valve itself, you have
17 another test connection that you would flush that
18 side, that segment of it. So you flush both sides.

19 CONSULTANT WALLIS: So there are other
20 ways that stuff can come in, through these other
21 connections?

22 MR. DIAZ-QUIROZ: Well, the connections
23 themselves, if the line is -- you could possibly pump
24 water in there, but you will have to test the check
25 valve itself. I will discuss that later. That will

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1 require pumping water into it.

2 MEMBER BANERJEE: Are there sort of little
3 stand pipes with valves for flushing?

4 MR. DIAZ-QUIROZ: If you are looking for a
5 high point, the high point wouldn't exist because you
6 would have to either put it on the side or on the
7 bottom of the pipe.

8 MR. MARQUINO: But the low point --

9 MR. DIAZ-QUIROZ: But the low point is
10 still the squib valve.

11 MR. MARQUINO: The low point drains, I
12 imagine, will be conventional drain points. I am not
13 even sure if they are temporarily connected to the
14 drain system or permanently connected to the drain
15 system.

16 MR. DIAZ-QUIROZ: They are not permanently
17 connected, no.

18 MEMBER ABDEL-KHALIK: Now here upstream
19 and downstream refers to --

20 MR. DIAZ-QUIROZ: The squib valve.

21 MEMBER ABDEL-KHALIK: Upstream is the --

22 MR. DIAZ-QUIROZ: Right, right.

23 MEMBER ABDEL-KHALIK: -- is the tank?

24 MR. DIAZ-QUIROZ: Is the tank, right, the
25 tank.

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1 MEMBER ABDEL-KHALIK: Downstream is the
2 vessel?

3 MR. DIAZ-QUIROZ: The vessel, the nozzle,
4 right, right.

5 MEMBER BANERJEE: So you have two stand
6 pipes of some sort facing downwards, let's say --

7 MR. DIAZ-QUIROZ: Okay.

8 MEMBER BANERJEE: -- which have their own
9 little valves on them.

10 MR. DIAZ-QUIROZ: Right.

11 MEMBER BANERJEE: These, let's say, are
12 facing downwards, which are used for flushing.

13 MR. DIAZ-QUIROZ: Right.

14 MEMBER BANERJEE: That is not shown in
15 the figure.

16 MR. DIAZ-QUIROZ: No, it's not. That
17 detail is not shown in the figure, you're right.

18 MEMBER BANERJEE: Are there any other
19 details we should know about, other than these --

20 MR. DIAZ-QUIROZ: Well, the final routing,
21 of course, is not completed. So, I mean, there's
22 plenty of detail to be had.

23 CHAIR CORRADINI: So I don't want to hold
24 you up. Did you have another question?

25 MEMBER BANERJEE: Yes, I do.

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1 CHAIR CORRADINI: Keep going.

2 MEMBER BANERJEE: Now, in existing BWR
3 lines, has there been gas found during normal
4 operation?

5 MR. DIAZ-QUIROZ: Well, there is operating
6 experience that has shown in some lines, the hydrogen
7 has been mentioned, I believe.

8 MEMBER BANERJEE: Right.

9 MR. DIAZ-QUIROZ: Right. And that was due
10 to sloping, inappropriate sloping on the high points
11 where you had venting at high points, yes.

12 MEMBER BANERJEE: However, there was gas
13 generation?

14 MR. MARQUINO: So one example, specific
15 example of that, is somehow after operating our plants
16 for 30 years, if there was an event that occurred
17 where during shutdown non-condensable gas that was in
18 solution in the instrument lines came out of solution
19 and lowered the liquid content in the instrument line,
20 and gave a false water level indication, so you will
21 see we get into that in one of the subsequent slides.

22 That would only expose the high-pressure and
23 potentially high-temperature portion of the line,
24 which is just the very last segment.

25 Between the bioshield and the vessel, you

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1 could have a high temperature and pressure. So that
2 little length might have dissolved gas that could come
3 out.

4 MEMBER BANERJEE: I am just trying to
5 think back because this is a generic issue, as you
6 know, that we are facing.

7 MR. DIAZ-QUIROZ: Right.

8 MEMBER BANERJEE: So I would like to know
9 how many BWRs have had experience with gas being in
10 the safety injection lines historically. Is it just
11 one? Is it ten? Is it -- how many?

12 MR. DIAZ-QUIROZ: I don't know that.

13 MEMBER BANERJEE: And how many times has
14 it been found and where? Because, I mean, this is an
15 issue which is facing us in the operating reactors
16 right now.

17 CHAIR CORRADINI: But your connection here
18 is, I mean, if I might just rephrase, you want to make
19 sure that they have taken lessons learned from those
20 operational experiences, right?

21 MEMBER BANERJEE: Right, lessons --

22 CHAIR CORRADINI: I don't know if they
23 will be able to answer all those questions that you
24 are asking.

25 MEMBER BANERJEE: Lessons learned, I don't

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1 know if it has progressed to that stage yet. I think
2 it is still an open issue, right?

3 MR. MARQUINO: Well, maybe the staff could
4 comment on that because I can't remember whether the
5 operating plant experience that triggered this was a
6 BWR, a PWR, or both, but we could do some research on
7 that and get back to you.

8 MEMBER BANERJEE: Okay. Yes.

9 MEMBER SHACK: But in an operating plant,
10 he can't reroute the pipe.

11 MEMBER BANERJEE: No.

12 MEMBER SHACK: He's got some options here
13 that he doesn't have in an operating plant.

14 MEMBER BANERJEE: Well, it is a question
15 of whether the experience from the operating plants --
16 because it is very hard to detect, and it is hard to
17 prevent as well.

18 So, if I remember, there was a lot of
19 discussion on problems associated with detection of
20 these sort of gas inclusions. So we need to
21 understand what the operating plant experience has
22 been, whether sloping has actually gotten rid of
23 things --

24 MR. DEAVER: Can I make a comment on that?

25 MEMBER BANERJEE: Yes.

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1 MR. DEEVER: This is Jerry Deaver with
2 GEH.

3 A comparable system in operating plants is
4 the core spray line. In the core spray line geometry,
5 where it comes in the vessel, we have piping inside
6 the vessel, and they have a quarter-inch vent line
7 right at the top of the header. So that is the
8 venting path in BWRs.

9 I have never heard of a problem in
10 operating BWRs in this system because of that vent
11 line or that vent hole that is in the piping. So it
12 is self-venting, too.

13 MEMBER BANERJEE: So, if there is gas in
14 the safety injection lines, where does it arise in the
15 BWRs? Where?

16 CHAIR CORRADINI: In the operating plants?

17 MEMBER BANERJEE: Yes.

18 CHAIR CORRADINI: I guess let's take that
19 as an action item. I thought Wayne's answer to you
20 about this was the only place, at least in the current
21 design, that they are concerned about this is, once
22 you get out of the squib, through the shield, into the
23 vessel, and that run a pipe where they could,
24 essentially, generate some hydrogen. And they are
25 going to consider that in the subsequent discussion.

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1 MR. WACHOWIAK: And we have a few slides
2 here that discuss our search for sources of non-
3 condensable gas.

4 CHAIR CORRADINI: So I guess I take it
5 that the staff has got to get back to you about some
6 of the operating experience when they come up.

7 Graham, did you have a question?

8 CONSULTANT WALLIS: Yes, I have a point
9 that occurs to me here.

10 The GDCS water is cold.

11 MR. DIAZ-QUIROZ: Right.

12 CONSULTANT WALLIS: And the water down
13 near the squib valve region there is probably pretty
14 warm. It has been sitting there kind of close to the
15 vessel.

16 MR. DIAZ-QUIROZ: It has been sitting
17 there. You have thermal conduction.

18 CONSULTANT WALLIS: So, over a period of
19 time, there is kind of occurring natural circulation
20 in the 8-inch pipe with cold water flowing down --

21 MR. DIAZ-QUIROZ: Right.

22 CONSULTANT WALLIS: -- and warm water
23 flowing up. And over a long period of time, because
24 there's dissolved gas in the cold water, there will be
25 some gas emitted from that cold water, but it will

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1 bubble all the way up to the block valves. So there
2 is something going on there. It's not as if nothing
3 is happening.

4 MR. DIAZ-QUIROZ: Right. Right. It's not
5 that nothing is happening, but, as you said, it will
6 bubble up, and you have this kind of warming --

7 CONSULTANT WALLIS: Probably there is some
8 thermal cycling rather than with any kind of gas.

9 MR. DIAZ-QUIROZ: Right.

10 CONSULTANT WALLIS: So that's just
11 something that you might consider. There is some
12 natural circulation up and down in that 8-inch pipe
13 all the time.

14 MR. DIAZ-QUIROZ: Right. Right. It's not
15 insulated, but exposed to the reactor --

16 CHAIR CORRADINI: I am sorry, Said, go
17 ahead.

18 MEMBER ABDEL-KHALIK: I was going to talk
19 about the in-service testing. Is there also a startup
20 test to go along with that would assure that the lines
21 are filled on day one?

22 MR. DIAZ-QUIROZ: On day one, well, there
23 is flow testing required for the lines themselves.
24 And, yes, the procedure, you will have to be able to
25 fill them. So the valve will be in place. You will

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1 use the drain points to drain, make sure they are
2 filled properly.

3 MEMBER ABDEL-KHALIK: So there is a
4 section in the startup testing program that deals with
5 this?

6 MR. WACHOWIAK: And to deal with the non-
7 condensable gases, there is an ITAAC that is going to
8 be required. We are going to need to demonstrate that
9 these lines do self-vent.

10 MEMBER ABDEL-KHALIK: Okay.

11 MR. WACHOWIAK: So we will write a
12 procedure that -- I don't know what it is right now,
13 but we will write a procedure that demonstrates that
14 the gas that gets into these lines will vent to the
15 different high points.

16 CONSULTANT WALLIS: You seem to be making
17 an awful lot of fuss about a trivial problem. I mean
18 gas does --

19 CHAIR CORRADINI: Could I get that in
20 writing?

21 (Laughter.)

22 CONSULTANT WALLIS: Well, I mean we
23 haven't got to the meat of this thing yet. We're
24 talking about whether stuff, gas slides up a slope. I
25 mean it is absurd to spend much time on that.

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1 CHAIR CORRADINI: Just so we have that, I
2 will roll back that discussion.

3 (Laughter.)

4 MR. DIAZ-QUIROZ: Sources of non-
5 condensable gases, as mentioned just now, you have
6 dissolved gas on both segments of the line toward the
7 GDCS pool, toward the nozzle. One is at a lower
8 pressure, basically, under the gravity head from the
9 pool down to the point of the GDCS injection valve.
10 Then the other is at reactor pressure during normal
11 operating pressure. These are standby modes for the
12 GDCS line.

13 There is a small segment. So we will
14 have, depending on the final sloping of that branch
15 line that leads into the nozzle, where the nozzle
16 itself is a flow restrictor which is 3 inches -- you
17 go from 6 inches to 3 inches -- where the sloping, you
18 will have this little pocket that will occur where you
19 could possibly accumulate some gases.

20 So, depending on the final sloping, again,
21 depending on the severity of the sloping, but you
22 could have just a possible little pocket there of gas
23 that could occur during standby mode.

24 MEMBER BANERJEE: The GDCS pool is how far
25 below the intake or the --

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1 MR. DIAZ-QUIROZ: The intake itself?

2 MEMBER BANERJEE: Yes.

3 MR. DIAZ-QUIROZ: So you are looking at
4 5.9 meters. So you're looking at, roughly, about 5.8
5 meters from the minimum to the intake. So you have
6 some volume that will remain in the tanks when they
7 drain.

8 MR. MARQUINO: It is on slide six.

9 MR. DIAZ-QUIROZ: Well, here, we don't
10 show the pool. So the relation, you know, the pool
11 floor to that intake, but it will be above the floor
12 about a meter or so.

13 So you have this driving head of 5.9
14 meters. It will drain down to where it will
15 eventually, of course --

16 MEMBER BANERJEE: And that is the minimum
17 level?

18 MR. DIAZ-QUIROZ: That is the minimum
19 level, right. Right. So you look at the maximum
20 level being about 6.1, 6 nominal.

21 MEMBER BANERJEE: So, even if the GDSC
22 pool reaches saturation, you still have 5.9 meters of
23 head?

24 MR. DIAZ-QUIROZ: Right, from the pool
25 itself, and then the line routing down towards the

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1 bottom squib valve, the nozzle, basically; there's
2 difference in height.

3 CONSULTANT WALLIS: Now I don't understand
4 this presentation. You spent all that time on stuff
5 which is not important.

6 What really matters is the worst case and
7 how does TRACG handle it, and what does it predict? I
8 don't see any TRACG outputs here. Tell us what you
9 predict for the worst case.

10 MEMBER BANERJEE: Well, they are trying to
11 reassure us that this won't happen.

12 CONSULTANT WALLIS: The only thing that
13 matters is the worst case and show that it works.

14 MR. MARQUINO: We will get there.

15 CONSULTANT WALLIS: Can you get to that?

16 MR. DIAZ-QUIROZ: Okay. All right. I
17 will go ahead and move on.

18 So, first, during LOCA, the GDCS injection
19 valve opens, and then you have the high pressure
20 segment, of course, depressurizes and any possible
21 dissolved gas will eventually come out because of
22 that.

23 Steam entering, might enter. The primary
24 route for steam, of course, is through the break, if
25 it is above the waterline, and also the DPV line. So

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1 any gas, of course, will be carried out mostly through
2 there. You might have steam entering that line. It
3 might carry some gas, but, of course, then, when flow
4 starts, you will quench the steam, if there is steam
5 in there.

6 Then, again, radiolytic gas is produced
7 inside the vessel, and, of course, will exit out
8 through the steam itself, through the break or the
9 DPVs.

10 This is just a quick statement on --

11 MR. MARQUINO: So, if you will bear with
12 us for a minute?

13 CONSULTANT WALLIS: oh, I have a question
14 here about steam entering quenched by GDCS. I read
15 your report, and you said that the GDCS flow was two
16 or three times enough to quench the steam. How do you
17 know how much steam is entering there? Steam loves to
18 enter and condense. How did you know how much steam
19 was entering?

20 MR. MARQUINO: Dr. Alamgir did that
21 evaluation. He can answer that on the bridge line, if
22 you would like.

23 We have provided an RAI response, 21.6112,
24 on that.

25 CONSULTANT WALLIS: The extreme assumption

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1 is it just brings the water up to saturation, and that
2 gives you the steam flow. Then you look at the
3 counter-current flow, presumably, and see if that can
4 be maintained. Is that what he did?

5 MR. MARQUINO: Well, the only potential
6 there is you saw there's a horizontal length of
7 piping --

8 CONSULTANT WALLIS: Yes.

9 MR. MARQUINO: -- to the vessel. So,
10 because the water level in some breaks drops below the
11 nozzle, that length of piping can drain out, and we
12 can have the liquid flowing in that pipe. So we could
13 get steam along the top of the pipe.

14 Now, in my simple understanding of that,
15 the volume of steam that would enter it is the volume
16 of steam in the top of the pipe.

17 CONSULTANT WALLIS: No, the steam would
18 come at MACCl, if it wanted to get to the water. It
19 is not a trivial thing when you put subcooled water in
20 contact with steam.

21 MR. MARQUINO: Right.

22 CONSULTANT WALLIS: I'm not sure how you
23 understand how much steam rushes in that pipe --

24 CHAIR CORRADINI: Let's go to the bridge
25 line. Let's just, before we discuss it, is the

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1 gentleman that you just mentioned on the bridge line?

2 MR. MARQUINO: Yes. Is the bridge line
3 open?

4 (Speaker on bridge line attempts to
5 speak.)

6 CHAIR CORRADINI: You are going to have to
7 speak a bit louder, please.

8 MR. ALAMGIR: This is MD Alamgir from GEH.
9 Can you hear me?

10 CHAIR CORRADINI: Yes.

11 MR. ALAMGIR: Okay. What is the question,
12 please?

13 CONSULTANT WALLIS: How do you know the
14 rate -- in your report and on this slide here, No. 9,
15 it says that the steam entering is quenched by the
16 GDCS flow. This is if the injection line is exposed
17 to steam at the RPV.

18 I just don't know how you know how much
19 steam is entering.

20 MR. ALAMGIR: We have .1612 where the
21 TRACG calculation shows that, given the large -- the
22 GDCS flow, it quenches everything --

23 CONSULTANT WALLIS: How do you know the
24 steam flow rate?

25 MR. ALAMGIR: That calculation shows

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1 whatever is approaching the cold front, it condenses
2 right outside the venturi and the exit of the GDCS
3 pipe into that.

4 CONSULTANT WALLIS: How do you know how
5 much steam has to be condensed?

6 CHAIR CORRADINI: I think Dr. Wallis is
7 asking you, did you do hand calculations so you are
8 confident in the TRACG calculation?

9 MR. ALAMGIR: Yes, we did.

10 CONSULTANT WALLIS: How does TRACG know
11 how much steam is condensed? If steam sees cold
12 water, it rushes towards it, doesn't it?

13 MR. ALAMGIR: We know that there is also a
14 big hole up there, DPV.

15 CONSULTANT WALLIS: Well, I think you need
16 to explain this in writing, so that I can understand
17 it.

18 CHAIR CORRADINI: It's in the RAI, though,
19 Graham, I think.

20 CONSULTANT WALLIS: I read it. I just
21 said in the RAI it asserts that the steam is quenched
22 by the GDCS, but it doesn't explain how they calculate
23 that. It just asserts it.

24 MEMBER BANERJEE: I guess if you wanted to
25 do a bounding calculation, to answer Graham, you would

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1 say simply that the steam enters at the velocity of
2 sound.

3 CONSULTANT WALLIS: But, then, that's far
4 too much --

5 MEMBER BANERJEE: It is 300 meters per
6 second.

7 CONSULTANT WALLIS: That's far too much
8 steam.

9 MEMBER BANERJEE: And that sort of
10 condenses --

11 MEMBER SHACK: Isn't it their TRACG
12 calculation with the counter-current flow flag turned
13 on?

14 CONSULTANT WALLIS: It probably it, and it
15 says it knows how to calculate --

16 MEMBER BANERJEE: It doesn't know how to
17 calculate flooding in horizontal pipes.

18 CONSULTANT WALLIS: How about this
19 condensation at MACC1?

20 MEMBER BANERJEE: It's impossible. It's
21 not possible that TRACG does that.

22 CONSULTANT WALLIS: I think it does.

23 MR. ALAMGIR: It is at the MACC1 velocity
24 in the GDCS line with that situation. That is my
25 personal --

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1 CONSULTANT WALLIS: MACC1 is a limiting
2 case?

3 MEMBER BANERJEE: Yes, that is what I am
4 saying. If you use MACC1, then you've got it.

5 CONSULTANT WALLIS: I very much doubt it.

6 CHAIR CORRADINI: Wait a minute. Let's
7 just roll back. Before we beat him up by long
8 distance, so can you explain to us -- you said two
9 things that I want to get clear.

10 One is you said you did the TRACG
11 calculation which indicated that whatever was flowing
12 in was condensed. Then you said you did a check
13 calculation. Can you explain the check calculation
14 you did?

15 MR. ALAMGIR: Yes. The check calculation
16 is based on the aspect ratio. The venturi is 3
17 inches, and the DPV is very large compared to that.

18 One hand calculation approximation that I
19 made is that, if the steam has flowed proportional to
20 the areas, this is the amount of steam that would
21 flow. Then I took that steam and then compared it
22 with the subcooling available at the GDCS line. It is
23 overwhelmingly large. It is able to condense
24 everything.

25 CONSULTANT WALLIS: But you need to know

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1 the velocity, not just the area. If it has MACC1, it
2 is going to have a tremendous flow rate, isn't it?

3 MR. ALAMGIR: I must say that I did not
4 consider MACC1 because, to me, it seems incredible.

5 CONSULTANT WALLIS: Well, I think there is
6 an experiment that you cite where the water actually
7 flushes the steam out, and condensation occurs outside
8 the pipe. Isn't this on --

9 MR. ALAMGIR: The experiment is Slovenian.
10 It shows in almost similar conditions that the cold
11 water condenses the steam and pushes out the front out
12 of the pipe in 8 seconds.

13 CONSULTANT WALLIS: The assertion that the
14 steam entering is quenched I think is not supportable.
15 But if you can show that the water pushes the steam
16 out, so that steam doesn't enter at all, that makes
17 sense.

18 MR. ALAMGIR: Well, Professor Wallis, the
19 test in Slovenia, and the pictures are in the RAI
20 response, the plots, temperature profiles about the
21 pipe; show that the cold water is able to condense the
22 steam and push it out.

23 MEMBER BANERJEE: But what was the
24 diameter of the pipe?

25 MR. ALAMGIR: For?

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1 CHAIR CORRADINI: In the experiment.

2 MR. ALAMGIR: Which pipe? The test?

3 MEMBER BANERJEE: Yes, in the Slovenian
4 experiment.

5 MR. ALAMGIR: Well, it is about the size
6 of -- about 4, 8, I think about 4 inches, but I will
7 check and come back to you.

8 MEMBER BANERJEE: And what is the size --

9 CHAIR CORRADINI: Say it again? Let's
10 just slow down. What did you say?

11 Are you on speaker phone at GEH? Hello.

12 All right. So hang on a second.

13 What's the problem? He's on speaker
14 phone.

15 Our transcriber, our recorder, can't hear
16 you. If you can just pick up the phone, if that is
17 possible, so he can hear what you are saying?

18 MR. ALAMGIR: I am not in a room where I
19 can pick up the phone.

20 CHAIR CORRADINI: Okay, fine.

21 MR. ALAMGIR: The diameter is 73
22 millimeters. I just looked at the paper for the test.

23 MEMBER BANERJEE: And what is the GDSC
24 line?

25 CHAIR CORRADINI: Just so we're clear, 73

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1 millimeters is 3 inches. So it is essentially the
2 same size.

3 MR. ALAMGIR: The same size as the
4 venturi, yes.

5 MR. MARQUINO: Can I ask a clarifying
6 question here? You are asking whether our code can
7 calculate the flow rate of steam into the line. The
8 significance of that is how fast the line would
9 equilibrate with steam and liquid in it.

10 The volume of the line we are talking
11 about is a horizontal length that is, just eyeballing
12 this isometric, it is about 3 meters long.

13 CONSULTANT WALLIS: I don't know what you
14 mean. If you have cold water flowing along the pipe,
15 then you condense all the steam that flows in, that
16 would bring it up to saturation, unless there is some
17 limiting condition.

18 MR. MARQUINO: Okay. The water is going
19 to go to saturation eventually. It is either going to
20 go to saturation inside --

21 CONSULTANT WALLIS: Not down there.

22 MR. MARQUINO: -- the RPV -- well, if the
23 water goes into the RPV, it is going to condense
24 steam --

25 CONSULTANT WALLIS: In the RPV.

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1 MR. MARQUINO: -- and go to saturation.

2 CONSULTANT WALLIS: Sure. Right.
3 Absolutely.

4 MR. MARQUINO: If the steam enters the
5 pipe, the water is going to go to saturation in the
6 pipe.

7 CONSULTANT WALLIS: But does the steam
8 keep going and condense further up the pipe?

9 MR. MARQUINO: Because the steam can't go
10 in this vertical section here.

11 CONSULTANT WALLIS: It can go up the first
12 part, though.

13 MR. MARQUINO: Right.

14 CONSULTANT WALLIS: I mean if it is
15 horizontal, which it isn't.

16 MR. MARQUINO: So this section of pipe is
17 important in addressing your questions about --

18 CONSULTANT WALLIS: So you've probably got
19 the right answer. I am just saying that the assertion
20 that the steam entering is quenched and you've got two
21 or three times the amount of water to condense the
22 steam is not a supportable statement. You have other
23 arguments which are probably good. I am just saying I
24 don't like that argument because I don't think you can
25 support.

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1 MEMBER BANERJEE: Well, I think the issue
2 really is, imagine that steam enters that line. So
3 now you've got counter-current flow in a horizontal
4 length. So the steam is on top. The water is flowing
5 this way; the steam is going that way. Right? And
6 the steam is condensing on the water surface.

7 So, at some length, the steam will stop
8 flowing because it will all condense. What you've got
9 is the water flowing. However, the water outflow now
10 has an area which is significantly less than the
11 diameter of the pipe. That is the concern.

12 So that the steam might be going in
13 through whatever open area there is in this counter-
14 current flow. The water is coming out, and
15 condensation is occurring until all the steam
16 condenses.

17 However, the water flow is impeded because
18 it is flowing through a smaller area. I mean, if you
19 really look at the boundary condition there, it is
20 whatever is the height for the critical flow out of
21 that pipe.

22 If you had an open pipe, and say you had
23 counter-current flow of steam and water, you would get
24 more flow of the water simply because of the fact that
25 you've got less area.

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1 Now what you are saying --

2 MR. ALAMGIR: Mr. Banerjee, I agree with
3 you, and the fact that the test in the high pressure
4 steam water, which is cited in the RAI response, it
5 indicates that there is no horizontal stratification,
6 and it is a flood of water pushing out the cold --

7 CONSULTANT WALLIS: If the Froude number
8 is big enough, that is what happens.

9 MR. ALAMGIR: So that is experimental
10 evidence.

11 CONSULTANT WALLIS: I will buy the
12 experimental evidence. I also will buy the argument
13 that, because the slope is so big -- it is not a
14 horizontal pipe; it is sloping upward to the RPV --
15 the steam isn't going to flow down there. I buy those
16 arguments. I just don't buy the statement that the
17 steam is quenched.

18 CHAIR CORRADINI: Okay. So, just to
19 summarize, I think we have beaten this one, at least I
20 judge we have beaten this one to death.

21 I have forgotten the name of the gentleman
22 on the line.

23 I think Dr. Wallis' point is he is not
24 quibbling with the conclusion; he is quibbling with
25 the explanation.

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1 CONSULTANT WALLIS: The rationale, right.

2 CHAIR CORRADINI: Yes, the rationale. So
3 I think that's got to be cleared up.

4 CONSULTANT WALLIS: I am not quibbling
5 with it, either. I am asserting it. It is not a
6 quibble.

7 (Laughter.)

8 MR. ALAMGIR: Thank you, Dr. Wallis. We
9 have a slight different point of view, but I respect
10 your point of view.

11 MEMBER BANERJEE: I haven't finished with
12 you, though.

13 (Laughter.)

14 CHAIR CORRADINI: So you got rid of one
15 person. You still have one to deal with, Dr.
16 Banerjee.

17 MEMBER BANERJEE: Right. Now I think that
18 these experiments that you are citing, if they were at
19 high pressure and at a high enough Froude number, they
20 would drive out the steam, so the steam could not
21 enter. So the condensation -- the pipe would
22 essentially run full.

23 CONSULTANT WALLIS: Right.

24 MEMBER BANERJEE: There's no room for
25 counter-current flow. But is this true of all

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1 conditions that you expect after the GDCS line is
2 uncovered? I mean, do these experiments assure you
3 that, under all the conditions that would occur, that
4 you will not get steam entering that line?

5 Now I am actually willing to buy Graham
6 Wallis' point that the line slopes upwards; therefore,
7 it makes it more difficult to enter. But, if it was
8 truly a horizontal line, I think you would have a
9 problem.

10 But can you answer the range of conditions
11 covered by the experiment compared to what you might
12 guess --

13 CONSULTANT WALLIS: I think they are going
14 to tell us, when we get to the end of this very long
15 day, they are going to tell us that the Froude number
16 is probably 2 or 3, or something useful like that.

17 MEMBER BANERJEE: Well, if you told us
18 that now, that the gravity wave velocity is going to
19 be much less than the full velocity, so you can't get
20 a counter-current gravity wave going back, then I
21 would buy that argument, but that you can do by hand.

22 CONSULTANT WALLIS: We haven't see that
23 argument yet.

24 MEMBER BANERJEE: Right. And I wouldn't
25 believe TRACG because TRACG doesn't calculate gravity

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1 waves, as far as I know. Does it?

2 CONSULTANT WALLIS: By the way, I think we
3 agree there is no problem if they slope the pipe up.

4 CHAIR CORRADINI: Okay. Then you two have
5 convinced each other. All right. So let's move on.

6 Thank you, and stay on the line, though.

7 MR. ALAMGIR: Thank you.

8 MR. MARQUINO: Thanks.

9 Can we go to slide 12? I would like to do
10 11 and 12 in reverse order.

11 Slide 12 describes another alternate
12 calculation that we did on elbow CCFL effects in the
13 GDCS line. So here we postulated that, despite what
14 Professor Wallis says, we assume the line is
15 completely full of non-condensable gas, and then we
16 calculated how long it would take that non-condensable
17 gas to bubble out of the line into the GDCS pool.

18 CHAIR CORRADINI: So, Wayne, just to say
19 it again, what part of the line was full of non-
20 condensable gas?

21 MR. MARQUINO: The whole line.

22 CHAIR CORRADINI: From the squib up?

23 MR. MARQUINO: No. From the vessel nozzle
24 all the way back to the pool --

25 CONSULTANT WALLIS: That's not the worst

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1 case.

2 MR. MARQUINO: We hypothetically said that
3 the whole line is full of gas, and we calculated how
4 long it would take that mass of gas to bubble back
5 into the pool.

6 CONSULTANT WALLIS: Seventy seconds. Now
7 TRACG calculates something like that. Because if
8 you're ever going to show us the TRACG predictions, I
9 noticed in the --

10 CHAIR CORRADINI: You can't criticize
11 them. They are trying to do the hand calculations
12 first.

13 CONSULTANT WALLIS: The RAI was the same
14 thing, that you have this gas escaping up into the
15 GDCS pool before the squib valve even blew.

16 MR. MARQUINO: Right, right.

17 CONSULTANT WALLIS: That's not the worst
18 case. The worst case is, if they leave that block
19 valve closed and then the squib valve pops; when the
20 squib valve pops, that's what you have got to
21 consider.

22 MR. MARQUINO: Yes, that's true.

23 CONSULTANT WALLIS: If you could get to
24 that worst case and you could show us that that one
25 impedes the flow, that is all we need to do.

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1 MEMBER BANERJEE: And that you can do by
2 hand.

3 MR. MARQUINO: Yes, but here we are
4 shortcutting this because, if we did the TRACG, more
5 TRACG cases, the question is, can TRACG do this?

6 CONSULTANT WALLIS: Okay.

7 MR. MARQUINO: So we are trying to --

8 CONSULTANT WALLIS: I think TRACG does
9 have a flooding correlation. Doesn't TRACG have a
10 flooding correlation?

11 MR. MARQUINO: I think it does, but --

12 MEMBER BANERJEE: Let him get to it,
13 please. He is going to tell us.

14 MR. MARQUINO: So to --

15 CONSULTANT WALLIS: So you think you are
16 going to escape by citing Banerjee and Wallis on page
17 12.

18 (Laughter.)

19 CHAIR CORRADINI: That was his plan. Let
20 him try to do it.

21 (Laughter.)

22 MEMBER BANERJEE: We could always retract
23 our correlation.

24 MR. MARQUINO: So, if there are problems
25 with these references, please let us know about it.

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1 (Laughter.)

2 We used the Wallis CCFL correlation. Dr.
3 Alamgir used that. And Dr. Shiralkar was involved in
4 this calculation also.

5 We used the Banerjee test data of elbows.

6 CONSULTANT WALLIS: Well, why do you do
7 this? Because it is got all the time in the world to
8 come out before you even try to blow -- it has got
9 years to come out of there. It has been sitting there
10 with an open top for years.

11 MR. MARQUINO: We agree.

12 CONSULTANT WALLIS: Why do you worry about
13 70 seconds?

14 (Laughter.)

15 MR. MARQUINO: We agree.

16 CONSULTANT WALLIS: Then why do you do it?
17 It is irrelevant.

18 MR. MARQUINO: Maybe we didn't understand
19 what the concern was. Because we were summoned here
20 to discuss non-condensable gas in the GDCS line.

21 MEMBER BANERJEE: Assuming it was there.
22 Yes.

23 MR. MARQUINO: We talked to the staff, and
24 we said, well, we submitted this RAI response that
25 addressed this point.

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1 CONSULTANT WALLIS: How is it sitting
2 there all that time without coming out?

3 MR. MARQUINO: And the staff said, well,
4 you submitted a TRACG calculation, but now show us
5 your qualification of TRACG for non-condensable gas in
6 the GDCS line. At that point, we said, well, we don't
7 have to use TRACG; we can do a direct calculation of
8 this. That is what we have provided here.

9 CONSULTANT WALLIS: Well, I would accept
10 this. You take 70 seconds. If you have gas in that
11 line and the block valve is open on top, it takes
12 about 70 seconds -- TRACG predicts something similar,
13 because I looked at the result -- to get the gas out.

14 This can happen anytime before any accident or
15 anything. So there is no gas in there unless the
16 block valve is closed on top.

17 CHAIR CORRADINI: But, Graham, if I could
18 just interject?

19 So let's say you're right, and the block
20 valve is closed. They see it is closed and they open
21 it. Isn't it the same 70 seconds?

22 CONSULTANT WALLIS: Yes, but after the
23 squib valve opens.

24 MEMBER BANERJEE: Oh, now you've got flow.

25 MS. CUBBAGE: The block valves are going

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1 to be --

2 CONSULTANT WALLIS: It's not with the
3 squib valve open. This is happening before the squib
4 valve is open.

5 CHAIR CORRADINI: Yes, but I am asking a
6 different question. I am saying that, if I
7 postulate --

8 CONSULTANT WALLIS: It is not the same
9 thing. You blow the squib valve, and then you open
10 the block valve. Then the water comes down and
11 prevents the things going out.

12 MEMBER BANERJEE: Yes, that is the issue.

13 MS. CUBBAGE: Excuse me. Excuse me.

14 How many block valves are we postulating
15 are closed?

16 CONSULTANT WALLIS: The only thing that
17 matters here is if the block valve on top near the
18 tank is closed.

19 MS. CUBBAGE: No, how many?

20 CONSULTANT WALLIS: Then they can trap
21 gas.

22 MS. CUBBAGE: But there's four lines
23 coming from --

24 CHAIR CORRADINI: All four block valves
25 are closed?

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1 CONSULTANT WALLIS: One of the lines --

2 MS. CUBBAGE: Well, then it doesn't
3 matter.

4 CONSULTANT WALLIS: Well, why are you
5 raising the issue then if it doesn't matter?

6 (Laughter.)

7 CHAIR CORRADINI: I think I want to let
8 Wayne continue, right, to do the calculation. Then
9 let's walk through it. Because in January of '07,
10 actually, we got all over GEH about the sloping of the
11 lines and the confidence we had in non-condensable
12 gases blocking flow that would block core cooling.
13 Okay?

14 So you proceed, and let's understand the
15 hand calculation, then go to the TRACG calculation.
16 Then we will come back and attack you.

17 MEMBER ABDEL-KHALIK: The concern at the
18 time was that the check valve would not be normally
19 open.

20 MEMBER BANERJEE: That was the concern.

21 CHAIR CORRADINI: That was one of the
22 concerns. There was a range of concerns.

23 MEMBER ABDEL-KHALIK: And it is normally
24 open now by design.

25 MR. DIAZ-QUIROZ: By design, yes.

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1 MEMBER ABDEL-KHALIK: Yes.

2 MEMBER BANERJEE: Yes, I think that the
3 concern was that gas could be trapped between the
4 squib valve and the check valve. Let's be precise.

5 CONSULTANT WALLIS: That gas could be
6 trapped in the line if the block valve -- maybe all
7 the block valves are closed.

8 MEMBER BANERJEE: No, no, no.

9 CONSULTANT WALLIS: I don't know.

10 MEMBER BANERJEE: The concern that we
11 specifically had was -- that's why I kept asking you,
12 is the check valve open or not normally?

13 MR. DIAZ-QUIROZ: Right.

14 CONSULTANT WALLIS: But we hadn't thought
15 about the problem enough to know what was the worst
16 case then.

17 MEMBER BANERJEE: There could be worse
18 cases, but our concern at that time was gas trapped in
19 that region.

20 Okay. So let's carry on.

21 MR. MARQUINO: Okay. Let's back up to
22 slide 11.

23 This provides information on TRACG
24 calculations where we apply a delay time to the start
25 of injection, where we evaluated how long the

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1 injection could be delayed, and we evaluated how much
2 the flow rate could be reduced.

3 So, given that it would take 70 seconds
4 for the line to vent if it was completely full of gas,
5 we can reduce the GDCS flow in TRACG to 1/7th of the
6 value calculated in the licensing basis and still have
7 enough flow to make up for boiloff in the core.

8 CONSULTANT WALLIS: So excuse me. This is
9 the hand calculation where you actually have the gas
10 in there when you blow the squib valve.

11 MR. MARQUINO: Uh-hum.

12 CONSULTANT WALLIS: Because the TRACG
13 calculation I saw in the RAI, you actually had it
14 bending out before you blew the squib valve.

15 MR. MARQUINO: This is a subsequent
16 calculation.

17 CONSULTANT WALLIS: A different
18 calculation.

19 MR. MARQUINO: It is a different
20 calculation, yes.

21 CONSULTANT WALLIS: So this is more like
22 the worst case? There's gas in there when you blow
23 the squib valve. That's the worst case.

24 MR. MARQUINO: Yes.

25 CONSULTANT WALLIS: In the line, the top

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1 line. Not in the lines of the RPV, but the line to
2 the --

3 MR. MARQUINO: Actually, I will be more
4 specific. The 1/7th value, that was simply determined
5 by the decay heat at the time GDCS flow starts. The
6 steam generation from that decay heat and the flow
7 rate in the licensing basis calculation, and --

8 CONSULTANT WALLIS: That's from all tanks?
9 That's from all tanks?

10 MR. MARQUINO: Yes.

11 CONSULTANT WALLIS: So all the lines have
12 gas in them?

13 MR. MARQUINO: Yes. If you want to look
14 at it that way, yes.

15 CONSULTANT WALLIS: So this is really a
16 bad case.

17 MEMBER BANERJEE: Well, it is a bounding
18 calculation.

19 CONSULTANT WALLIS: But then that means
20 all the block valves have been closed.

21 CHAIR CORRADINI: Now I am getting
22 confused.

23 Go through your thing, so I understand
24 what you are doing, before we quiz you on it.

25 MR. MARQUINO: Okay. The 1/7th GDCS flow,

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1 there is no additional TRACG calculation involved in
2 that. It is simply a matter of looking in the DCD at
3 the time GDCS flow starts, what is decay heat at that
4 time; what would be the steam generation based on that
5 decay heat; what is the GDCS flow rate after it
6 starts?

7 The steam generation of 1/7th of decay
8 heat; therefore, if the GDCS flow were reduced
9 forever by that amount, if it was only 1/7th of the
10 flow predicted by TRACG, we would still be making up
11 for steam generation because decay heat is only going
12 to get lower from that point in time.

13 CHAIR CORRADINI: Okay. Keep on going.

14 MR. MARQUINO: The second sub-bullet is a
15 TRACG calculation where we basically didn't turn on
16 GDCS flow. We reduced it to a very small number,
17 something like 1 percent, and then we looked for how
18 long it will take the core to heat up. A delay of 400
19 seconds could be tolerated before the core would start
20 heating out. So we could go out to 900 seconds after
21 the LOCA before having any core heatup.

22 Four hundred seconds is greater than 70
23 seconds. So, even if the line was full of non-
24 condensable gas that had to bubble out, we still would
25 not have any core heatup.

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1 MEMBER BANERJEE: Let me ask you about the
2 hand calculation. That assumes that you are working
3 along a flooding line which is somewhat less than for
4 a vertical pipe because you have an elbow there,
5 right? So it is some half of 2/5ths, or whatever.

6 So you have got a Jg-Jl relationship and
7 you are calculating the liquid penetration and the gas
8 penetration to get that 70 seconds clearing; you are
9 doing that by hand, correct?

10 MR. MARQUINO: Yes.

11 MEMBER BANERJEE: So that would be the
12 time for the Jg, or whatever you calculate, to clean
13 this thing out?

14 CONSULTANT WALLIS: It seems long, doesn't
15 it?

16 MEMBER BANERJEE: Well, they did it.

17 CHAIR CORRADINI: But can I ask --

18 MEMBER BANERJEE: At least that is
19 understandable, what you have done.

20 CHAIR CORRADINI: Can I ask a
21 clarification?

22 MEMBER BANERJEE: Yes.

23 CHAIR CORRADINI: You did that based on
24 the initial flow rate? The Jg plus Jl with --

25 CONSULTANT WALLIS: They calculate the

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1 flow rate from the displacement --

2 CHAIR CORRADINI: Let me ask him.

3 MR. MARQUINO: I want Dr. Alamgir or Dr.
4 Shiralkar to answer.

5 The question is, what flow rate was used
6 in the calculation of 70 seconds?

7 MEMBER BANERJEE: If you go back to the
8 previous slide, the flooding correlation is there,
9 right, if you just go back?

10 So there is a relationship between J_g and
11 J_f ?

12 MR. MARQUINO: Yes.

13 MEMBER BANERJEE: Which is that
14 correlation?

15 CONSULTANT WALLIS: Which lets the stuff,
16 then, back into the GDCS pool. The worst case is, if
17 the flow rate coming out of the GDCS pool is just
18 enough to hold the gas stationary.

19 MR. MARQUINO: Right.

20 MEMBER BANERJEE: So zero gas penetration,
21 J_g equal to zero.

22 CONSULTANT WALLIS: That's possible, but
23 it doesn't last very long.

24 MEMBER BANERJEE: So what is J_f ?

25 CONSULTANT WALLIS: It doesn't last very

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1 long because the RPV is depressurized.

2 MR. MARQUINO: Right.

3 CONSULTANT WALLIS: That is what saves you
4 in all of this, is that the RPV is depressurizing
5 rapidly, so things flush out.

6 MEMBER BANERJEE: No, but the question,
7 Graham, is, what is Jf to make Jg zero then?

8 CONSULTANT WALLIS: Does that get
9 achieved? Right.

10 MEMBER BANERJEE: Yes.

11 CONSULTANT WALLIS: Right.

12 MR. ALAMGIR: Dr. Shairalkar, are you
13 online?

14 If not, I will answer this question on his
15 behalf. He had done the calculation.

16 Can you hear me?

17 MR. MARQUINO: Yes.

18 MR. ALAMGIR: Okay. So what is the
19 flooding correlation, one equation? The other
20 equation is based on the fact that the liquid that is
21 coming down has displaced equal volume of the gas,
22 given that the squib valve is closed.

23 CONSULTANT WALLIS: So you are assuming no
24 flow into the RPV?

25 CHAIR CORRADINI: Correct.

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1 CONSULTANT WALLIS: Well, that's wrong
2 because there is a pressure difference, and it could
3 actually be flowing the other way.

4 MR. MARQUINO: Just let him explain what
5 he did. It is conservative.

6 CONSULTANT WALLIS: No, it's not.

7 MEMBER BANERJEE: No, no, it's not. Let
8 him explain. Go ahead.

9 MR. ALAMGIR: So the assumption made is
10 the volume of the gas that is displaced is equal to
11 the volume of the liquid that is coming down, and that
12 provides another relationship between J_g^* and J_l^* ,
13 which is vary it as J_g equals anj_l , and that is a
14 solution for either J_g or J_l . From that, 70
15 seconds --

16 CONSULTANT WALLIS: Well, you should have
17 read what I wrote in July. The worst case is, if the
18 pressure of the whole line, the pressure drop in the
19 whole line and the gravity head is just enough to get
20 you a J_f down, which is just enough to hold the gas
21 stationary.

22 MEMBER BANERJEE: Which is J_g^* equal to
23 zero.

24 CONSULTANT WALLIS: Then understand this
25 situation will tend to persist.

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1 MR. WACHOWIAK: Just enough to hold it
2 stationary in an 8-inch line.

3 CONSULTANT WALLIS: Yes. That situation
4 will persist forever, but it doesn't because the RPV
5 pressure goes down.

6 MR. MARQUINO: But what they said was, if
7 you have liquid coming in, you have to have gas
8 exiting.

9 CONSULTANT WALLIS: No, you don't because
10 liquid goes into the RPV.

11 MEMBER BANERJEE: You don't. If you look
12 at the correlation, if J_f^* is 1, roughly, then it will
13 be zero gas penetration.

14 CONSULTANT WALLIS: It will hold the gas
15 stationary.

16 MEMBER BANERJEE: There will be no gas.

17 MR. MARQUINO: Okay. We are looking at
18 this as there is no flow going in at the vessel
19 nozzle.

20 CONSULTANT WALLIS: That's not true.

21 MEMBER BANERJEE: No, that's not the --

22 CHAIR CORRADINI: I think we are learning
23 things, but I don't think we are getting forward
24 relative to what they have done.

25 CONSULTANT WALLIS: Well, we are getting

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1 forward a great deal because what I am hoping these
2 guys did was to look at the worst case, and that is
3 the only thing they have to do, and I don't think they
4 have got there yet. I'm surprised.

5 CHAIR CORRADINI: I thought they have
6 approached the worst case in three different ways, and
7 they have come up with a conclusion that --

8 CONSULTANT WALLIS: Well, this stuff about
9 a seventh flow in 400 seconds, that is very useful,
10 but the question is, how long does it take to get the
11 gas out of there if the pipe is full of gas? And if
12 it just so happens that the liquid flow is just right
13 to hold that gas stationary, it is not going to go
14 anywhere.

15 CHAIR CORRADINI: So can I ask a question,
16 just since we are learning at this point for a few
17 more minutes?

18 So that correlation up there is applicable
19 to an 8-inch pipe?

20 MR. ALAMGIR: No, it is for a 37- to 40-
21 plus-millimeter diameter.

22 CHAIR CORRADINI: Okay. So I would
23 maintain, based on physics, that there's no way an 8-
24 inch pipe can let gas below it not bubble up above it.

25 MEMBER BANERJEE: No, Mike, you're wrong.

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1 They have done full-scale experiments in the elbow
2 from a steam generator to a hot leg at Dresden.

3 CHAIR CORRADINI: Air/water?

4 MEMBER BANERJEE: No.

5 CONSULTANT WALLIS: Steam/water.

6 MEMBER BANERJEE: High pressure steam
7 water down to air/water. That correlation there
8 roughly holds, up to 14-inch pipes.

9 CONSULTANT WALLIS: But that is a bend.
10 That is a bend. It is not a vertical pipe.

11 MEMBER BANERJEE: Yes, that is a bend. It
12 is at the elbow.

13 So your point is not correct.

14 CHAIR CORRADINI: Well, then I will put it
15 to the side.

16 MEMBER BANERJEE: But that correlation is
17 pretty okay.

18 MR. ALAMGIR: I just want to make a
19 passing comment that it is an experiment. Professor
20 Banerjee, you know this one.

21 MEMBER BANERJEE: Yes.

22 MR. ALAMGIR: For about the same size as
23 the GDCS nozzle --

24 MEMBER BANERJEE: Right.

25 MR. ALAMGIR: -- 200 millimeters. There

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1 the correlation is limiting. In fact, your tests are
2 the most limiting, which is good.

3 CONSULTANT WALLIS: I feel you should do
4 it this way: if the pipe is full of gas, then if the
5 liquid flow is just about right to hold the gas there,
6 this doesn't persist for very long because the RPV
7 pressure is dropping. As soon as that drops, it just
8 flushes everything out of there. That is what you
9 should be doing.

10 CHAIR CORRADINI: But, Graham, isn't that
11 the 70 seconds versus the 400 seconds calculation?

12 CONSULTANT WALLIS: No. No. The 70
13 seconds is a bogus --

14 CHAIR CORRADINI: No, no, but they need to
15 go -- the pressurization would take it to that point
16 in less than 400 seconds. That was Wayne's original
17 point.

18 CONSULTANT WALLIS: Seventy seconds is the
19 time that, if you have the squib valve closed, so
20 there's no flow, so that the volume or flow of gas out
21 is the same as the volume flow of liquid down, that is
22 the 70 seconds.

23 MEMBER BANERJEE: At zero.

24 CONSULTANT WALLIS: That is the 70
25 seconds.

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1 MEMBER BANERJEE: Seventy seconds would
2 clear it.

3 CONSULTANT WALLIS: That is the time it
4 takes to get the stuff out if the squib valve is
5 closed. As soon as you open the squib valve, the
6 liquid can flow into the RPV and take the gas with it
7 or it can hold the gas in place or it can let it come
8 out.

9 MEMBER BANERJEE: Well, Graham, if you
10 wanted to bound this, there are two different ways. I
11 think they have answered the question about the steam
12 counter-current flow, which is the first part, which
13 is the condensation.

14 If we assume that the Slovenian
15 experiments cover the range of conditions of interest,
16 then they've got experimental evidence behind them,
17 which is really good.

18 With this case, there are two bounding
19 cases. One is zero liquid penetration, which is J_f
20 zero, and they have shown that you clear the line in
21 70 seconds.

22 The other bounding case is J_g zero and you
23 will get some J_f out of that, which will be J_f^* of the
24 order 1.

25 CHAIR CORRADINI: So may I ask a question

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1 at this point?

2 MEMBER BANERJEE: Yes.

3 CHAIR CORRADINI: So, if that is the
4 case --

5 MEMBER BANERJEE: Yes.

6 CHAIR CORRADINI: -- I would maintain that
7 flow rate is larger than 1/7th flow that they have
8 just calculated.

9 MEMBER BANERJEE: Could be, but I don't
10 know.

11 CHAIR CORRADINI: We can do the hand
12 calculation.

13 MEMBER BANERJEE: I don't know. I don't
14 know.

15 CHAIR CORRADINI: But wait. Just let's
16 proceed.

17 So I still think, at least as I understood
18 what Wayne was expressing, it is that that 1/7th flow
19 is the most limiting case, given that that Jf* is
20 greater than that.

21 MEMBER BANERJEE: Well, if it is, then
22 that is fair enough.

23 CHAIR CORRADINI: Because, then, Graham's
24 point is the water leaks through, the gas is magically
25 held in place, and I still cool the core.

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1 CONSULTANT WALLIS: Not magically; it's
2 physically by clear mechanics.

3 (Laughter.)

4 CHAIR CORRADINI: At this point, since I
5 am still personally not sure that correlation is
6 applicable to an 8-inch pipe, it is held there and it
7 leaks past and cools the core.

8 MEMBER BANERJEE: Well, what he is saying
9 is that correlation is probably a limiting case, that
10 they have evidence which suggests that --

11 CONSULTANT WALLIS: The gas is broken up
12 into smaller bubbles and stuff.

13 MEMBER BANERJEE: Yes, but it is not a bad
14 correlation to use.

15 CHAIR CORRADINI: Okay. But have I
16 expressed it correctly, that the two extremes are, for
17 this, J_g^* is zero and J_f^* is zero. With that, it
18 still shows that we are essentially okay.

19 MEMBER BANERJEE: Then you're okay.

20 CHAIR CORRADINI: Okay.

21 CONSULTANT WALLIS: Now what really saves
22 you is that, because the RPV pressure is dropping so
23 rapidly, the pressure drop driving the liquid flow
24 increases rapidly, and that J_f gets so big that it
25 just pushes the steam. Once the gas begins to go out,

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1 the hydrostatic head builds up more rapidly, and it
2 comes out. So that is the answer really.

3 I mean, if the RPV pressure were not
4 dropping the way it is -- I think it is dropping like
5 a stone, unless you guys are wrong. That will sweep
6 out the gas. That is the answer to it.

7 CHAIR CORRADINI: Right. It is designed
8 to do that.

9 CONSULTANT WALLIS: All these pseudo-
10 answers are not really very good.

11 MEMBER BANERJEE: But, Graham, what you
12 are saying is right, but I think if they can show,
13 even if the pressure is not rapidly dropping --

14 CONSULTANT WALLIS: Even if the gas stays
15 there forever, they are still all right.

16 MEMBER BANERJEE: They still have enough
17 flow.

18 CONSULTANT WALLIS: I guess they could do
19 that.

20 MEMBER BANERJEE: Then they are home free,
21 basically.

22 CONSULTANT WALLIS: I think they are home
23 in all kinds of ways.

24 MR. ALAMGIR: Dr. Banerjee, I do not see a
25 flooding occurring here due to hydraulic jump, just

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1 because there is no sustained source of non-
2 condensable gas. There is just a pocket.

3 If you think of another condition where
4 there is bubble-rise velocity, including the bubble-
5 rise velocity, it is about the same order. So I do
6 not see it as a scenario where it would be held down.

7 With due respect --

8 CONSULTANT WALLIS: If you have liquid
9 flowing down a pipe, there is a certain velocity at
10 which it will prevent gas flowing out, right?

11 MEMBER BANERJEE: Well, what he is saying
12 is, what correlation should you use? But if you use
13 the most conservative correlation and you are still
14 getting more than 1/7th the flow, you know, the GDSC
15 flow, then you are fine, aren't you? Or is that too
16 conservative? Maybe you should answer that question.

17 MEMBER SHACK: Well, you can do an
18 experiment. What happens, actually, if you have
19 stagnant gas in a pipe, and you turn on the liquid,
20 you tend to get a big slug flow bubble. Then the
21 question is, is that stable?

22 I think you can solve the problem. I
23 think I need to see the most recent RAI response
24 because the one I saw doesn't go through any of this
25 stuff. It is previous to all the arguments I heard.

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1 MR. ALAMGIR: We should keep in mind that
2 there are eight lines.

3 CHAIR CORRADINI: This was prepared
4 specifically for this meeting.

5 CONSULTANT WALLIS: Then we need to see it
6 in writing. I think you need to edit out the stuff
7 which is not --

8 CHAIR CORRADINI: Wait. Let him talk,
9 Graham.

10 CONSULTANT WALLIS: Okay.

11 MR. ALAMGIR: So then this is full of gas.
12 So that is an extreme assumption.

13 CONSULTANT WALLIS: Even then, you're all
14 right.

15 CHAIR CORRADINI: So let me just ask Wayne
16 and your compadres down in North Carolina, what you
17 prepared for this meeting, is this going to be
18 formally sent to the NRC?

19 MR. MARQUINO: If the NRC requests that.

20 CHAIR CORRADINI: Okay.

21 MS. CUBBAGE: The NRC has not requested
22 that.

23 CONSULTANT WALLIS: So you are resolving
24 this without even getting an answer to the question,
25 right?

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1 MS. CUBBAGE: We will speak to our
2 conclusions in a moment.

3 CONSULTANT WALLIS: Oh, you will? Okay.

4 CHAIR CORRADINI: Okay. So are you clear
5 as to the questions raised by the Committee, Wayne?

6 MR. MARQUINO: Yes.

7 CHAIR CORRADINI: Okay. Is it Adrian?
8 I'm sorry.

9 MR. MARQUINO: No. It's MD Alamgir.

10 CHAIR CORRADINI: Alamgir. Excuse me.

11 MD, do you understand the questions
12 raised?

13 MR. ALAMGIR: I understand the question
14 raised, that there could be a hypothetical situation
15 where there is zero gas flow and liquid is coming
16 down.

17 CHAIR CORRADINI: And just to drive the
18 nail into the dead body -- hang on -- just to drive
19 the nail into the dead body, the point made by Dr.
20 Banerjee was that, if you took the correlation
21 expressed, set Jg to zero, looked at the Jf you got,
22 and showed that that flow is essentially larger than
23 your 1/7th flow, which essentially gave you cooling,
24 or made up exactly for decay heat, that would be the
25 worst of the worst.

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1 CONSULTANT WALLIS: My point, you've got
2 to consider first the gas is very slowly moving up the
3 pipe. It takes a long time to --

4 CHAIR CORRADINI: Can I at least get my
5 point across before we --

6 CONSULTANT WALLIS: It is not the worst.
7 It is not the worst.

8 CHAIR CORRADINI: Do you understand?

9 MR. ALAMGIR: Let me replay what you just
10 said.

11 For J_g equals zero, calculate J_l , and show
12 that as greater than $1/7$ th.

13 CHAIR CORRADINI: That was what Dr.
14 Banerjee suggested as a worst case.

15 CONSULTANT WALLIS: No. What you do is
16 put the gas in there, fill in the pipe, calculate J_f ,
17 because you've got a hydrostatic head; you've got
18 friction. You know how much hydrostatic head you have
19 lost. If you calculate this J_f , I think you will find
20 it is big enough to sweep the gas out.

21 CHAIR CORRADINI: Okay.

22 CONSULTANT WALLIS: That is what you
23 should do. Don't do some hypothetical thing.

24 MR. ALAMGIR: Now I know you do not
25 believe in TRACG, but TRACG has mechanistic models

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1 which already show that it can do it.

2 CONSULTANT WALLIS: TRACG does it? I'm
3 not sure TRACG --

4 CHAIR CORRADINI: We are not going to
5 leave until we have a mission. Dr. Alamgir restated
6 the question. If that is not the question, I would
7 like to --

8 CONSULTANT WALLIS: Do it right. Just do
9 it right and it will be okay.

10 CHAIR CORRADINI: Well, let's just
11 clarify. Hold on.

12 CONSULTANT WALLIS: Don't ask me to solve
13 the problem for you.

14 MS. CUBBAGE: Can I suggest that, after
15 the staff's presentation, we could come to a
16 conclusion and action items?

17 CHAIR CORRADINI: Yes. But to finish this
18 part off, Dr. Banerjee suggested a procedure.

19 Dr. Alamgir, you understand that
20 procedure?

21 MR. ALAMGIR: I understand as I stated a
22 few minutes ago.

23 CHAIR CORRADINI: Right. Okay. Fine.
24 Let's move on.

25 CONSULTANT WALLIS: Now wait a minute. If

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1 they are going to put in something which is still
2 somewhat half-baked, I am not going to take it again.

3 CHAIR CORRADINI: But, Graham, at this
4 point, I need them to move on.

5 CONSULTANT WALLIS: I know. It is a
6 trivial problem. It is a homework problem. Just do
7 it right. That's all they have to do. Don't do some
8 half-baked thing which is not really a fully wrapped-
9 up answer, and it is easy.

10 MEMBER BANERJEE: Well, let's do this,
11 Mike.

12 CONSULTANT WALLIS: Just do it.

13 MEMBER BANERJEE: After the staff
14 presentation, we will internally come to a position in
15 discussion amongst us.

16 CHAIR CORRADINI: Fine.

17 MEMBER BANERJEE: And then we will --

18 CHAIR CORRADINI: Fine.

19 MEMBER BANERJEE: -- either be satisfied
20 or need some more clarification.

21 Let's move on.

22 CHAIR CORRADINI: Let's move on.

23 CONSULTANT WALLIS: Did you guys see this
24 thing I wrote in June or July?

25 MR. WACHOWIAK: So we will move on by

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1 moving back up one slide here.

2 CHAIR CORRADINI: Whatever you want to do
3 to move on, move on.

4 MR. WACHOWIAK: We just want to finish
5 this up.

6 In terms of the flow, they calculated the
7 1/7th by the method that Wayne said, but you've
8 already seen these types of flows before in the PRA
9 presentation. Depending on the break size, we have
10 presented that 1/8th to 2/8ths or to one-quarter of
11 the flow -- 1/7th is right in the middle there -- is
12 what we needed in the PRA, calculated by alternate
13 means, which is MACC, completely independent of what
14 they are doing.

15 So you have seen those types of flow rates
16 before for this plant?

17 CHAIR CORRADINI: Yes.

18 MR. WACHOWIAK: Okay.

19 MR. DIAZ-QUIROZ: Let's go to the GDCS
20 check valve.

21 MR. WACHOWIAK: Okay.

22 MEMBER ABDEL-KHALIK: That first bullet on
23 the summary slide --

24 MR. WACHOWIAK: Okay.

25 MEMBER ABDEL-KHALIK: -- where you say gas

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1 injection lines continuously vent due to sloping, and
2 check valve design, correct?

3 MR. WACHOWIAK: Right. Yes.

4 MEMBER ABDEL-KHALIK: I mean that is the
5 major thing.

6 MR. WACHOWIAK: Yes.

7 MEMBER ABDEL-KHALIK: Thank you.

8 MR. DIAZ-QUIROZ: This particular part of
9 the presentation is on the GDCS check valve. GEH has
10 responded to particular RAIs on this topic.

11 CHAIR CORRADINI: If you hit CTRL-L, you
12 will actually get full screen.

13 MR. WACHOWIAK: There is a driver issue
14 with this computer.

15 CHAIR CORRADINI: Okay, fine. Sorry.
16 Sorry.

17 MR. DIAZ-QUIROZ: We responded to the RAI
18 on this topic, 3.9-200. I will just quickly go over
19 the check valve requirements, in-service testing.
20 You already heard some of that.

21 Check valve type, we have spoken to
22 vendors. We have sort of narrowed down our selection.

23 What's the LOCA operation? Of course, it
24 is similar to what was previously discussed.

25 Hydrodynamic loads, as far as what is the

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1 process, what are we going to look at when the final
2 pipe routing is completed.

3 The requirements for the check valve
4 itself, it is to be installed horizontally, and the
5 pipe will be held normally open or vertically and held
6 by gravity.

7 There is an ITAAC for this particular
8 valve itself to confirm forward flow and reverse flow
9 coefficients. That is to assure that it will open and
10 close and have the proper flow through it.

11 There is remote indication on the check
12 valve, as previously discussed. That is a
13 requirement.

14 The valve qualification of this particular
15 valve will verify the applicable design requirements
16 have been met and will also address the orientation of
17 the valve performance, whatever orientation it is.

18 Of course, in-service testing will be done
19 through the ASME OM Code. The IST program is
20 required, again, by technical specifications.

21 The check valves themselves will be tested
22 every refueling outage. Those are through those drain
23 points, test line connections, where you will have
24 flow test in reverse to make sure it closes.

25 In particular, like I just mentioned,

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1 there have been discussions with valve vendors. We
2 looked at several valves. One, in particular, is a
3 nozzle check valve which we think meets the
4 requirements that we have for this particular valve.
5 It has got a short stroke. It is a lightweight disc,
6 rapid disc closure, minimizes impact.

7 This particular valve would be installed
8 in a vertical orientation such that gravity holds it
9 open, and there would be a light spring on it to
10 resist gravity, such that it is still in the open
11 position, but sort of pretty much it is in a neutral,
12 you might call it, position.

13 For example, here you have this valve here
14 where this would be the top of the valve, installed
15 vertical. Flow, normal flow would be in this
16 direction.

17 Of course, here the valve is shown in the
18 closed position. That would be, of course, after the
19 GDCS injection valve opens.

20 As soon as the core GDCS injection
21 pressure exceeds RPV pressure, it would push open the
22 valve and push down the disc portion. Then,
23 thereafter, it would just be held down by gravity
24 itself, and flow would occur through it.

25 MEMBER BANERJEE: Can we just go back for

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1 a minute?

2 MR. DIAZ-QUIROZ: Sure. Go ahead.

3 MEMBER BANERJEE: Is there any sort of
4 issue that -- you've got some indicator as to where
5 this valve is during normal --

6 MR. DIAZ-QUIROZ: Right. Right. You have
7 the stem to indicate that position. The stem, there's
8 ways to show that indication.

9 MEMBER BANERJEE: Because it could be
10 potentially closed if there was a back pressure,
11 right, or something?

12 MR. DIAZ-QUIROZ: Well, the back pressure,
13 of course, would be during the initial opening of the
14 squib valve where potentially the check valves could
15 see anywhere from 60 to 200 psi, depending on what the
16 LOCA scenario is. So, even then, you would have it to
17 where the hard seat would be on the valve body itself,
18 and then, of course, the disc, that is what prevents
19 backflow. Of course, it seats up against the valve
20 body, the seat that is on the valve body itself.

21 So, if you are saying, potentially, you
22 could have a stuck closed valve because of its seating
23 after squib actuation, of course, the valve, then, at
24 that point wouldn't function as its normal function
25 would be. Then, at that point, it would be considered

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1 a single failure. Of course, that kind of criteria
2 would have to go into the qualification of the valve,
3 have some sort of reliability taken to it. The PRA
4 sets that reliability criteria. So that would go into
5 the qualification of the valve.

6 MEMBER BANERJEE: And the valve is
7 qualified and tested under the sort of conditions that
8 could be expected?

9 MR. DIAZ-QUIROZ: Right, and here, the
10 worst-case condition for the valve is not during LOCA,
11 where the squib valve is actuated when needed, because
12 there is the level in the reactor pressure vessel. It
13 is because, during normal operation, you might have
14 this issue with a spurious actuation of a squib valve,
15 where the check valve would see normal operating
16 pressure of around 1,000 psi. That would be the
17 limiting case for this valve in this case. At that
18 point, of course, spurious actuation of the squib
19 valve, you have an inop trench line and then, at that
20 point, tech specs come into play.

21 MEMBER BANERJEE: So then you could see
22 very high pressure differential?

23 MR. DIAZ-QUIROZ: Right. It could see at
24 that point, if it were actuated before it was needed.

25 CONSULTANT WALLIS: Right.

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1 MEMBER BANERJEE: Thank you.

2 Have such valves been used before
3 somewhere?

4 MR. DIAZ-QUIROZ: Yes. These valves,
5 these nozzle check valves are used in Europe in some
6 of the nuclear power plants, yes.

7 CONSULTANT WALLIS: So, the next slide, it
8 says that the RPV pressure could be 220 psig at the
9 time of actuation.

10 MR. DIAZ-QUIROZ: Right.

11 CONSULTANT WALLIS: That is 220 psi on
12 this thing closing it, not jamming it?

13 MR. DIAZ-QUIROZ: What was that again?

14 CONSULTANT WALLIS: If you've got the RPV
15 pressure up at 220 psi --

16 MR. DIAZ-QUIROZ: Right.

17 CONSULTANT WALLIS: -- which is on the
18 next slide --

19 MR. DIAZ-QUIROZ: Right.

20 CONSULTANT WALLIS: -- then the pressure
21 from this GDCS pool is much less than that.

22 MR. DIAZ-QUIROZ: Right.

23 CONSULTANT WALLIS: So this valve is
24 really jammed shut, isn't it?

25 MR. DIAZ-QUIROZ: It is closed shut.

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1 CONSULTANT WALLIS: So I wonder, if you
2 close it shut with too much pressure, it may jam.

3 MR. DIAZ-QUIROZ: Right, and then that is
4 a reliability issue that is going to have to be
5 addressed in the qualification of the valve.

6 CONSULTANT WALLIS: Right. Right.
7 Especially that type of valve, which has a seat where
8 it could jam up in the seat there.

9 MR. DIAZ-QUIROZ: Right.

10 CONSULTANT WALLIS: Yes.

11 MR. DIAZ-QUIROZ: You could budge it --

12 CONSULTANT WALLIS: I guess the angle of
13 the seat is such that it won't wedge itself in there.

14 MR. DIAZ-QUIROZ: Right. That's part of
15 the qualification.

16 CONSULTANT WALLIS: You've got to qualify
17 it for --

18 MR. DIAZ-QUIROZ: Right. Right. So it
19 would have to sustain a --

20 CONSULTANT WALLIS: For maybe a 400 psi
21 pressure difference or something, something
22 conservative.

23 MR. DIAZ-QUIROZ: Right. Well, in this
24 case, the worst case, 1,000 psi.

25 CONSULTANT WALLIS: Okay.

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1 MR. DIAZ-QUIROZ: Okay. Let's go on to
2 the next slide, please.

3 CONSULTANT WALLIS: Another one.

4 MR. DIAZ-QUIROZ: I'm sorry. Go back.

5 CONSULTANT WALLIS: We did No. 6.

6 MR. DIAZ-QUIROZ: Sorry about that.

7 Okay. I was just discussing normal
8 operating, meaning LOCA operation. So, again, as you
9 stated, about 200 psi during LOCA, that is the max it
10 could possibly see during LOCA.

11 CONSULTANT WALLIS: Well, you pop the
12 valve, the squib valve, quite a long time before you
13 actually get injection.

14 MR. DIAZ-QUIROZ: Right. That is to
15 assure that there aren't any timing issues.

16 CONSULTANT WALLIS: Right.

17 MR. DIAZ-QUIROZ: When the pressure drops
18 below the injection pressure, it is open and it is
19 ready to go.

20 CONSULTANT WALLIS: It gives you the 130
21 seconds, which is more than the 70 seconds it takes to
22 get that gas out of that line.

23 MR. DIAZ-QUIROZ: Right. Right.

24 CONSULTANT WALLIS: So this gets the gas
25 out before there is any flow at all.

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1 MR. DIAZ-QUIROZ: Right.

2 CONSULTANT WALLIS: Is that your argument
3 then?

4 (Laughter.)

5 CHAIR CORRADINI: Let's move on.

6 CONSULTANT WALLIS: If it is closed, then
7 you get the counter-current flow at equal volumes.

8 MR. DIAZ-QUIROZ: Right. In this case,
9 right, I am talking about --

10 CONSULTANT WALLIS: That makes sense.
11 That makes sense.

12 MR. DIAZ-QUIROZ: -- normal, expected
13 operation during a LOCA.

14 CONSULTANT WALLIS: That is when you get
15 the gas out --

16 MR. DIAZ-QUIROZ: Right. Right.

17 Then it would take some upwards of 130
18 seconds for the injection pressure to exceed the
19 reactor pressure.

20 CONSULTANT WALLIS: Why do you open it so
21 early? Why do you pop the squib valve so early?

22 MR. DIAZ-QUIROZ: Right. It is an issue
23 with timing and having the flow ready when rapid
24 pressure --

25 MR. MARQUINO: It is because the

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1 depressurization is different for different breaks,
2 steamline breaks versus liquid breaks. So we can't
3 have it open at exactly the right moment in every
4 break.

5 CONSULTANT WALLIS: So you have a margin
6 of some sort then?

7 MR. MARQUINO: Right.

8 CONSULTANT WALLIS: So you make sure it is
9 open when you need the flow?

10 MR. MARQUINO: Right.

11 CONSULTANT WALLIS: When you can get the
12 flow? It says up to 130 seconds. What is the
13 shortest time?

14 MR. DIAZ-QUIROZ: The shortest time
15 escapes me right now.

16 CONSULTANT WALLIS: I was going to ask, it
17 says, "remains closed until the reactor pressure is
18 just above the GDCS injection pressure". What is that
19 pressure where it is just above the GDCS injection
20 pressure?

21 MR. DIAZ-QUIROZ: That is approximately 19
22 psi. So that is the gravity --

23 CONSULTANT WALLIS: So it has to drop to
24 19 psi --

25 MR. DIAZ-QUIROZ: Right.

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1 CONSULTANT WALLIS: -- before you get any
2 flow? Okay. So we just need to look at how long it
3 takes to get --

4 MR. DIAZ-QUIROZ: Right, and that is the
5 pressure --

6 CONSULTANT WALLIS: -- from 60 to 19.

7 MR. DIAZ-QUIROZ: And we are talking about
8 a pressure difference because the reactor pressure
9 vessel and the GDCS pool --

10 CONSULTANT WALLIS: So this is another
11 solution to this question about the gas. If you've
12 got more than 70 seconds --

13 MR. DIAZ-QUIROZ: Right.

14 CONSULTANT WALLIS: So you can skin this
15 cat all kinds of ways.

16 MR. DIAZ-QUIROZ: Right, you can. That 19
17 psi is the pressure difference, of course --

18 CONSULTANT WALLIS: Right.

19 MR. DIAZ-QUIROZ: -- because you have the
20 vessel itself communicates with the drywell, which is
21 pressurized. So it is a really different step.

22 Again, as that pressure starts to exceed
23 the reactor pressure, the check valve opens, and then
24 you have gradual flow, and it increases as the reactor
25 pressure vessel keeps going down in pressure. So you

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1 have this gradual flow buildup in the GDCS injection
2 line.

3 CONSULTANT WALLIS: There is no water
4 hammer or anything. There's no reason why there
5 should be? There's no sudden change of flow rate?
6 There's no condensation or anything in there?

7 MR. DIAZ-QUIROZ: At that point, as we
8 previously discussed, if there is, it will exist in
9 the horizontal end toward the nozzle.

10 CONSULTANT WALLIS: All right. So there
11 is no reason for a sudden closing leading to water
12 hammer?

13 MR. DIAZ-QUIROZ: Right. During the
14 initial, of course, event of the GDCS actuation
15 itself.

16 MEMBER BANERJEE: Now when you get to the
17 stage where you can get uncover, and if you get a
18 sudden condensation event, that could set up a water
19 hammer, right? Condensation shocks are very strong.

20 CONSULTANT WALLIS: But is it going to go
21 down that inclined pipe, is the question.

22 MR. DIAZ-QUIROZ: Right. You have a
23 vertical run, and then you have that horizontal run.

24 MEMBER BANERJEE: Oh, they are talking
25 about having very cold water coming in contact with

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1 the steam, right? Generally, in the experience I have
2 had, I have managed to shatter a stainless steel pipe.

3 CONSULTANT WALLIS: So, if they had a
4 horizontal pipe, they might well be in trouble.

5 MEMBER BANERJEE: Yes.

6 CHAIR CORRADINI: You are talking the last
7 couple of meters? Is that what you are concerned
8 about?

9 MEMBER BANERJEE: Yes.

10 MR. DIAZ-QUIROZ: Right. So you have this
11 squib valve that is normally closed, and that segment
12 is, of course, at reactor temperature as it gets
13 closer to the --

14 MEMBER BANERJEE: Yes, now it is, but --

15 MR. DIAZ-QUIROZ: Right. Once it opens,
16 you get a quick reverse flow through it. You want to
17 close the check valve.

18 MEMBER BANERJEE: Then, once the core
19 level drops and you start to get saturated steam, or
20 whatever, in it, and you put very cold water --

21 CONSULTANT WALLIS: This is like water
22 hammer in the feedwater line of a PWR --

23 MEMBER BANERJEE: Yes.

24 CONSULTANT WALLIS: -- which actually did
25 pop.

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1 MEMBER BANERJEE: Yes.

2 CONSULTANT WALLIS: There were 18-inch
3 pipes which grew by 2 inches from that water hammer.

4 MEMBER BANERJEE: It is an amazing thing
5 if it happens, but I assume what is happening is that
6 the thing, the water that is coming in is condensing
7 outside. I mean condensing the steam outside. That
8 is the argument that is being made.

9 CONSULTANT WALLIS: Or in a very small
10 region --

11 MEMBER BANERJEE: Yes.

12 CONSULTANT WALLIS: -- because it is an
13 upward-sloping pipe.

14 MEMBER BANERJEE: Yes. So it is not
15 getting that high surface area that you get, that you
16 need for a --

17 CONSULTANT WALLIS: And this TRACG somehow
18 is predicting, because of some glitch in the code,
19 some fluctuating pressures, which would have flow
20 going both ways for a while.

21 MEMBER BANERJEE: Have you considered the
22 potential for water hammer once the core uncovers?

23 MR. DIAZ-QUIROZ: Water hammer, if you go
24 on to the next slide here, of course, the water hammer
25 has a lot to do with the pipe routing itself, the

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1 configuration.

2 Right now, those loads on the valve have
3 not been calculated because of that, but the GEH
4 design process will evaluate the loads on the check
5 valve and other components along the line because of
6 that, and due to water hammer issues. Of course, this
7 is going to be at the final pipe routing stage, where
8 the valve would be qualified, of course. You will
9 know what the valve's performance is. Then you will
10 know the final pipe routing, and then you will
11 evaluate what kind of loads can be seen on this check
12 valve and this squib valve and other components
13 themselves.

14 MEMBER BANERJEE: How would you evaluate
15 the loads for that?

16 MR. DIAZ-QUIROZ: The loads, meaning the
17 methodology itself?

18 MEMBER BANERJEE: Yes. I mean, will you
19 postulate some --

20 MR. DIAZ-QUIROZ: Right. So you have to
21 postulate, right. It would be at normal design,
22 normal operating pressures, 1,000 psi, which is one of
23 the issues, and then design basis conditions to LOCA
24 conditions. Then, of course, the LOCA conditions
25 would have to take into effect the schema from the

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1 line, which could create another water hammer effect.

2 We do call out those design requirements.

3 MEMBER BANERJEE: Now, during normal
4 operation, of course, this is full of essentially
5 saturated water.

6 MR. DIAZ-QUIROZ: It is sitting there,
7 right.

8 MEMBER BANERJEE: You have no issue.

9 MR. DIAZ-QUIROZ: Right.

10 MEMBER BANERJEE: In terms of when you
11 pull it down --

12 MR. DIAZ-QUIROZ: Right.

13 MEMBER BANERJEE: -- you've got the
14 potential.

15 MR. DIAZ-QUIROZ: Right.

16 CONSULTANT WALLIS: If you have
17 inadvertent squib valve operation, you have 1,000 psi
18 across this valve?

19 MR. DIAZ-QUIROZ: During normal standby
20 mode, yes, there's 1,000 psi across the squib valve.

21 CONSULTANT WALLIS: But that would be
22 qualified for that, too.

23 MR. DIAZ-QUIROZ: Well, it will have to
24 be, yes. Yes. The DPVs themselves have the same
25 qualification requirements, and those have been tested

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1 and have been shown to open with 1,000 psi
2 differential across them.

3 So, as I previously mentioned, the valve
4 qualification will have to verify applicable design
5 requirements have been met for this valve and to
6 address, of course --

7 MEMBER BANERJEE: But I think what Graham
8 is saying is that 1,000 psi qualification probably is
9 sufficient, but there has to be a way to evaluate
10 whether you could get some steam saturation and have
11 really cold water there.

12 MR. DIAZ-QUIROZ: Right, the LOCA
13 condition.

14 MEMBER BANERJEE: Yes.

15 MR. DIAZ-QUIROZ: When you drain,
16 partially drain the segment, and steam enters, and
17 then you have this cold flow come in.

18 MEMBER BANERJEE: Yes.

19 MR. WACHOWIAK: I think you answered that
20 on one of the previous slides. The condition here
21 isn't like a pump condition, where we've got a pump
22 providing a high head to drive that cold flow there.
23 It is the differential pressure between the reactor
24 vessel and the tank. So it is going to start out at
25 zero pressure differential and then it ramps, the

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1 pressure differential ramps up slowly. So it is a
2 trickle of water that goes to more and more water. So
3 you don't get the initial driving of a --

4 MEMBER BANERJEE: Well, also, initially,
5 you are --

6 MR. WACHOWIAK: To get the high contact
7 area to drive the water hammer.

8 MEMBER BANERJEE: The only potential is if
9 you drop the level and you get steam in.

10 MR. WACHOWIAK: Even then --

11 MEMBER BANERJEE: At some point, you've
12 got subcooled water.

13 MR. WACHOWIAK: -- the rampup of the flow
14 rate is from zero to trickle, to a little less. So
15 there is no mechanism to drive all the subcooled water
16 there to be in contact with all the steam at the same
17 time to drive the water hammer.

18 MEMBER BANERJEE: No, no, no.

19 MR. WACHOWIAK: The steam will be moving
20 out of the pipe at the same time as the reactor
21 vessel.

22 MEMBER BANERJEE: Are you saying that the
23 uncovering of the GDCS line will occur gradually over a
24 period of time?

25 MR. WACHOWIAK: No.

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1 MR. DIAZ-QUIROZ: No. What he is saying
2 is that, because the reactor pressure vessel at some
3 point does reach the same injection pressure of the
4 line, that you will have this gradual flow rampup in
5 the line because the reactor pressure vessel will keep
6 dropping in pressure. So you have this gradual
7 increase rampup in flow. So you won't get immediate
8 full flow.

9 MR. WACHOWIAK: It is not like pump flow.

10 MEMBER BANERJEE: Yes, I realize that.

11 MR. WACHOWIAK: Okay.

12 MEMBER BANERJEE: But what I am saying is
13 there is another event which occurs, and I am not sure
14 at what point, when the GDSC line itself will uncover
15 and allow steam in potentially, yes.

16 MR. DIAZ-QUIROZ: Right.

17 MEMBER BANERJEE: And you have very cold
18 water coming in at that point because it is basically
19 water which is coming from the GDSC tank.

20 MR. DIAZ-QUIROZ: Right. There is a
21 segment where you still have that reverse flow; you
22 still have some warm water, but you're right, that
23 particular scenario of the water hammer has to be
24 analyzed, and there are requirements to analyze water
25 hammer in the line and for the components as well.

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1 MEMBER BANERJEE: Because then you will
2 have cold water coming in contact with steam. There
3 is an issue as to --

4 CONSULTANT WALLIS: That is why you slope
5 the line up.

6 MR. DIAZ-QUIROZ: Right.

7 MR. WACHOWIAK: So the portion that is
8 subject to that is very small.

9 CONSULTANT WALLIS: Is it just like --

10 MEMBER BANERJEE: No, I agree that, if you
11 slope the line up, you reduce the probability --

12 CONSULTANT WALLIS: For the water hammer,
13 if you have a horizontal feedwater pipe going into a
14 steam vessel, then you get all kinds of problems. So
15 you don't do that. You redesign the thing so the
16 steam can't get back in there.

17 MR. DIAZ-QUIROZ: Okay. This is a very
18 quick presentation. So, in summary, the valve
19 qualification will be the applicable design
20 requirements are met.

21 There are check valves that exist, that
22 currently exist, by vendors that can meet these
23 requirements. Of course, qualification would happen,
24 too.

25 And just the third bullet, I just want to

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1 reiterate that, as far as during LOCA operation, this
2 will see a quarter of the normal reactor pressure,
3 which is 1,000 psi. So it has to be qualified to be
4 able to withstand 1,000 psi --

5 CONSULTANT WALLIS: Well, I am glad we got
6 this far because what we saw for too long on this GDSC
7 BWR review was cartoons that showed things which
8 weren't really fully designed yet. As you know very
9 well, the design, the devil is always in the details
10 of these things.

11 MR. DIAZ-QUIROZ: Right.

12 CONSULTANT WALLIS: And you learn after a
13 while that you have to have a U-bend, you have to have
14 a slope, you have to have this, that, and the next
15 thing.

16 And if you do that early on, then you
17 don't have to spend so much time explaining things to
18 us.

19 MR. DIAZ-QUIROZ: Yes.

20 CONSULTANT WALLIS: But when you have
21 cartoons which don't represent all these things, it is
22 clear you haven't thought them out, it takes a long
23 time.

24 Well, I don't want to say any more.

25 MR. DIAZ-QUIROZ: Okay. Well, that

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1 concludes this presentation. It was pretty short.

2 CHAIR CORRADINI: Okay. Any other
3 questions for GEH?

4 (No response.)

5 Okay. I am going to change things a bit.
6 If it is all right, I would like to take a break now.
7 All right? We are about 25 minutes behind. Let's
8 take a break until 10:25. All right? And we will get
9 back together, and staff will be, still an open
10 session, talking about their presentation relative to
11 the GDCS.

12 *(Whereupon, the foregoing matter went*
13 *off the record at 10:11 a.m. and went back on the*
14 *record at 10:29 a.m.)*

15 CHAIR CORRADINI: Okay. Bruce, do you
16 want to lead us off here?

17 MR. BAVOL: Yes. My name is Bruce Bavol.
18 I am the Project Manager for the chapters dealing
19 with the issues we are talking about today.

20 I would like to get right into it and
21 introduce Tom Scarbrough. He is going to be
22 discussing the GDCS line non-condensables and the
23 check valve issues.

24 MR. SCARBROUGH: My name is Tom
25 Scarbrough. I am with the Component Integrity Branch

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1 in NRO. With me is George Thomas, and he is in the
2 Systems Branch of NRO.

3 So I will go through this. You have heard
4 a lot about the system and such, so I will try not to
5 repeat things that you already heard.

6 But, basically, the GDCS provides coolant
7 flow. The staff has reviewed the GDCS design
8 qualification and testing. Based on the review of the
9 DCD, RAIs, and the responses, and the discussions with
10 GEH, those all involve things that we have talked
11 about this morning on non-condensables, closure loads,
12 potential water hammer, all of those sorts of things.

13 GEH did revise the DCD to provide more
14 specific provisions for the GDCS design and
15 components. They had check valve design attributes.
16 They discussed the design process, including
17 addressing potential water hammer, things of that
18 nature. So that is something we think we have done
19 for the review.

20 In terms of the design itself, you have
21 seen the design. You have seen that basically there
22 are four divisions. There is sort of three separate
23 operations there: the short-term cooling of the
24 injection, the long-term equalizing, and the deluge
25 line to the lower drywell.

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1 The water comes from the different pools.
2 There's a 44.3-foot elevation between the GDCS
3 minimum-level pool and the center line of injection
4 nozzles. There's ITAAC that confirms that the GDCS
5 injection lines have no elevated piping loops and are
6 self-venting.

7 So that is just an overview of the design.

8 Then the next figure is just a simple
9 diagram that we pulled out of tier one. You have seen
10 a much better drawing this morning of it. But,
11 basically, this is an overview of the system in case
12 you want to point to anything in particular. But I
13 will go on to the next one.

14 Basically, we looked at this system in two
15 respects.

16 CONSULTANT WALLIS: This is another one of
17 these cases where the cartoon is very misleading. It
18 doesn't show the sloping-up of the lines.

19 MR. SCARBROUGH: Yes.

20 CONSULTANT WALLIS: And even if you tried
21 to slope up that line from the GDCS pool, it's got
22 such a long -- it sticks out so far, which is
23 unrealistic, that you can't slope it as they say.

24 MR. SCARBROUGH: Right.

25 CONSULTANT WALLIS: This is the sort of

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1 thing which is very misleading to a group --

2 MR. SCARBROUGH: Yes, these are, in fact,
3 the drawings that are in the tier one. They are just
4 sort of conceptual. But you're right, that's why, in
5 terms of we did ask for an RAI and received an
6 isometric drawing of it to get a better feel for it,
7 but you're exactly right, these are not clear.

8 In terms of the valve functional design
9 and qualification, the GDCS valves will be qualified
10 following the DCD provisions in Section 3.9.3. That
11 section specifies the use of ASME standard QME-1-2007,
12 and that is just the ASME standard which was recently
13 accepted in Reg Guide 1.00, Revision 3, with some
14 minor conditions that aren't really related to this
15 subject here.

16 In those areas of QME-1, they talk about
17 testing it. They have to make sure that these check
18 valves don't stick and test it under high enough
19 pressure that they encompass the various design
20 pressures. So all those types of things are part of
21 the qualification for the valves.

22 We did perform an audit at GEH back in
23 July which we looked at how the QME-1 standard was
24 incorporated into the design specs for all these
25 valves and also the qualification. There is an ITAAC

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1 which talks about qualification in tier one. So that
2 is how we look at that.

3 MEMBER ABDEL-KHALIK: Are the squib valves
4 covered by the same standard?

5 MR. SCARBROUGH: Yes, in our opinion, they
6 are because QME-1 talks about power-operated valves.
7 Then we give examples of what those power operators
8 are. Then we say, "and other designs", other power
9 operators.

10 So, in your opinion and GEH's opinion,
11 from our discussions with them, they consider the
12 QME-1 to encompass squib valves. Now, in our
13 discussions with Westinghouse, they read it a little
14 more narrowly, but, in their procurement specs, what
15 they have done is they have taken all the provisions,
16 the basic provisions of QME-1, and just put them right
17 into their specifications. So the net result is the
18 same, but it is just how they interpreted the
19 standard. But, in our view, it covers squib valves.

20 CONSULTANT WALLIS: Can I ask you
21 something now about valve P-1 on the slide, no number?

22 MR. SCARBROUGH: Okay.

23 CONSULTANT WALLIS: Now P-1 is the block
24 valve at the top of the pipe there, right? P-1 is a
25 valve, isn't it? There's a block valve; at the

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1 location, it says P-1. There is a block valve --

2 MR. SCARBROUGH: There is a block valve.
3 Yes, sir, there's a block valve up there.

4 CONSULTANT WALLIS: And if that is closed,
5 there is a non-condensable possible problem. If that
6 is open, there is no non-condensable problem because
7 non-condensables have long gone out of that pipe.

8 MR. SCARBROUGH: These are locked-open
9 valves. These are valves that must be verified before
10 startup that they are locked in open position.

11 CONSULTANT WALLIS: They're locked open?
12 Now I understand that is a valve which, to operate,
13 you have to go in there and open it. You can't
14 control it from the control room?

15 MR. SCARBROUGH: No. I don't know if they
16 will have it, but they will lock those open. Those
17 have to be, you're right, those are valves that have
18 to be open.

19 CONSULTANT WALLIS: The only way there
20 could be the kind of problem we have talked about this
21 morning for endless time was if that valve is left
22 closed, because if it is open, the non-condensables
23 are long gone up that pipe, right?

24 MR. SCARBROUGH: Right.

25 CONSULTANT WALLIS: So the only thing you

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1 have to worry about is, could it be left closed? I
2 think of TMI, where they left the auxiliary feedwater
3 valves, 12, closed during maintenance, and they didn't
4 know it in the control room, but they were able to
5 open them from the control room.

6 If these guys doing maintenance leave that
7 closed, they've got trouble in spades because they
8 will never get any GDCS flow, no matter what is in the
9 non-condensables.

10 MR. SCARBROUGH: Right, down that line,
11 right.

12 CHAIR CORRADINI: Just two things. One, I
13 guess they have to answer this, but just one
14 correction for the record. For TMI, the operators
15 have to go out into the field to open the valves.

16 CONSULTANT WALLIS: Oh, they have to go in
17 there? They couldn't do it from the control room?

18 CHAIR CORRADINI: No. Those block
19 valves --

20 CONSULTANT WALLIS: Okay.

21 CHAIR CORRADINI: They were out of
22 service, closed.

23 CONSULTANT WALLIS: Okay. Well, they did
24 do it. They did open them.

25 CHAIR CORRADINI: But they had to go out

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1 into the field, just for the thing.

2 So I'm sorry. I didn't mean to interrupt
3 you.

4 CONSULTANT WALLIS: So I guess you're
5 right there. Okay.

6 MR. WACHOWIAK: This is Rick Wachowiak
7 from GEH.

8 Those valves do not have a remote
9 operator. It is a manual valve. You need to go into
10 the containment to close the valve.

11 CONSULTANT WALLIS: So it seems to me that
12 the non-condensable stuff is really irrelevant because
13 the only way you would have the problem is that if
14 that valve is closed. If that valve is closed, you've
15 got a bigger problem in spades. So that is what you
16 have to worry about: is there a situation where they
17 could leave that valve closed? It is very difficult
18 to go in there and open.

19 MR. THOMAS: Dr. Wallis, can I answer that
20 one?

21 CONSULTANT WALLIS: You might require that
22 it be operated from the control room.

23 MR. THOMAS: You know, before the system
24 startup, they compare the lineup checking -- okay?

25 CONSULTANT WALLIS: Yes.

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1 MR. THOMAS: But, also, it is verified by
2 a second person, actually. So there is a
3 systematic --

4 CONSULTANT WALLIS: But I am just saying,
5 presumably, at TMI they had some checks, too, but they
6 still left the valve closed.

7 MR. THOMAS: So there would be less
8 probability of having a problem with that --

9 CONSULTANT WALLIS: So it is in terms of a
10 PRA question. It is a PRA question.

11 MS. CUBBAGE: Can one person talk at a
12 time, please, for the transcriber?

13 CHAIR CORRADINI: So, George, finish what
14 you are saying. No, go ahead and finish. I want to
15 make sure I understood.

16 MR. THOMAS: Okay. You know, before
17 system startup, there would be a valve lineup checking
18 by the operator, okay, in the plant. When he goes
19 through that valve lineup, there is a second person
20 verifying that valve lineup. So the probability of
21 having a normally open valve which is supposed to be
22 locked open, you know, it is a very, very low
23 probability. It is very difficult to postulate that
24 valve being --

25 CHAIR CORRADINI: But, from a probability

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1 standpoint, I don't want to discuss it, but that is
2 the procedure they use.

3 MR. THOMAS: Right.

4 CHAIR CORRADINI: And that is for all the
5 eight lines?

6 MR. THOMAS: Right, all eight lines, yes.

7 MR. WACHOWIAK: That is part of the
8 procedure that we use.

9 MR. THOMAS: Right.

10 MR. WACHOWIAK: Since we identified this,
11 as Dr. Wallis said, as an important lineup, we have
12 double verification on the lineup. We require
13 indication of some manner, we haven't decided yet, of
14 that position in that control room.

15 We also incorporated into the testing of
16 the system this flushing. The flushing procedure
17 won't work unless those block valves are open. So we
18 have not only verification indication, but positive
19 evidence before we come out of the outage that those
20 valves will be open.

21 CONSULTANT WALLIS: Do you have an
22 interlock?

23 MR. WACHOWIAK: We do not want them to
24 have an operator in the control room because then
25 during operation somebody could close them after we

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1 have verified by these three independent means that
2 they are open.

3 CONSULTANT WALLIS: Do you have an
4 interlock or something that says you can't start up
5 the reactor if they are closed?

6 MR. WACHOWIAK: Yes, that is the tech
7 specs.

8 CONSULTANT WALLIS: It's in the tech
9 specs? Okay.

10 CHAIR CORRADINI: It is not automatic
11 though.

12 CONSULTANT WALLIS: Oh, it's not
13 automatic? You don't have an automatic interlock of
14 some sort?

15 MR. WACHOWIAK: No.

16 CHAIR CORRADINI: No.

17 CONSULTANT WALLIS: Okay. So all depends
18 on the operator doing that, the people in the plant
19 doing the right thing?

20 (Laughter.)

21 CHAIR CORRADINI: That is normal
22 operation.

23 CONSULTANT WALLIS: Yes, okay.

24 CHAIR CORRADINI: Go ahead.

25 MR. SCARBROUGH: All right. Thank you.

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1 So, on the next slide, slide eight, which
2 now we go into the in-service testing provisions, and
3 the safety-related valves are within the scope of the
4 IST program and they undergo periodic assessment of
5 operational readiness according to the ASME OM Code.
6 That is spelled out in Section 3.9.6.

7 For the GDCS check valves, they have to be
8 tested in both the open and closed directions during
9 refueling outages. Then the squib valve initiators,
10 every outage they take 20 percent out into a lab and
11 test, fire those 20 percent. If any of those fail,
12 they have to go back and pull the whole batch out. So
13 there is a process for making sure those work
14 properly.

15 Also, in the DCD, they spell out in table
16 6.3-3 flushing of these lines for various reasons,
17 functional testing of the check valves, making sure
18 the injection lines are clear, checking the venturis,
19 and making sure the deluge lines work properly. This
20 is all done during refueling outages. So they have
21 these test penetrations, and they will flush out both
22 trains, both legs of the injection lines. Then, also,
23 this table also mentions about the laboratory testing
24 of the squib valve initiator. So that is the IST.

25 Now, in the DCD itself, we wanted to make

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1 sure that the design provisions for the check valves
2 were spelled out. These were the provisions that they
3 included. Part of this was in response to our request
4 for additional information.

5 Their long-duration submersible piston
6 check valves are quality group A, seismic 1, class 1.

7 There are installed horizontal pipe runs and normally
8 held-open spring or vertical. We saw some examples of
9 what they might use today.

10 They have to meet minimum flow
11 requirements for a minimum fully open flow coefficient
12 in forward direction and maximum fully open flow
13 coefficient in the reverse direction, in case the
14 valve happens to stick open during the LOCA. So those
15 are the things.

16 Then, on the next page, there are some
17 additional design attributes that are spelled out in
18 the DCD. They have to evaluate the loads during
19 normal operation --

20 CONSULTANT WALLIS: Why do you want a
21 fully open coefficient in the reverse direction?

22 MR. SCARBROUGH: In case it happened to
23 stick open, you wouldn't want too much flow. You
24 don't want this thing like blowing backwards with a
25 lot of flow.

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1 CONSULTANT WALLIS: You want a low
2 coefficient?

3 MR. SCARBROUGH: Yes. They give you a
4 minimum there.

5 CONSULTANT WALLIS: Okay. Because it
6 talks about a maximum.

7 MR. SCARBROUGH: Well, you can't have any
8 more than --

9 CONSULTANT WALLIS: You want to have a
10 lower maximum?

11 MR. SCARBROUGH: Yes, sir. Yes.

12 CONSULTANT WALLIS: Okay. Okay.

13 MR. SCARBROUGH: Thank you.

14 So you evaluate the loads and make sure
15 that the valves remain open during normal operating
16 conditions, which is a zero DP, and that they will
17 close under the reverse flow.

18 Then you have evaluation of hydrodynamic
19 loads, the closure loads, including potential water
20 hammer, and you must have remote position indication
21 in the control room. So those are all the things that
22 are addressed as part of the design process and using
23 the QME standard as well.

24 Now the squib valves themselves, we also
25 discussed with them, including design attributes for

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1 those valves. Because, as we heard this morning, the
2 design of those is not finalized yet.

3 But, in terms of the design attributes,
4 they are horizontally-mounted, and that is something
5 that, in terms of the sloping discussion, this is a
6 provision for the squib valves. So they need to be
7 horizontally-mounted.

8 They are straight through. They are long
9 duration. They have pyrotechnic. They have metal
10 diaphragm seals.

11 The GDCS injection and equalizing squib
12 valves are quality group A, category 1, and then class
13 1.

14 You can have no internal fragments or
15 missiles following actuation. You have to have a
16 minimum --

17 CONSULTANT WALLIS: Or gases.

18 MR. SCARBROUGH: Or gases, yes, sir.

19 Now one of the design attributes they need
20 to talk about, you mentioned that this morning about,
21 could gases go through? However they do design,
22 whether they are piston rings to hold those gases in,
23 or if they don't have them, they are going to have to
24 analyze, part as a qualification, that any gases that
25 do escape around that piston do not cause any problem

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1 down in the reactor. So they are going to have to
2 evaluate that.

3 Then there is a minimum flow coefficient.

4 The valve manufacturer has to perform full-flow tests
5 and provide that data and the remote position
6 indication in the control room.

7 We did discuss the squib valve design
8 features with GE when we did the audit in July. They
9 are discussing with various vendors and sources, the
10 contractors, how to go about designing these valves.
11 Westinghouse is farther along. We have been
12 interacting with Westinghouse quite a bit on their
13 squib valve designs. It is quite an art almost in
14 terms of a lot of testing going on with squib valves.

15 So we will be interacting with them.

16 That was part of our closeout of the
17 audit, was that they will let us know as they get
18 closer for these types of valve qualification. So we
19 are involved in those reviews as well.

20 CONSULTANT WALLIS: What do you mean by
21 position indication?

22 MR. SCARBROUGH: Position indication. We
23 need to be able to show that this thing is closed
24 during normal operation. Then, once it fires, they
25 need to show clearly that it is open and you have no

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1 blockages.

2 CONSULTANT WALLIS: The fact that it is
3 fired is not good enough? They've got to actually
4 show that it is open?

5 MR. SCARBROUGH: Right.

6 CONSULTANT WALLIS: There has to be some
7 device that shows that the thing is fully open?

8 MR. SCARBROUGH: Yes, sir, and that is
9 what they are working on right now in terms of the
10 design that we know with Westinghouse, getting a
11 confirmative signal to show that it really is fully
12 open.

13 MEMBER ABDEL-KHALIK: Now one of the
14 concerns that were raised earlier was that a common
15 mode failure for these valves is that you are going to
16 buy them from a certain manufacturer, and they are
17 going to put the wrong squib in all the valves, and
18 this has happened, actually.

19 I can see that testing of 20 percent of
20 the valves every outage would sort of examine that
21 problem. At least you would have 20 percent of them
22 or a significant fraction of them open. But if they
23 are of the same vintage, if they are made at the same
24 time by the same manufacturer, how do you avoid that
25 problem?

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1 MR. SCARBROUGH: Well, if you pulled out
2 this group and you found any of these failed, then you
3 need to expand that to the whole batch. Then, if you
4 find more problems, you need to expand even more.

5 So you might be shut down for quite a
6 while if you start to find any failures for these
7 because these are critical valves. If you have
8 failures of these to fire, they will have to expand
9 the sample out.

10 So that is a concern, that as part of the
11 qualification process, they are going to have to show
12 that the repetitive nature, the reliability of these
13 are such that you won't get that common mode problem.

14 If you see a problem, you will see, you will find it
15 as part of this 20 percent sample you are going to do.

16 MEMBER ABDEL-KHALIK: But how do you do
17 that on day one, when the plant starts?

18 MR. SCARBROUGH: Well, before they put
19 them in there, they are going to have to have, I would
20 imagine, a sample firing of the ones, of the batches
21 that they put in there, so that they will be able to
22 show that, before they put them in there, that they
23 take a sample of that batch and fire it. But that is
24 what I would imagine, and I think that is a very
25 good --

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1 MEMBER ABDEL-KHALIK: But is that spelled
2 out somewhere, that requirement?

3 MR. SCARBROUGH: I don't know, but I can
4 look into it and find out because that is a good
5 point. They should make sure that they have a sample
6 firing of the batch before they put it in the very
7 first time.

8 We can make sure that happens because we
9 are going to be looking at part of the qualification
10 process. That is part of like the actuator part of
11 the issue. So, yes.

12 MEMBER ABDEL-KHALIK: But just putting the
13 wrong squib --

14 MR. SCARBROUGH: Right.

15 MS. CUBBAGE: I would like to ask GE,
16 because I know we have had discussions about this
17 before here.

18 MR. WACHOWIAK: So it is partly done with
19 a batch control of the actuators, the pyrotechnic
20 actuators.

21 Chapter 6 of the DCD describes some of the
22 higher-level requirements on there. So, for example,
23 the equalizing line valves and the injection line
24 valves do not have the same batch squib initiators in
25 them.

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1 They are required to be from different
2 batches. So that is one of the controls to address
3 common mode failures. The testing is another way. So
4 there are batch controls placed on that to preclude or
5 minimize common mode failure. We wouldn't say
6 eliminate, but it would tend to minimize that.

7 MEMBER ARMIJO: Do these devices have some
8 sort of a shelf-life problem or do they age and lose
9 their potency? So, when you fire them, they don't put
10 out as much force?

11 MR. WACHOWIAK: In general, I think the
12 answer to that is yes, but that is also a design
13 attribute that can be controlled to some degree.

14 MEMBER ARMIJO: So the guys that make this
15 stuff know what those characteristics are. So you
16 would have a replacement of these squibs periodically?

17 MR. WACHOWIAK: Right, and there's storage
18 requirements and there's going to be shelf-life
19 requirements. All that would be part of the valve
20 specifications.

21 MR. SCARBROUGH: Okay. So that is the
22 squib valve discussion.

23 Then the flow path, which is what you have
24 talked about quite a bit, but this is just a summary
25 word version of it. The injection line has a U-shaped

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1 bottom where the squib valves are the lowest point.
2 There is water between the GDCS squib valve and the
3 RPV to prevent gases coming down from that, from the
4 RPV. Then you have the GDCS piping self-venting back
5 to the GDCS pool.

6 Following installation, they are going to
7 have ITAAC, they have ITAAC, which provides assurance
8 that the as-built piping does provide the venting.

9 CONSULTANT WALLIS: You are going to put
10 gas in and show that it come out? Is that what they
11 do?

12 MR. SCARBROUGH: They will flush water
13 until the water comes out.

14 CONSULTANT WALLIS: But it provides
15 venting though. You've got to put bubbly water in or
16 something.

17 MR. THOMAS: Flushing and venting are
18 together.

19 MEMBER BANERJEE: He is just being mean.

20 (Laughter.)

21 MR. SCARBROUGH: Now, during outages, and
22 during initial startup, before startup, they are going
23 to have to use these test connections to flush out the
24 lines or move any gases.

25 CONSULTANT WALLIS: Yes, but how are you

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1 going to show, prove that it provides venting? You
2 asked them to provide venting.

3 MR. SCARBROUGH: Right. They are going to
4 have to show that there are no high points and that
5 the sloping analysis -- and that is something that we
6 have heard today.

7 CONSULTANT WALLIS: It is not an
8 experiment? It is just an argument?

9 MR. SCARBROUGH: Right, they are going to
10 have to show it, right.

11 CONSULTANT WALLIS: It is not an
12 experiment. Oh, I thought you wanted them to test
13 something.

14 CHAIR CORRADINI: Wait, wait, wait. Let's
15 back up.

16 I thought Said asked the question of GEH,
17 I thought, and it was answered that there would be,
18 essentially, within the plant startup, there would be
19 testing for flow conditions, et cetera. Is that what
20 we are discussing?

21 MR. THOMAS: Yes.

22 CHAIR CORRADINI: I thought that was
23 what --

24 MR. WACHOWIAK: Yes. This is Rick
25 Wachowiak from GEH.

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1 There's an ITAAC to confirm that the lines
2 vent, and our thoughts now are that we would use
3 combinations of inspections and testing using the
4 existing flush lines and possibly --

5 CONSULTANT WALLIS: I'll tell you what you
6 do. You close the block valve. You fill that with
7 gas. You open the block valve, and 70 seconds later
8 you show the gas is gone.

9 (Laughter.)

10 MR. WACHOWIAK: So you purposely try to
11 block the line?

12 CONSULTANT WALLIS: No. If you want to
13 prove that it provides venting, do it.

14 MR. WACHOWIAK: We will need a procedure
15 that has similar attributes to what you just stated.

16 MR. SCARBROUGH: Okay. Then the actuation
17 of the water head sweeps the water out, sweeps the air
18 out, and any gases.

19 So the bottom line on this is the GDACS is
20 designed to allow the gravity-driven reactor coolant
21 flow upon squib valve actuation. There's ITAAC, which
22 confirms that the piping is installed in accordance
23 with design. And there's IC activities during outages
24 to remove the gases that might interfere with the
25 flow.

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1 Now, with that said, this morning we have
2 heard some things which are more important than we
3 heard in the RAI response. One is the sloping issue.

4 That is something that we will be talking to GE about
5 in terms of increasing the specification of that in
6 documentation, either in DCD --

7 CONSULTANT WALLIS: Excuse me. You didn't
8 hear about sloping the lines until this morning?

9 MS. CUBBAGE: No, we were aware that the
10 lines had a requirement to be sloped, but I think
11 there is a question about the level of specificity of
12 the degree of sloping.

13 Because we heard GE this morning talk
14 about a certain sloping, but then they backed away and
15 said, whether they had the adequate space, it might be
16 different sloping. So I think we might want to
17 discuss with them pinning down a minimum sloping.

18 MR. SCARBROUGH: Yes, the sloping is one
19 of the design parameters that was laid out
20 specifically. So we need to talk more about that. So
21 we will also be talking about some of the other
22 responses to make sure that it is clear as to what the
23 basis for some of their answers are in the RAI. So we
24 will be talking about that as well, based on some of
25 those things we heard this morning.

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1 So, with that, that's our presentation.

2 CONSULTANT WALLIS: So you think the non-
3 condensable gas problem doesn't exist, apparently?
4 You haven't raised that? You haven't said why you
5 think it doesn't exist.

6 MR. SCARBROUGH: Well, we did ask
7 questions in terms of non-condensables, and they
8 provided answers in terms of the design without the
9 high points in the lines. They talked about the
10 flushing activities during the --

11 CONSULTANT WALLIS: Why don't you just put
12 it to rest? Why don't you say the block valve is
13 locked open, and because the block valve is open, any
14 gas in the line will vent to the GDCS pool, and it
15 will be gone? So there will be no gas on that side of
16 the line. The gas on the other side will vent to the
17 vessel. So there's no gas in the line unless the
18 block valve is closed. If the block valve is closed,
19 then they have a major problem quite apart from non-
20 condensable because they can't get any water out of
21 the thing. Why don't you just say that and put the
22 whole thing to rest, instead of all this long
23 discussion?

24 MEMBER BANERJEE: Well, you also have to
25 say the check valves will be open.

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1 CONSULTANT WALLIS: Yes, say that, too.
2 But, you know, just say it. Just don't leave it
3 hanging as if it is still something that they might be
4 asked about, if you are convinced.

5 I am not telling you what you must think.
6 You think it yourself. But say something like that.
7 Put it to rest.

8 MS. CUBBAGE: The staff position is that
9 the design of the system allows for self-venting, that
10 the system will be flushed prior to starting up every
11 outage, and that is our position.

12 CONSULTANT WALLIS: You have to explain
13 that, therefore, there is no problem, because this
14 problem has been raised and talked about for a long
15 time. Maybe you ought to explain why this problem we
16 spent so much time on for some reason isn't a problem.
17 You have to explain that very clearly, I think, not
18 just say that they are going to make them vent. Say
19 they will then.

20 MEMBER ABDEL-KHALIK: Because it is a real
21 problem that was solved by design.

22 CONSULTANT WALLIS: Well, okay. So
23 convince them -- you know, say why it is solved, why
24 the design solves the problem. Explain that.

25 MR. DONOGHUE: This is Joe Donoghue from

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1 the Reactor Systems Branch.

2 That is what the SER is going to say.

3 CONSULTANT WALLIS: Here it says they are
4 going to design it so it works. You have to say you
5 have looked at the design, and you are convinced that
6 it will work. You just have to say that.

7 MS. CUBBAGE: Right.

8 CONSULTANT WALLIS: Okay, say that then.

9 MR. DONOGHUE: That's what we are saying.

10 CONSULTANT WALLIS: Yes.

11 CHAIR CORRADINI: Are we in violent
12 agreement?

13 (Laughter.)

14 Okay, good. All right. So I will let the
15 staff go. Thank you very much.

16 Now we are going to have to go into closed
17 session. So we close the current bridge line and open
18 up the other bridge line for the GE folks.

19 So those that aren't supposed to be here,
20 please leave.

21 (Whereupon, at 10:55 a.m., the above-
22 entitled matter went out of open session and into
23 closed session.

24
25
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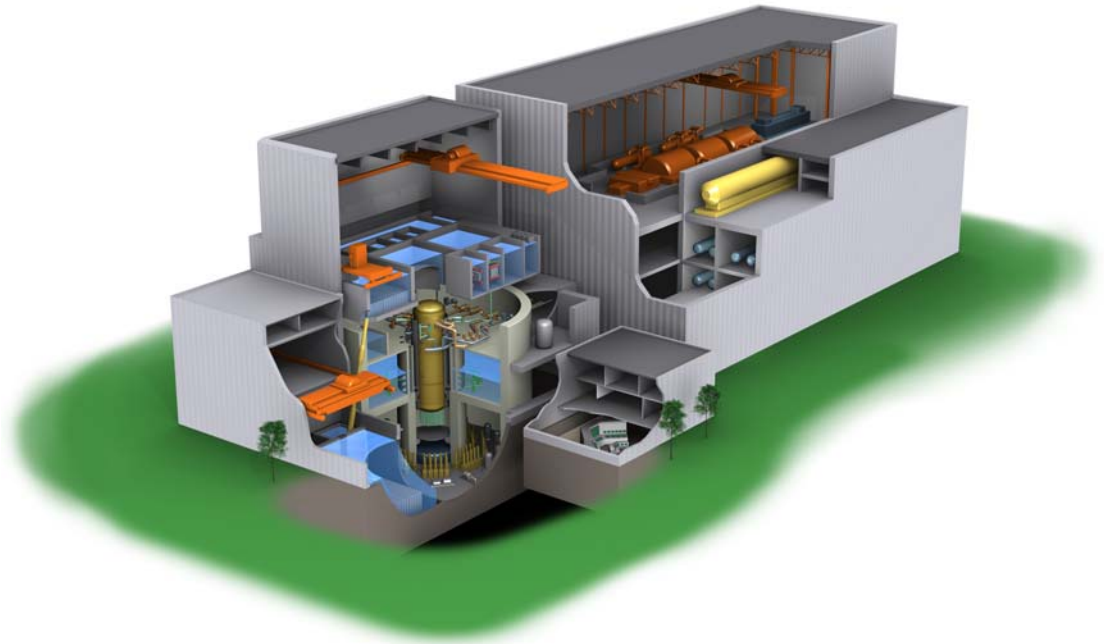
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ESBWR

Non-Condensable Gas in GDCS Line

ACRS Meeting

Wayne Marquino
Jesus Diaz-Quiroz
October 21, 2009



HITACHI

GE Hitachi Nuclear Energy₁

Agenda

- GDCS Operation – During a LOCA
- GDCS Injection Line Configuration
- Inservice Testing GDCS Injection Lines
- Sources Non-Condensable Gases
- Alternate Calculations - GDCS Flow
- Summary

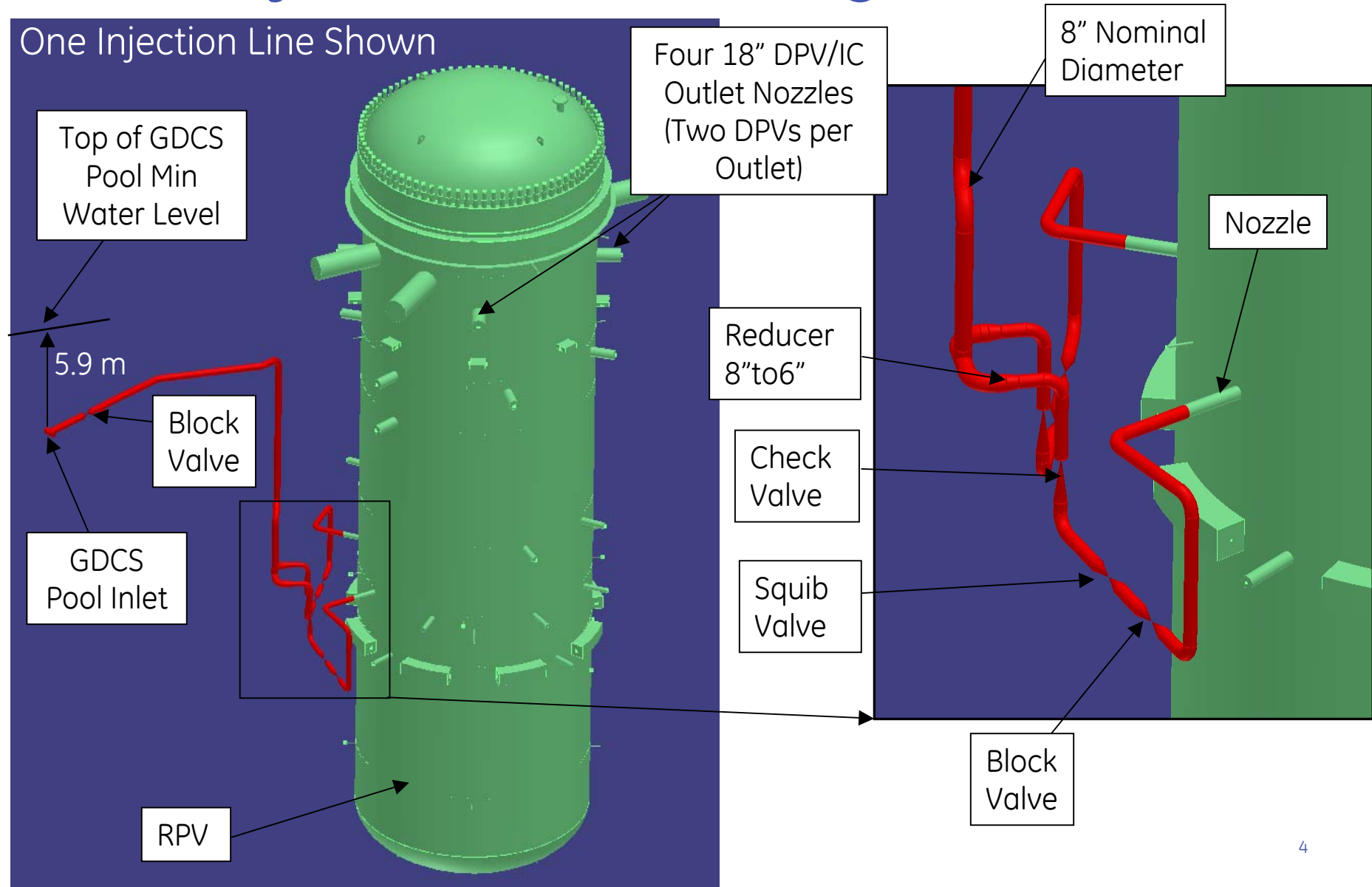
GDCS Operation – During a LOCA

Progression of LOCA till GDCS Injection

- Loss of Coolant Accident: Line Break at Normal Water Level
- Level 1 Reached
- Confirmed Level 1: ADS/GDCS/SLC Timer Initiated
- DPV Actuation Starts: 50 Seconds after Level 1 Confirmed
- GDCS Injection (Squib) Valves Open: 150 Seconds after Level 1 Confirmed
- GDCS Check Valve Closes: RPV Pressure Greater Than GDCS Injection Pressure
- GDCS Flow Begins: RPV Below Maximum GDCS Injection Pressure
- RPV Steam Flows: DPVs Remain Open

**RPV and GDCS pools communicate with drywell during LOCA
- RPV via break and opened DPVs; GDCS pools via gap
between top of pool wall and drywell ceiling.**

GDCS Injection Line Configuration



GDCS Injection Line Configuration

Piping

- Four 8" Nominal Diameter Injections Lines – Approximate Total Length 18 m (from pool inlet to 8"to6" reducer)
- Each Injection Line Branches into Two 6" Nominal Diameter Lines – Approximate Total One Branch Line 10.9 m (from 8"to6" reducer to RPV nozzle)
- Components for Each Branch Line: 8"to6" Reducer, Check Valve, Squib Valve, Block Valve, 3"Throat Diameter Nozzle, Test Line Connections at Upstream of Squib Valve and Check Valve and Downstream of Squib Valve

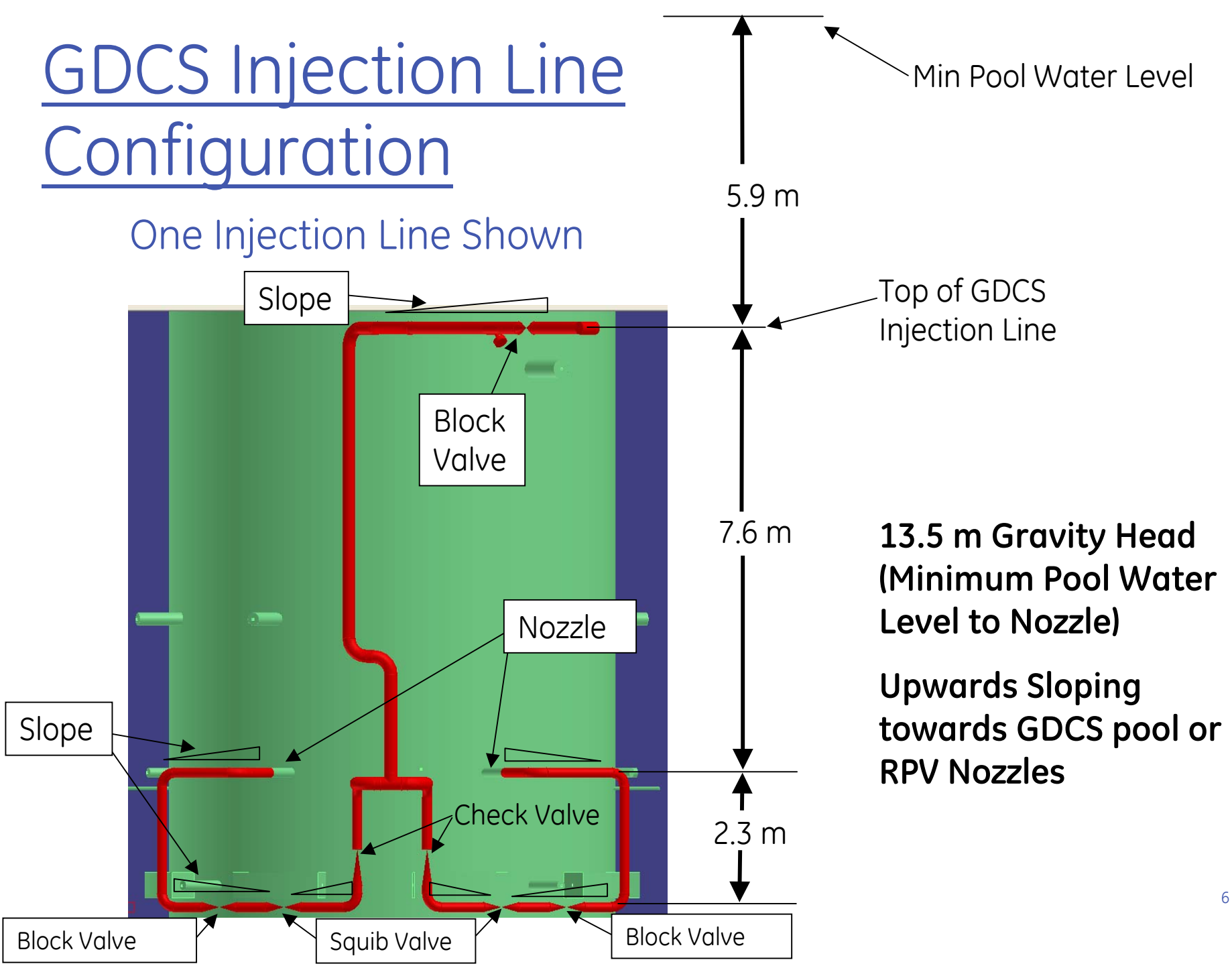
Sloping of Horizontal Runs

- Upstream of Squib Valve – Sloped Upwards Towards GDCS Pools
- Downstream of Squib Valve – Sloped Upwards Towards RPV Nozzles

Injection Lines Vent to GDCS Pools and RPV Nozzles

GDCS Injection Line Configuration

One Injection Line Shown



Inservice Testing GDCS Injection Lines

Flush GDCS Injection Lines Every Refueling
Outage Inservice Test Program Required by
Technical Specifications

- Upstream of Squib Valves
 - Block Valves Closed and Test Line Connections Used to Test Check Valves and Flush Line
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Sources Non-condensable Gases

GDCS Standby Mode

- Dissolved Gas GDCS Injection Lines
 - Low Pressure Upstream of Squib Valve Remains In Solution
 - High Pressure Downstream of Squib Valve Remains In Solution
 - Small Segment Between 6" Pipe and Nozzle – Nozzle is a flow restrictor with maximum 3" throat diameter

Sources Non-condensable Gases

GDCS Injection During LOCA (Squib Valves Opened)

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 - Squib valve and check valve block the flow path until there is a pressure gradient which supports from the GDCS pool toward the RPV.

Alternate Calculations – GDCS Flow

- Conservative Hand Calculation Using Trapped Noncondensable Gas in GDCS Line, with Elbow CCFL**
 - Net Effect - GDCS initiation would be delayed a maximum of 70 seconds
- Additional TRACG Sensitivity Analysis
 - 1/7th GDCS Flow - No Core Heat Up
 - GDCS injection delay of about 400 sec can be tolerated (i.e. to 900 sec) without heat up
- PRA Success Criteria – 1/8 to 2/8 GDCS Flow for No Core Heat Up
 - Two GDCS squib valves credited in PRA (2 out of 8 valves opening) but sensitivities show one squib can still provide sufficient flow (1 out of 8 valves opening)

Alternate Calculations - Elbow CCFL Effects on GDCS Flow Due To Trapped Non-Condensable Gas in GDCS Line

- Conservative Hand Calculation → Net Result: Effective GDCS flow initiation Delay of 70 seconds
 - Scenario: Trapped non-condensable gas flowing out of GDCS Line to GDCS Pool under Elbow CCFL conditions
 - Answers the question: “What if the GDCS Line has trapped non-condensable gas , how will it degrade GDCS flow due to Elbow CCFL?”
 - Uses Prof. Sanjoy Banerjee et al CCFL data** for air-water flow in elbows in the form of Prof. Wallis CCFL Correlation: $j_g^{*1/2} + 0.57 j_l^{*1/2} = 0.45$, and filling of closed volume initially occupied by gas $j_l=j_g$
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 - Total NC gas “escape time” from GDCS line to GDCS pool calculated

**See Backup Slide for References

Summary

- GDCS Injection Lines Continuously Vent Due to Sloping
- During LOCA RPV Vents to Drywell And GDCS Pool Airspace Also Vents to Drywell
- Alternate Calculations with Elbow CCFL a Maximum 70 Second Delay of GDCS Flow
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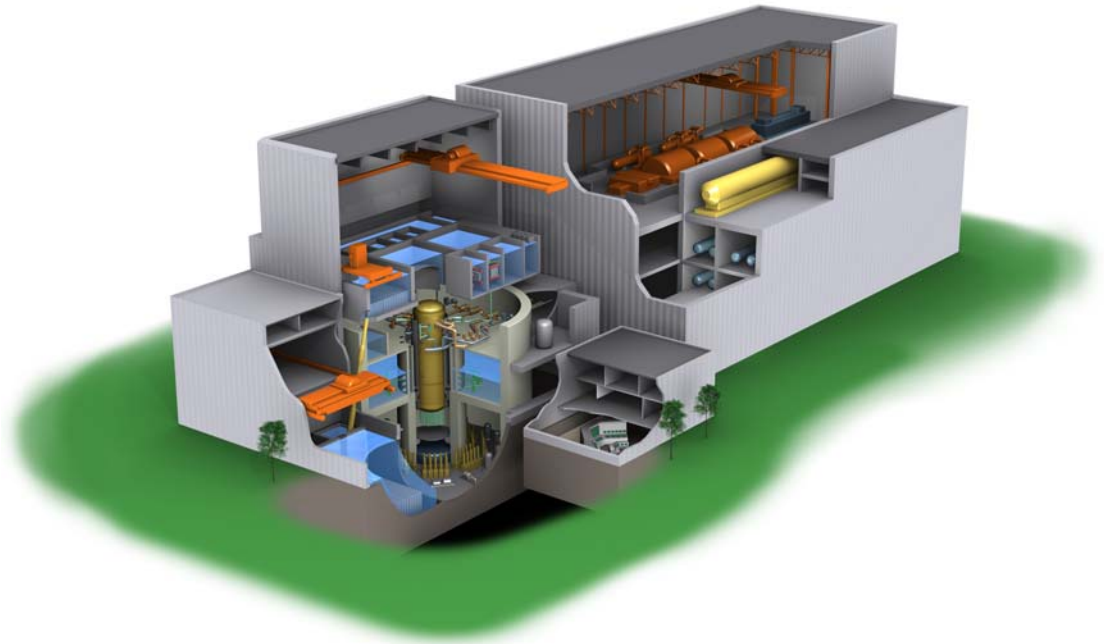
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- K. H. Ardron and S. Banerjee, Flooding in an Elbow between a Vertical and a Horizontal or Near Horizontal Pipe, Part II: Theory, Int. J. Multiphase Flow, Vol. 12, No. 4, pp 543-558, 1986

ESBWR

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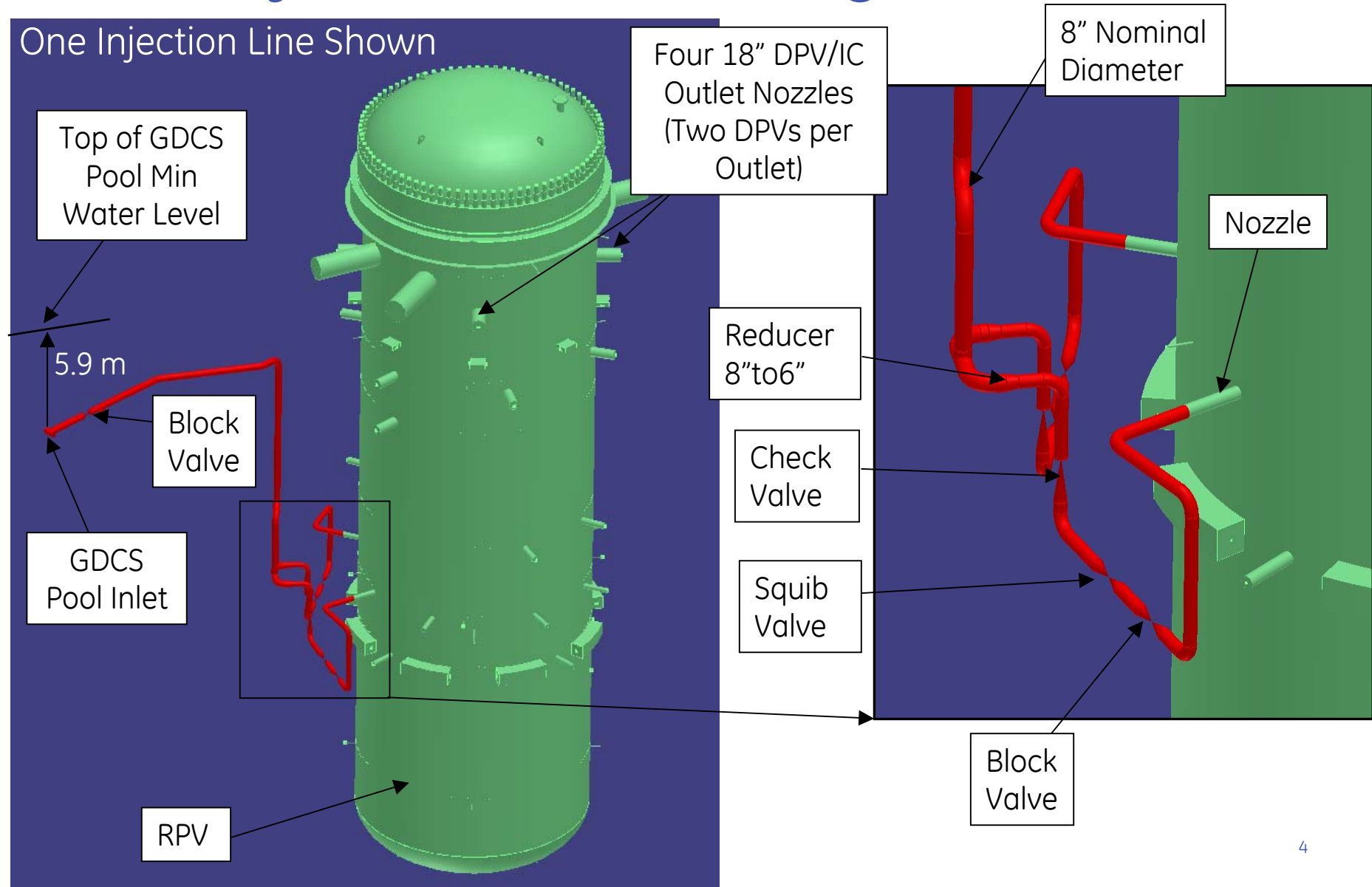
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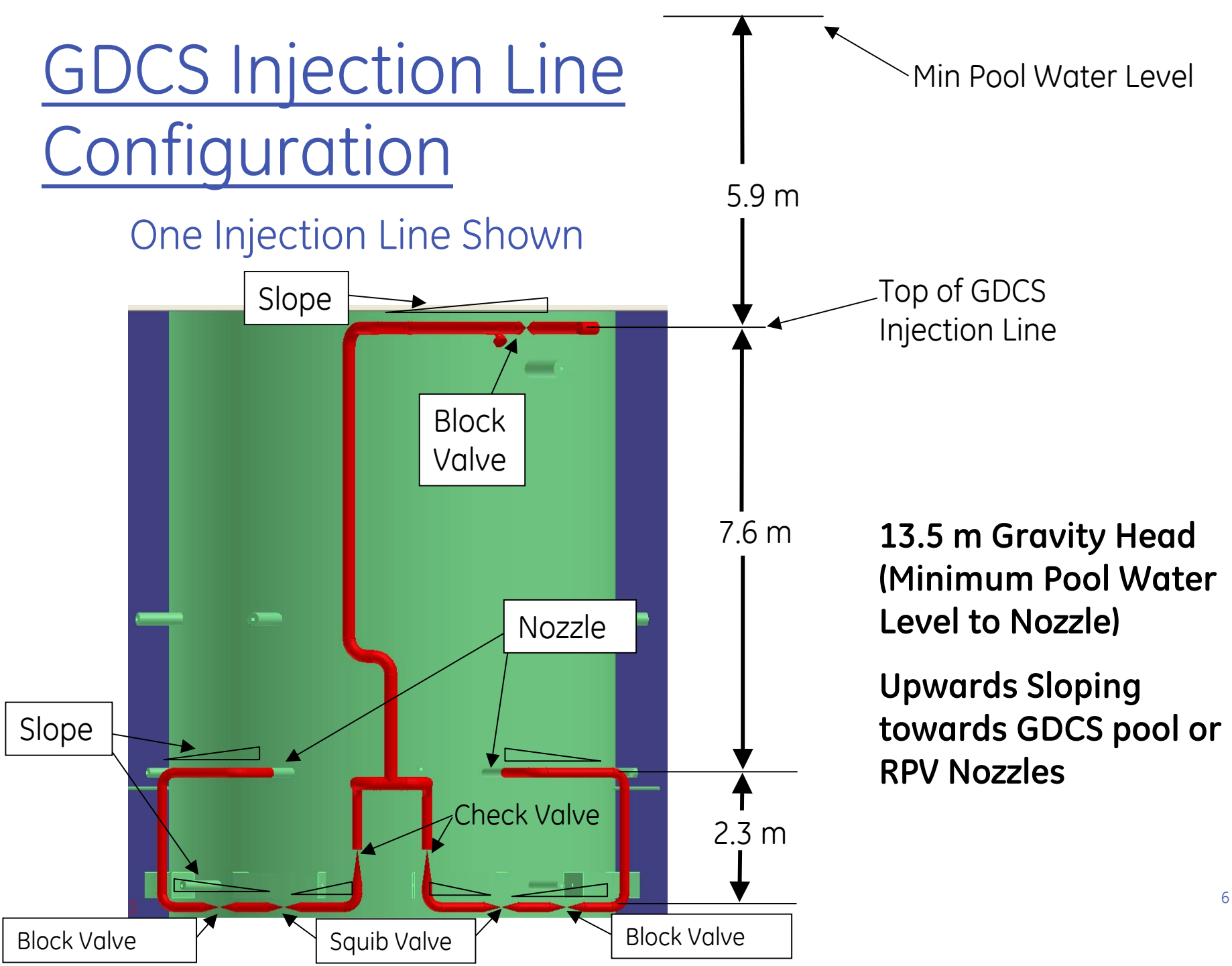
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- Conservative Hand Calculation → Net Result: Effective GDCS flow initiation Delay of 70 seconds
 - Scenario: Trapped non-condensable gas flowing out of GDCS Line to GDCS Pool under Elbow CCFL conditions
 - Answers the question: “What if the GDCS Line has trapped non-condensable gas , how will it degrade GDCS flow due to Elbow CCFL?”
 - Uses Prof. Sanjoy Banerjee et al CCFL data** for air-water flow in elbows in the form of Prof. Wallis CCFL Correlation: $j_g^{*1/2} + 0.57 j_l^{*1/2} = 0.45$, and filling of closed volume initially occupied by gas $j_l=j_g$
 - Conservatively assumes GDCS line filled with 0.98 m³ non-condensable gases.
 - Total NC gas “escape time” from GDCS line to GDCS pool calculated

**References

- H. Siddiqui, S. Banerjee, and K. H. Ardron, Flooding in an Elbow between a Vertical and a Horizontal or Near Horizontal Pipe, Part I: Experiments, Int. J. Multiphase Flow, Vol. 12, No. 4, pp 531-541, 1986
- K. H. Ardron and S. Banerjee, Flooding in an Elbow between a Vertical and a Horizontal or Near Horizontal Pipe, Part II: Theory, Int. J. Multiphase Flow, Vol. 12, No. 4, pp 543-558, 1986



Presentation to the ACRS Subcommittee

ESBWR Design Certification Review
SRSB - Reactor Systems Issues

OCTOBER 21, 2009



SRSB - Reactor Systems Issues

Outline of Presentation

- Brief the Subcommittee on reactor systems issues:
 - Non-condensables in GDCS Line
 - Design of GDCS Check Valves
 - *TRACE Confirmatory Calculations (IE)
 - *NEDC-33326 GE14E Initial Core Design Nuclear Report
 - *Critical Power Testing (NEDC-33413P)
 - *Stability/Chimney
 - *Feedwater Temperature Operating Domain (NEDO-33338)
- Answer the Committee's questions

* Meeting discussion will be Closed due to proprietary material.



Presentation to the ACRS Subcommittee

ESBWR Design Certification Review Non-Condensables in GDCS Line & Design of GDCS Check Valves

Presented by

Thomas Scarbrough - NRO/DE/CIB2

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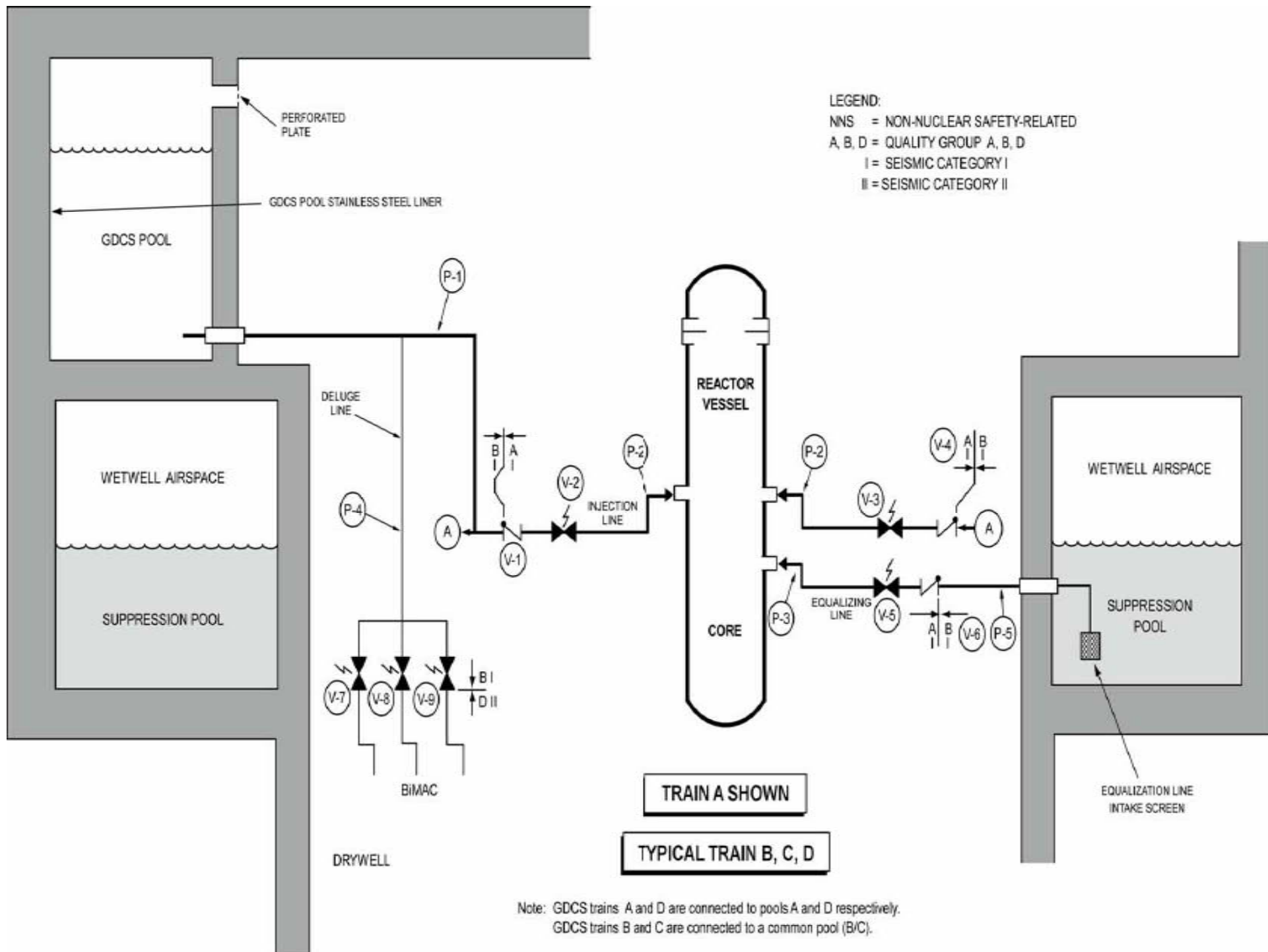
October 21, 2009

Introduction

- ESBWR Gravity-Driven Cooling System (GDSCS) provides emergency core cooling following reactor depressurization in case of loss of coolant accident
- NRO staff reviewed GDSCS design, qualification, and testing based on ESBWR DCD provisions, RAI responses, and discussions with GEH
- GEH revised ESBWR DCD to provide more specific provisions for GDSCS design and components

GDCS Design

- GDCS has 4 divisions with each division consisting of short-term cooling (injection) system, long-term cooling (equalizing) system, and deluge line to lower drywell
- GDCS supplies cooling water from GDCS pools and suppression pool using explosive-actuated (squib) valves, check valves, and normally open block valves
- Minimum Elevation change between minimum water level of GDCS pools and centerline of GDCS injection line nozzles is 44.3 ft
- ITAAC confirms that as-built GDCS injection piping has no elevated piping loops or high point traps from squib valves to pools and to RPV nozzles





Valve Functional Design and Qualification

- GDCS valves will be qualified to perform their safety functions in accordance with ESBWR DCD Tier 2 Section 3.9.3 provisions
- ESBWR DCD specifies use of ASME Standard QME-1-2007 for qualification of active mechanical equipment accepted in Regulatory Guide 1.100 (Revision 3)
- NRC confirmed application of QME-1-2007 during audit of GEH design and procurement specifications in July 2009
- Qualification will be verified by ITAAC listed in ESBWR DCD Tier 1



Inservice Testing (IST) Activities

- Safety-related valves within scope of IST Program undergo periodic assessment of operational readiness in accordance with ASME OM Code as described in ESBWR DCD Tier 2 Section 3.9.6
- ESBWR DCD Tier 2 Table 6.3-3 specifies flushing of GDCS lines for functional test of check valves, GDCS injection lines, venturi within GDCS reactor pressure vessel (RPV) injection nozzles, and deluge lines during refueling outages
- ESBWR DCD Tier 2 Table 6.3-3 also specifies laboratory testing of initiators in squib valves



Check Valve Design Attributes

- ESBWR DCD Tier 2 Section 6.3.2 specifies design attributes for GDCS check valves, including:
 - Long duration submersible piston check valves
 - Quality Group A, Seismic Category I, ASME Section III Class 1
 - Valves will be installed in horizontal piping run and held normally open by spring, or in vertical piping run and held normally open by gravity
 - Valves will meet requirements for minimum fully open flow coefficient in forward direction and maximum fully open flow coefficient in reverse direction



Check Valve Design Attributes (continued)

- Design process will evaluate loads on valve disk during normal and design-basis conditions to ensure valves remain open under normal operating conditions (0 DP) and will close under low reverse DP/flow conditions
- Design process includes evaluation of hydrodynamic loads, including potential water hammer effects
- Remote position indication



Squib Valve Design Attributes

- ESBWR DCD Tier 2 Section 6.3.2 specifies design attributes for GDCS squib valves, including:
 - Horizontally mounted, straight through, long duration submersible, pyrotechnic-actuated, non-reclosing valve with metal diaphragm seals and flanged ends
 - Quality Group A, Seismic Category I, ASME Section III Class 1
 - No internal fragments or missiles following actuation
 - Valves meet minimum flow coefficient at full GDCS flow
 - Valve manufacturer performs full flow test and provides test data
 - Remote position indication

GDCS Flow Path

- Each GDCS injection line makes U-shape bottom loop with squib valve at lowest point with no elevated loops
- Water in GDCS line between squib valve and RPV will prevent gases from entering this line segment
- GDCS piping from squib valve to GDCS pool designed to be self-venting
- Following installation, ITAAC will provide assurance that as-built GDCS piping provides venting
- During refueling outages, test connections allow for flushing GDCS lines to remove any gases
- Upon GDCS actuation, water head sweeps away gases that might come out of solution during plant operation

Conclusion

- GDCS designed to allow gravity-driven reactor cooling flow upon squib valve actuation following reactor depressurization
- ITAAC will confirm GDCS piping installed in accordance with design
- IST activities during refueling outages will remove gases that might interfere with GDCS flow



ACRS Subcommittee Presentation
ESBWR Design Certification Review

Discussion/Committee Questions