

# **Official Transcript of Proceedings**

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UNITED STATES OF AMERICA  
NUCLEAR REGULATORY COMMISSION  
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ADVISORY COMMITTEE ON REACTOR SAFEGUARDS  
(ACRS)  
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AP1000 REACTOR SUBCOMMITTEE  
+ + + + +  
OPEN SESSION  
+ + + + +  
WEDNESDAY  
FEBRUARY 7, 2018  
+ + + + +  
ROCKVILLE, MARYLAND  
+ + + + +

The Subcommittee met at the Nuclear  
Regulatory Commission, Two White Flint North, Room  
T2B1, 11545 Rockville Pike, at 1:02 p.m., Harold B.  
Ray, Chairman, presiding.

COMMITTEE MEMBERS:

HAROLD B. RAY, Chairman  
RONALD G. BALLINGER, Member  
DENNIS BLEY, Member  
CHARLES H. BROWN, JR., Member

1 MICHAEL CORRADINI, Member  
2 VESNA B. DIMITRIJEVIC, Member  
3 WALTER L. KIRCHNER, Member  
4 JOSE A. MARCH-LEUBA, Member  
5 DANA A. POWERS, Member  
6 JOY L. REMPE, Member  
7 PETER C. RICCARDELLA, Member  
8 GORDON R. SKILLMAN, Member  
9 JOHN W. STETKAR, Member  
10 MATTHEW W. SUNSERI, Member  
11  
12 ACRS CONSULTANT:  
13 UPENDRA ROHATGI  
14  
15 DESIGNATED FEDERAL OFFICIAL:  
16 WEIDONG WANG  
17  
18 ALSO PRESENT:  
19 CLINT ASHLEY, NRO  
20 JAMES BRADLEY CHAMBERLAIN, Southern Nuclear\*  
21 JASON EISENHAUER, Westinghouse\*  
22 DONALD HABIB, NRO  
23 JESSE KLINGENSMITH, Westinghouse\*  
24 YUEN-LI LI, NRO

1 KEVIN MCNAMEE, Westinghouse  
2 GREG MAKAR, NRO  
3 ANDREW PFISTER, Westinghouse  
4 SHAYAN SINHA, Westinghouse  
5 COREY THOMAS, Southern Nuclear  
6 BOYCE TRAVIS, NRO  
7 ANDREA D. VEIL, Executive Director, ACRS  
8 KAI ZHANG, Westinghouse\*

9  
10 \*Present via telephone  
11  
12  
13  
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## P R O C E E D I N G S

1:02 p.m.

MEMBER RAY: Well, now that we've got essentially everyone here, we'll please call the meeting to order.

This is a meeting of the AP1000 Reactor Subcommittee, a Standing Subcommittee of the Advisory Committee and Reactor Safeguards.

I'm Harold Ray, Chairman of the Subcommittee.

ACRS members in attendance are Ron Ballinger, Matt Sunseri, Dick Skillman, Dana Powers will join us shortly as will Mike Corradini, Dennis Bley, John Stetkar, Jose March-Leuba, Walt Kirchner, Charlie Brown, Joy Rempe and Vesna Dimitrijevic. And, thank you, Pete Riccardella.

He wasn't there when I wrote my list down and so I missed him.

Thank you.

Also, ACRS Consultant, Upendra Rohatgi is present and will assist the Subcommittee in this review.

Weidong Wang is the Designated Federal Official for the meeting.

In this meeting, the Subcommittee will

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1 review a Westinghouse Topical Report, WCAP 17938-P  
2 Revision 2 entitled AP1000 In-Containment Cables and  
3 Non-Metallic Insulation Debris Integrated Assessment  
4 and the associated staff Safety Evaluation Report.

5 The WCAP proposed changes to Tier 2  
6 provisions of the existing AP1000 DCD. These  
7 provisions are critical to ensuring that the natural  
8 circulation function of the passive design is not  
9 compromised by debris which might result from a pipe  
10 break or from chemical effects following flooding.

11 These are GSI 191 considerations as  
12 uniquely applied to natural circulation, differential  
13 pressures in the AP1000.

14 The existing DCD requires that zero debris  
15 result from a pipe break or flooding. And, this was  
16 to be achieved by use of insulation and chilling  
17 materials and by location or protection of electrical  
18 cable so that debris would not result from pipe rupture  
19 or flooding.

20 Further development of the design has made  
21 it necessary to use alternate materials for which  
22 suitable equivalency, those words in quotes, must be  
23 demonstrated and to establish more specific  
24 requirements for the electrical cable.

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1           The standard of zero debris remains a  
2           requirement -- remains the requirement, therefore, our  
3           review is to establish whether the alternate materials  
4           and requirements addressed by the WCAP that we are  
5           reviewing maintain that -- comply with that  
6           requirement.

7           We will hear presentations from the NRC  
8           staff and the representatives from the design  
9           certification holder.

10          We have received no written comments or  
11          requests for time to make oral statements for members  
12          of the public regarding today's meeting.

13          Part of the presentations I expect after  
14          our break will be closed in order to discuss information  
15          that is proprietary to Westinghouse and its contractors  
16          pursuant to 5 U.S. Code 552(b)(c)(4).

17          Attendance at these portions of the meeting  
18          that deal with such information will be limited to the  
19          NRC staff and its consultants, Westinghouse and those  
20          individuals and organizations who have entered into  
21          appropriate confidentiality agreement with them.

22          Consequently, we will need to confirm at  
23          that time that we have only eligible observers and  
24          participants in the room for the closed portion.

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1           The Subcommittee will gather information,  
2           analyze relevant issues and facts and formulate  
3           proposed positions and actions as appropriate, and this  
4           is important, for deliberation by the Full Committee.

5           The rules for participation in today's  
6           meeting have been announced and are part of the Notice  
7           of this meeting published previously in the Federal  
8           Register.

9           A transcript is being kept and will be made  
10          available as stated in the Federal Register Notice.

11          Therefore, we request that participants  
12          in this meeting use the microphones located throughout  
13          the room when addressing the Subcommittee.

14          The participants should first identify  
15          themselves and speak with sufficient clarity and volume  
16          so that they may be readily heard.

17          We'll now proceed with the meeting, but  
18          first, let me turn to Don and ask if he has any opening  
19          remarks.

20                 MR. HABIB: Thank you very much and I  
21                 appreciate this opportunity to make the presentations  
22                 and we don't have any other remarks at this time.

23                 MEMBER RAY: That's fine.

24                 Then, I'll turn it over to which ever of

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1 the gentlemen here will take charge for Westinghouse  
2 and please you to proceed.

3 MR. SINHA: Good afternoon.

4 My name is Shayan Sinha, I will be  
5 presenting the public slide material for Westinghouse.

6 We also wanted to thank you for the  
7 opportunity, we are grateful to be able to discuss this  
8 topical report with the ACRS.

9 I'd like to begin by talking about a little  
10 bit of background of the GSI 191 related design basis,  
11 specifically, how they apply to AP1000.

12 So, the resolution of GSI 191 requires  
13 nuclear plants to place limits on potential sources  
14 of debris inside containment. This is to ensure that  
15 you don't have potential -- some blockage following  
16 a loss of coolant accident where there's a pipe break  
17 inside containment.

18 The AP1000 actually significantly reduces  
19 and eliminates many of the debris sources that are found  
20 in typical Generation II plants. And, by incorporating  
21 a lot of these lessons learned into the design prior  
22 to construction and operation.

23 The maximum allowable fibrous debris  
24 inside containment for AP1000 is 6.6 pounds. And, this

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1 is all attributable to latent debris. So, in other  
2 words, the expectation is that following a loss of  
3 cooling accident, there would be no debris generated  
4 as a result of that -- fibrous debris generated as a  
5 result of that LOCA.

6 There's metal reflective insulation used  
7 within the AP1000 extensively including only insulation  
8 for the reactor vessel itself.

9 The DCD provides requirements of what must  
10 be demonstrated if and AP1000 decides to use a type  
11 of insulation other than metallic reflective  
12 insulation, or MRI. And, these requirements include  
13 that we need to demonstrate that the insulation is a  
14 suitable equivalent to MRI for the purposes of GSI 191.

15 And, in order to qualify as a suitable  
16 equivalent, testing must be performed to show that  
17 debris is not generated or transported.

18 And, finally, there's a requirement in the  
19 DCD that states that the suitable equivalent testing  
20 must be approved by the NRC.

21 So, the purpose of this topical report,  
22 WCAP 17938, is to gain approval for three items.

23 The first item is to establish a zone of  
24 influence applicable to AP1000 in-containment cables

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1 that demonstrates that the cabling will not generate  
2 debris following a LOCA.

3 The second is to gain approval for that  
4 the non-metallic insulation used in the AP1000 reactor  
5 vessel insulation system is a suitable equivalent to  
6 MRI for the purposes of GSI 191.

7 And then, the third item is to gain approval  
8 for the AP1000 to utilize the approved methodology for  
9 defining debris generation break size from NEI Guidance  
10 Document 04-07.

11 So, this methodology is generically  
12 approved, is part of the safety evaluation for NEI 04-07  
13 by the NRC. However, what we're trying to do in this  
14 topical report is gain approval to use this methodology  
15 for AP1000.

16 And, as I'll demonstrate in the -- I'll  
17 discuss in the next few slides, testing analysis has  
18 been completed that shows that the cabling and the NMI  
19 does not generate debris following a LOCA.

20 So, there was two factors that led to the  
21 creation of this topical report, WCAP 17938. The first  
22 factor is that the AP1000 -- there was an issue  
23 identified that the AP1000 cabling contained fibers  
24 and other materials that were not originally considered

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1 as a debris source when -- as part of the AP1000 GSI  
2 1919 related evaluations.

3 So, as this issue was resolved, corrective  
4 actions were taken and these corrective actions  
5 included developing a testing program to establish a  
6 zone of influence for the containment cabling.

7 And, the second factor is that the  
8 non-metallic insulation is required for certain  
9 subcomponents of the reactor vessel insulation system  
10 because some of these subcomponents performed functions  
11 other than insulation such as shielding or in vessel  
12 retention.

13 So, if you take a look at this diagram here  
14 to the right, the CA31 module shown at the top of the  
15 reactor vessel performs a shielding function. It is  
16 needed to prevent radiation streaming upward into  
17 containment.

18 And then, the lower neutron shield which  
19 is more on the bottom half of the reactor vessel shown  
20 here forms a shielding function that provides shielding  
21 for the lower reactor cavity.

22 Then, finally, the water inlet doors at  
23 the very bottom of the vessel support this in vessel  
24 retention support for certain beyond design basis

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1 events.

2 MEMBER REMPE: So, when I was reviewing  
3 the information for this meeting, I kept thinking to  
4 myself, jeepers, shouldn't Westinghouse have known that  
5 the cabling -- I mean, this isn't your first PWR, right,  
6 that would exist and these materials might exist and  
7 that you might need this material?

8 And, why, you know, right now, the way you  
9 presented it, it was like, well, okay, we figured you  
10 might have to do some qualification for NMI.

11 But, I just was surprised. I mean, did  
12 this all come as a surprise to you all and you didn't  
13 think about it during design certification?

14 MR. PFISTER: So, I'll take the question  
15 on cabling first because they're separate.

16 Traditionally, cabling isn't considered  
17 a source of debris for GSI 191. As we try to do, we  
18 look into what the industry has done. That's not a  
19 source that's generally being considered as a debris  
20 generation source.

21 Or, if it is, it's just rolled into the  
22 other margin for operating plants.

23 And, the insulation design within cabling  
24 is going to be vendor specific.

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1           And so, as we went through the process of,  
2           you know, defining the specification for cabling,  
3           working with vendors and procuring cabling, you know,  
4           we became aware that there is fibrous materials as  
5           insulation within some cables, not all cables. But,  
6           that is a material that cable vendors use.

7           So, within the design certification,  
8           there's some generic language that says, you know,  
9           insulation or other materials won't become debris.

10          And, because we work through NEI guidance  
11          where we have established ZOIs, whether it was through  
12          an NEI program or a PWR OG program or something specific  
13          for AP1000, there had never been an established ZOI  
14          for cabling.

15          So, we identified, this is a gap and said,  
16          not necessarily that it is a debris source, but it  
17          certainly could be one. So, we had to take the  
18          necessary steps to say, where must it be located  
19          relative to high energy lines in order to preclude it  
20          from being a debris source?

21          So, that's where this came from.

22          MEMBER RAY: Where -- you said -- well,  
23          we are going to have some specific questions about the  
24          testing of cabling and so on. Is that best addressed

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1 in the proprietary portion of the discussion?

2 MR. PFISTER: Yes.

3 MEMBER RAY: Okay, go ahead, Walt.

4 MEMBER KIRCHNER: This might be  
5 proprietary, too, so I can hold it. I was just curious  
6 what the shielding material is that --

7 MR. PFISTER: So, we use two different  
8 shielding materials. So, I'll speak generically about  
9 them.

10 MEMBER KIRCHNER: Okay, or you can just  
11 wait until later and we can --

12 MR. PFISTER: Yes, and then I can answer  
13 it generically now and then --

14 MEMBER KIRCHNER: And, not to force you  
15 all the way back to slide two or one, how do you know  
16 you have 6.6 pounds of latent material? And, how do  
17 you measure that and what's the -- is there a tech spec  
18 that governs operation as a result of that?

19 MR. PFISTER: So, as to the shielding  
20 question first and --

21 MEMBER KIRCHNER: There's some precision  
22 there --

23 MR. PFISTER: -- the 6.6 --

24 MEMBER KIRCHNER: -- that's often hard to

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1 measure in light weight --

2 MR. PFISTER: Yes.

3 MEMBER KIRCHNER: -- material.

4 MR. PFISTER: So, the shielding material,  
5 so within the lower neutron shield, we use a boron  
6 silicone material. And, to note, that all the  
7 shielding is non-safety related shielding. So, this  
8 is shielding that we only credit during normal  
9 operations and shutdown, not shielding that we credit  
10 for accidents.

11 And, within CA31, which is shield --  
12 essentially shield blocks that will go into more detail  
13 --

14 MEMBER RAY: Let interrupt you for just  
15 a second.

16 You were asking about the 6.6, weren't you?

17 (OFF MICROPHONE COMMENTS)

18 MR. PFISTER: He asked -- so, I was  
19 answering the question about shielding then I was going  
20 to answer --

21 MEMBER RAY: Okay.

22 MR. PFISTER: -- the 6.6.

23 MEMBER RAY: I missed the --

24 MR PFISTER: And, within the CA31 which

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1 are 60 individual blocks inherently designed within  
2 the refueling cavity floor, we use boron carbide for  
3 shielding there.

4 So, relative to your second question, how  
5 do we demonstrate 6.6 pounds? And so, ultimately,  
6 that's something that must be demonstrated prior to  
7 fuel load and prior to each refueling.

8 It's done in almost the exact same way you  
9 would do it for an operating PWR is that, as part of  
10 your containment cleanliness program, you have to  
11 quantify and demonstrate containment cleanliness. You  
12 typically do that, they almost call it a white glove  
13 test where you go around and you test certain areas.

14 And then, you know, the -- I think the  
15 industry standard is, of the debris that you quantify  
16 for all of containment, the assumption is 15 percent  
17 of that debris is fibrous.

18 And so, when they do their containment  
19 cleanliness and they go in, you know, to their pre-fuel  
20 load inspections, you know, as part of their containment  
21 cleanliness program, that would define how you measure  
22 the total amount of debris.

23 And then, industry standard is 15 percent  
24 of that is assumed to be fibrous.

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1                   MEMBER KIRCHNER: What struck me was that  
2 the 6.6 is a fairly precise number.

3                   MR. PFISTER: Yes. And so, the 6.6 was  
4 established during design certification as part of the  
5 fuel assembly and sump testing. And so, that's  
6 essentially the limit we were able to push our fuel  
7 assembly testing to.

8                   You know, with the combination of latent  
9 debris and chemical debris to show we didn't get  
10 unacceptable DP across the fuel.

11                  MEMBER KIRCHNER: No, I knew the basis for  
12 the amount, but I was curious about how you measure  
13 it to that precision.

14                  MEMBER RICCARDELLA: Are your limits  
15 smaller than a conventional PWR because of the passive  
16 nature of the system?

17                  MR. PFISTER: Essentially, the answer is  
18 yes. So, you'll see a range of limits within PWRs.  
19 You'll see what they consider high fiber plants where  
20 the limits are much, much higher.

21                  And, you'll see low fiber plants. You  
22 know, we're probably the lowest of the low fiber plants.

23                  But, a lot of that's driven by acceptable  
24 DP we can withstand due to the passive recirculation.

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1 MEMBER RICCARDELLA: Okay, thank you.

2 MR. SINHA: Okay, so, on slide six, this  
3 just summarizes the results that came from our program  
4 to evaluate the non-metallic insulation and the  
5 in-containment cables.

6 So, firstly, the first bullet talks about  
7 the zone of influence of four diameters. There are  
8 four times the debris generation break size was  
9 established for in-containment cables. And, this was  
10 done through an extensive large-scale jet impingement  
11 testing program which was conducted at a facility that  
12 had been previously used by the pressurized water  
13 reactor zoners group for other operating plant  
14 evaluations related to GSI 191.

15 And so, this cable as the OI, was able to  
16 be incorporated into the design requirements and then  
17 the location of the cables and the cable trays, we  
18 consider them as, you know, as the locations were  
19 developed for the plant.

20 The WCAP also invokes the alternative  
21 evaluation methodology from NEI 04-07 for determining  
22 the limiting RCS break size, you know, in our debris  
23 generation evaluations.

24 And so, this was done through a structural

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1 evaluation that reviewed whether the hot leg or cold  
2 legs would fully separate following a loss of coolant  
3 accident.

4 And then, this is compared against the NEI  
5 04-07 criteria and shown to be acceptable for AP1000.

6 And then, finally, jet impingement and  
7 submergence testing program was performed for the  
8 non-metallic insulation. And, the insights from this  
9 programs were used to strengthen the design of the  
10 elements for the reactor vessel insulation system.

11 So, essentially, this resulted in design  
12 changes that used a thicker and more robust  
13 encapsulation for the neutron shield blocks.

14 And then, the final slide is the  
15 conclusions for the public portion.

16 The jet impingement testing program that  
17 was conducted was used to justify a cable ZOI for L/D  
18 for the AP1000 in-containment cabling.

19 The cabling was found to contribute no post  
20 LOCA debris.

21 The application of the NEI 04-07 ultimate  
22 break methodology was acceptable for the AP1000. And  
23 then, the encapsulated non-metallic insulation was  
24 found to not produce debris when subjected to the jet

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1       impingement from the limiting RCS lines -- line breaks.

2               And then, the cabling and the NMI were  
3       evaluated for chemical debris and found that neither  
4       types of components would contribute to chemical  
5       debris.

6               And, this -- the conclusions related to  
7       jet impingement and chemical debris were used to make  
8       the conclusion that the non-metallic insulation in the  
9       reactor vessel insulation for AP1000 is a suitable  
10      equivalent to MRI for the purposes of GSI 191.

11              And then, I just wanted to highlight the  
12      overall conclusion that the WCAP justifies that there's  
13      no debris -- no new debris generated for AP1000 from  
14      the cables and the non-metallic insulation.

15              So, that is all we have for the public  
16      portion. We can open it up for questions.

17              MEMBER BROWN: Just a question on the  
18      previous slide, two previous slides, six.

19              What the design was changed to use thicker  
20      and more robust -- what's meant by more robust? I  
21      missed that if you --

22              MR. SINHA: Yes, we're going to detail it  
23      more --

24              MEMBER BROWN: You're going to talk about

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1       that -- okay, then, we'll wait.

2                   MR. SINHA:   So, it's the weld type that  
3       we use.

4                   MEMBER BROWN:  It's the what -- the weld  
5       --

6                   MR. SINHA:   We use a more robust weld type.

7                   MEMBER BROWN:  -- the welding --

8                   MR. PFISTER:  The welding techniques that  
9       we use.

10                  MEMBER BROWN:  Okay, all right.

11                  MEMBER RAY:   Any other questions?

12                  MR. ROHATGI:   Anyway, are you going to  
13       change the weld technique that you'll discuss later  
14       on?

15                  MR. SINHA:   Yes.

16                  MR. ROHATGI:   Because they're not going  
17       to be all the same techniques?

18                  MR. SINHA:   Correct.

19                  MR. ROHATGI:   Okay.

20                  MR.     SINHA:       Yes,     the     different  
21       subcomponents have different weld techniques.

22                  MEMBER RAY:   Okay, we've got the scope of  
23       the discussion here clear, I think, and the purpose  
24       of it and so on.

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1 Anything else?

2 (NO RESPONSE)

3 MEMBER RAY: If not, we will have an  
4 opportunity for public comment following the staff open  
5 discussion.

6 MR. SINHA: I apologize, I actually had  
7 -- there's one other comment I wanted to make was about  
8 the utility -- the licensee, Southern Nuclear wanted  
9 to make a comment about the usage of this topical report  
10 for Vogtle Units 3 and 4.

11 MEMBER RAY: Okay, that's fine. Please  
12 --

13 MR. THOMAS: Yes, this is Corey Thomas from  
14 Southern Nuclear, Vogtle 3 and 4 Licensing.

15 First of all, this WCAP is important to  
16 us from a construction sequence to allow us to continue  
17 with the installation of non-metallic insulation inside  
18 containment and installation of the cable inside  
19 containment.

20 Thank you.

21 MEMBER RAY: Yes, and because of that, we  
22 were all geared up to write your letter this week.  
23 But, we understand that we've got a little more time.  
24 So, we'll have the Full Committee consider whether

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1       they wish to write a letter on right now forecasted  
2       to be the April Full Committee meeting.

3               Okay, again, we're in public session. We  
4       will ask for any public comment, but following the staff  
5       presentation.

6               So, we'll trade places now and proceed with  
7       the staff and then return -- we may get to the closed  
8       session before our break if things continue to move  
9       this quickly.

10              And, you'll want to remove that card,  
11       that's good.

12              Okay, Don, could you launch the ship,  
13       please?

14              MR. HABIB: Thank you and good afternoon.

15       The staff's here to make our presentation -- public  
16       presentation for the AP1000 In-Containment Cables  
17       Non-metallic Insulation Debris Integrated Assessment  
18       and the draft Safety Evaluation that it prepared.

19              So, these are our speakers and they'll  
20       introduce themselves.

21              I'm going to turn it over to Clint Ashley  
22       who's the first presenter.

23              MEMBER RAY: Before you do, let me say,  
24       on the agenda I was given, maybe I should direct to

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1 Weidong, shows only Westinghouse speaking in the closed  
2 session. That implies to me that you don't have any  
3 closed material to present.

4 MR. HABIB: That's correct. But we do --

5 MEMBER RAY: But, we may have questions  
6 for you that need to be discussed in closed session.

7 So, I just want to make that clear to everyone that  
8 staff will remain with us for purposes of questions  
9 that involve proprietary material and that could be  
10 relevant to the discussion we're about to have.

11 So, anyway, for all intents and purposes  
12 you'll be with us also in the closed session.

13 Go ahead.

14 MR. ASHLEY: So, good afternoon.

15 My name is Clint Ashley. I'm a Technical  
16 Reviewer in the Office of New Reactors.

17 And, we'd all like to thank you for the  
18 opportunity to present our draft Safety Evaluation on  
19 this particular topical report.

20 And, we do look forward to addressing any  
21 of your questions. And, as you mentioned, I think these  
22 slides are non-proprietary. But, we recognize that  
23 some of the discussions may go into proprietary  
24 information and we'll hold those over until the closed

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1 session.

2 So, going back one slide, we're just going  
3 to cover a few topics here initially and I'll discuss  
4 the introduction and overview and then we'll roll right  
5 into the staff's approach and our findings.

6 The next slide shows the presenters here,  
7 members of the technical team as well as the project  
8 manager. We also worked closely with NRR Technical  
9 Reviewer, Steve Smith, as part of this process. So,  
10 I wanted to make sure I acknowledged their involvement  
11 in this review.

12 So, the next several slides really just  
13 try to explain at a base level what a topical report  
14 is for those that may not be familiar with them, what  
15 guidance the staff used during the review.

16 And, you've already heard Shayan this  
17 morning what this topical report is all about. So,  
18 I'll probably be able to breeze through some of those  
19 background slides.

20 The -- a topical report is a standalone  
21 document containing technical information about a  
22 nuclear power plant safety topic and provides the  
23 technical basis for a licensing action.

24 And, typically, the objective is to add

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1 value by improving the efficiency of other licensing  
2 processes. For example, the process for reviewing  
3 license amendment requests or we call them LARs.

4 They improve the efficiency of the  
5 licensing process by allowing the staff to review  
6 proposed methodologies, designs or other safety related  
7 subjects on a generic basis so that they may be  
8 implemented by reference by multiple licensees once  
9 approved by the NRC staff.

10 And, in this particular topical report,  
11 Westinghouse updates the AP1000 plant safety analysis  
12 related to generic safety issue 191 which is concerned  
13 with the assessment of debris on pressurized water  
14 reactor sump performance.

15 The WCAP seeks review for three items and  
16 we'll talk about these in the next few slides.

17 The main guidance for evaluating this  
18 topical report is the Nuclear Energy Institute, NEI  
19 document 04-07. And, that was published in 2004 time  
20 frame, if I'm not mistaken.

21 The NEI 04-07 submission as approved in  
22 accordance with the staff's Safety Evaluation provides  
23 an acceptable overall guidance methodology for the  
24 plant specific evaluation sump performance.

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1 And, that staff safety evaluation was also  
2 completed in 2004 time frame.

3 One thing the NEI 04-07 document mentions  
4 is that it didn't really have enough information to  
5 conclude anything about chemical effects other than  
6 more study was needed.

7 So, the industry put together another  
8 topical report, 16530, that the staff approved. And,  
9 I believe that approval was completed in maybe the 2008  
10 time frame.

11 So, as Westinghouse already communicated  
12 earlier, the AP1000 safety evaluation really is based  
13 on a zero loss of coolant accident generated fibrous  
14 debris source term.

15 So, no LOCA generated fibrous debris,  
16 they've gotten rid of all that fibrous insulation that  
17 a lot of operating plants are plagued with.

18 And, the way they achieve this is through  
19 the use of metal reflective insulation. This is on  
20 main coolant piping, steam generators, all those large  
21 main coolant system components.

22 The DCD also does allow or permit a suitable  
23 equivalent insulation. And, as part of this WCAP,  
24 Westinghouse recognizes that there's going to be at

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1       least three locations for suitable equivalent  
2       insulation to replace metal reflective insulation.

3               And, the last bullet on this slide, the  
4       DCD does specify that NRC approval is required to use  
5       a suitable equivalent insulation.

6               Westinghouse already communicated this  
7       information. It's about electrical cabling. And, it  
8       was -- I would view it as more of a discovery item as  
9       Andy Pfister had communicated. So, I don't think  
10      there's any need to brief anymore on this slide.

11              Next?

12              So, in light of the AP1000 design basis  
13      in which the AP1000 design does not generate fibrous  
14      debris during a LOCA, and that coupled with a detailed  
15      design reviews which took place on cabling and  
16      non-metallic insulation.

17              The WCAP seeks approval for the following  
18      three items.

19              And, the first one is zone of influence  
20      for electrical cabling.

21              The second is use of non-metallic  
22      insulation as a suitable equivalent to metal reflective  
23      insulation.

24              And, the last one is use of the NEI 04-07

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1 alternate evaluation methodology for assessment of  
2 debris generation.

3 And, the next slide talks about what it  
4 means to be a suitable equivalent insulation from a  
5 debris generation perspective.

6 Testing must be performed that subjects  
7 the insulation to conditions that bound the AP1000 plant  
8 conditions.

9 Testing demonstrates that debris would not  
10 be generated to include chemical debris.

11 And, this must be approved by the NRC.

12 That's all called out in the DCD.

13 And so, the three requests for NRC approval  
14 are detailed in the subsequent slides.

15 And, at this point, I'll turn it over to  
16 Boyce Travis who's going to talk through the items one  
17 and two.

18 MEMBER RAY: Boyce, before you begin, let  
19 me just say that these points that were just covered  
20 about in quite detail in the DCD were in anticipation  
21 that we would be here having this discussion at the  
22 time.

23 That sort of detail isn't spelled out  
24 later, but it was just in unresolved matters as to

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1       whether MRI would be totally satisfactory throughout  
2       the design.   So, there was a provision made for suitable  
3       equivalent.   Here we are.

4               Go ahead.

5               MR. TRAVIS:   As Clint mentioned, my name's  
6       Boyce Travis.   I'm a Technical Reviewer in the  
7       Containment Branch at NRO.   I'll be discussing the  
8       first two requests in the WCAP.

9               So, item one of the WCAP requests approval  
10       for a ZOI for electrical cabling and containment.   In  
11       order to determine the acceptability of this, staff's  
12       goal was to ensure that the tested cables represented  
13       a bounding set for all the AP1000 cables and to ensure  
14       the test conditions for the facility bound the target  
15       conditions expected in the AP1000 plant.

16               In order to make this determination, staff  
17       observed the cable jet impingement testing facility.

18       We assessed the applicability of the test facility  
19       to produce the conditions representative of the AP1000  
20       plant.

21               And, in doing so, we reviewed both the test  
22       material -- physical test materials and the prepared  
23       test reports for the facility.   And, as part of our  
24       review, we issued RAIs.

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1                   And some additional detail on how we came  
2                   to our finding is on the following slide.

3                   So, as part of the review, staff looked  
4                   at observations from previous NRC visits to the test  
5                   facility.

6                   In about six, seven years ago, the Office  
7                   of Research visited the facility which was, at the time,  
8                   being contracted by the PWR Owners' Group. At that  
9                   time, the test facility was instrumented to determine  
10                  whether it was capable of producing jet conditions that  
11                  would be representative of the large PWR.

12                  At the time, the group from research found  
13                  that they thought it would be able to do so. And, this  
14                  topical report leverages some of that instrumented  
15                  testing in its evaluation of the test facility that  
16                  they used for both the cabling and the NMI.

17                  So, as part of the review and the topical  
18                  report, the test conditions that were generated by the  
19                  facility for this testing were compared to the facility  
20                  conditions from the previous testing to verify both  
21                  repeatability and the expected target conditions were  
22                  at jet impingement pressures expected for a PWR, in  
23                  this specific case, the AP1000.

24                  MEMBER RAY: Yes, I think we have some

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1 questions perhaps on this point. Our consultant will  
2 discuss them.

3 I don't think they will go into proprietary  
4 material. They have to do with process.

5 MR. TRAVIS: Okay.

6 MEMBER RAY: And, your oversight of how  
7 you're auditing of it.

8 But, if they do, then, of course, we'll  
9 stop and resume after we go into -- but we should discuss  
10 in the open session as much as we can that's not  
11 proprietary.

12 So, go ahead.

13 MR. ROHATGI: Yes, looking at this, when  
14 you did the cable testing and you're saying the  
15 conditions will bound the LOCA conditions in AP1000?

16 MR. TRAVIS: That's correct.

17 MR. ROHATGI: But, that didn't come out  
18 very clearly because, I don't want to go in detail of  
19 the size of the jet and all, but --

20 MEMBER RAY: Try and use the other  
21 microphone also. There's two microphones not being  
22 used there.

23 MR. ROHATGI: Okay, so, what I wanted to  
24 know is that how do you decide that this test facility

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1 bounds the condition expected in the containment?

2 MR. TRAVIS: Sure.

3 So, I'll try to do this at a high level  
4 and that's all I can do in the open session.

5 But, with respect to the pressure produced  
6 by the -- so, the previous testing performed at the  
7 facility was well instrumented. And so, for an  
8 expected conditions in the -- for expected test  
9 reservoir conditions, we have an expected pressure  
10 profile that's going to be generated by the jet.

11 At all conditions -- I'll say this, based  
12 on the locations that the cables were placed during  
13 testing and the distance the cables were from the jet  
14 -- from the facility exit nozzle, the instrumented  
15 conditions led staff to believe that for those -- for  
16 the -- specifically with regard to the cables, once  
17 we get into talking about the blocks, it becomes a little  
18 more nebulous.

19 But, specifically with regard to the  
20 cables, the pressure the cables experienced from the  
21 jet is -- would be equal to a greater than that they  
22 would see in the AP1000 based on the instrumented test  
23 facility and the reservoir conditions of the test  
24 facility as was reviewed by the staff.

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1                   MR. ROHATGI: So, the jet has a velocity,  
2 I don't know, stop me if I go in anything -- so the  
3 jet which is running impinged has a velocity profile  
4 and the center of the jet will have the largest static  
5 pressure?

6                   MR. TRAVIS: That's correct.

7                   MR. ROHATGI: I mean static pressure may  
8 be uniform. So, the question, so, when you impinge  
9 on this cable, have you moved around the jet to see  
10 each of the cables is subjected to largest static  
11 pressure or it was just one short?

12                   And, because the damage was -- seems to  
13 be random from some cable on the left were damaged or  
14 sometimes on the right, but how do they connect to the  
15 center of the jet?

16                   MR. TRAVIS: So, I think we're going to  
17 be getting in to proprietary discussion very quickly  
18 there.

19                   MR. ROHATGI: Yes, I'll wait, I'll wait.

20                   MR. TRAVIS: So, if we could hold that to  
21 where I can fully answer the question?

22                   MR. ROHATGI: That's fine, thank you.  
23 Okay, thank you.

24                   MR. TRAVIS: Okay, so, I guess I'll go back

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1 and try and continue -- pick up where we left off.

2 So, as I was saying, as part of the review,  
3 staff determined that the facility produced conditions  
4 that would bound the expected conditions at a distance,  
5 a scaled distance from the jet as would be experienced  
6 in the AP1000.

7 And so, as part of testing, the applicant  
8 performed tests at different scale, length over  
9 diameter ratios and determined a ZOI for what -- when  
10 damage would occur, when the onset of damage would occur  
11 and when no damage would occur due to cables.

12 And then, did repeated tests to determine  
13 -- to make sure that those conditions were represented  
14 or that those test conditions could be repeated.

15 And so, that was, at one point, the  
16 applicant conservatively made their request that their  
17 acceptable ZOI would be that which showed no debris  
18 generation.

19 The primary concern is quantifying a ZOI  
20 for the cables based on experimental observation and  
21 debris generation. And so, by choosing a ZOI that  
22 showed no damage to the cables, the staff felt that  
23 was a conservative choice in making what would be an  
24 acceptable ZOI for cable damage.

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1 I'll note that the applicant tested both  
2 aged and unaged cables to serve as a representative  
3 bounding set. And, those cables were aged both  
4 thermally and radiation -- they were fresh and unaged  
5 cables -- fresh and unaged cables tested both from a  
6 thermal perspective and a radiation perspective.

7 We can move on to the next slide.

8 MEMBER RAY: Could you repeat that for the  
9 record just to make sure it's --

10 MR. TRAVIS: Sure.

11 MEMBER RAY: -- clear. It was a little  
12 --

13 MR. TRAVIS: So, the --

14 MEMBER RAY: -- trailing off at the end  
15 there.

16 MR. TRAVIS: Yes.

17 There were aged and unaged cables tested.  
18 Aging consisted of both of thermal and radiation aging.

19 MEMBER POWERS: The thermal aging and the  
20 radiation aging were done together or separate?

21 MR. TRAVIS: That I would to -- I believe  
22 separately, but I would have to go back and check that  
23 to be sure.

24 MEMBER POWERS: Well, NRC funded Roger

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1       Cliff to look at in-containment cable degradation  
2       during service life. And, what he observed was that  
3       cable damage due to radiation and thermal conditions  
4       were synergistic. So, why would you do the aging  
5       separately if there's synergism between thermal and  
6       radiation damage?

7               I mean, this is research funded by the NRC,  
8       it's publically available.

9               MR. TRAVIS: So, I think that's a fair  
10       question. As I said, I'd have to go back and look at  
11       when the aging was performed.

12              I will say that, yes, because at the test  
13       facility and saw the cables. They were tested and I  
14       have verified the aging reports that do exist.

15              But, if we can hold my full answer to closed  
16       session, I'll go back and -- I have the topical report  
17       right there, and go back and look and make sure that  
18       I have a complete answer for you --

19              MEMBER POWERS: I'm very patient.

20              MR. TRAVIS: -- in a few minutes.

21              MEMBER POWERS: -- I'm not going anywhere  
22       until Saturday.

23              MR. TRAVIS: Understood.

24              And so, back to the slides.

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1 With regards to the cabling, the staff  
2 found that the topical report provided an acceptable  
3 technical basis for determining no debris will be  
4 generated by the cables at or beyond the proposed ZOI.

5 The testing generated -- the testing as  
6 part of the WCAP demonstrated no debris generation would  
7 occur outside that ZOI. And, therefore, the staff  
8 determined that that ZOI was acceptable.

9 As part of this finding, the staff imposed  
10 the limitation and condition as part of the WCAP stating  
11 that performance of cables within the ZOI, if any are  
12 present, is outside the scope of the WCAP and any cabling  
13 that was located within the ZOI would have to be assessed  
14 by an applicant or a licensee referencing the AP1000  
15 and the WCAP to determine that it was acceptably  
16 protected.

17 MEMBER REMPE: I have a question. In the  
18 report that Westinghouse submitted, they concluded that  
19 chemical testing was not needed. Submergence testing  
20 was not needed. And, they cited several reasons.

21 And, in the first reason they said was  
22 because of a letter that ACRS wrote. And, you guys  
23 actually mentioned that, too. But, nobody said, in  
24 your letter, at least your draft, you didn't mention

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1       that that didn't seem like a very good reference to  
2       support that ACRS dismissed it.

3               And, I was a little offended that they would  
4       even try and use that.   Because I read what was in that  
5       ACRS letter, it sure didn't support that you didn't  
6       need that.

7               And, you're shaking your head yes, that  
8       was a bad thing to do and I would have made the applicant  
9       prove that sentence.

10              MR. TRAVIS:   For that discussion on  
11       chemical effects, you're correct.

12              MEMBER REMPE:   Okay.

13              MR. MAKAR:   What we did -- what we added  
14       to that was the -- or in addition to that letter, there  
15       were a phenomena identification and ranking table.  
16       And then, a subsequent analysis which wasn't mentioned  
17       in their topical report that addressed organic  
18       materials from a variety of standpoints.

19              And so, they -- the reason that cable  
20       materials haven't been included in our standard  
21       chemical effects evaluations is because, as aa debris  
22       material in and of themselves is they have fallen into  
23       the category of uncertainty if you apply the accepted  
24       methodology that's based on a lot of conservative

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1 assumptions.

2 And, there are things that we don't know  
3 about like cables and other materials whether they would  
4 form a chemical precipitant or not.

5 Organic materials, including cables, have  
6 been looked at in different ways. Now, from a chemical  
7 resistance standpoint, they -- some of these materials  
8 are chosen, for example, in the chemical process  
9 industry because they have such good resistance to  
10 chemicals and elevated temperatures at -- over a variety  
11 of chemical conditions.

12 It could change with aging some, but  
13 they're often a material choice for aggressive chemical  
14 conditions.

15 What they are always -- the way they're  
16 always included is from the acidification acids they  
17 can generate under a radiation field in the post LOCA  
18 environment.

19 And, that acid is then included in the  
20 calculations that determine how much pH buffer one needs  
21 in the containment.

22 From -- then there are other possible  
23 contributors from the organics like agglomeration of  
24 things that are in the water and whether that helps

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1       you or hurts you from a debris generation and transport  
2       standpoint.

3               And, also complexation.    So, if these  
4       materials from the -- if the organic materials can bind  
5       with metallic ions or other things in the water, they  
6       can increase the solubility which could mean less  
7       precipitant.

8               So, we've looked at organic materials from  
9       a variety of ways and I don't think that, you know,  
10      the references we made didn't go into all that detail.

11              MEMBER REMPE:   Yes.   Well, again, I mean  
12      there were several things they cited.   It was just one  
13      of them didn't seem to jive and I was surprised that  
14      that wasn't disputed in your draft SE.

15              MEMBER RAY:   Okay, I just -- before we go  
16      off of this slide, because later on, my guess is as  
17      someone was just mentioning, we're going to get into  
18      things where we may forget the last point.

19              I just wanted to reiterate it, performance  
20      of cables within the zone of influence, if any, is  
21      outside the scope of the WCAP.

22              We're not trying to decide how much damage  
23      --

24              MR. TRAVIS:   That's exactly right.

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1                   MEMBER RAY:  -- would result to cables  
2                   inside the zone of influence.

3                   MR. TRAVIS:  That's exactly right.

4                   The staff's finding is based on at 4-D there  
5                   will be no damage to the cables.

6                   MEMBER RAY:  Yes.

7                   MR. TRAVIS:  Inside that 4-D, the WCAP  
8                   makes no finding.

9                   MEMBER RAY:  This is a -- the safety  
10                  evaluation is very thorough, very detailed, talks about  
11                  a lot of things which, based on rules like this, really  
12                  aren't relevant because they're talking about things  
13                  that, at the end of the day, are outside the scope of  
14                  what we're doing.

15                  MR. TRAVIS:  I'll just make a note real  
16                  quick that I think NEI 04-07, technically, you could  
17                  define the onset of incipient damage as your acceptable  
18                  ZOI.  That's why I said the applicant chose to  
19                  conservatively define 4-D --

20                  MEMBER RAY:  Four instead of three.

21                  MR. TRAVIS:  -- or whatever.

22                  MEMBER RAY:  Yes.

23                  MR. TRAVIS:  I won't get into the numbers  
24                  in the open session.

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1 But, yes. And so, that's why we were very  
2 prescriptive in this determination.

3 MEMBER RAY: Yes.

4 MEMBER SKILLMAN: Can I ask this, please?

5 The gentleman from Vogtle announced that  
6 this is an important action that we're undertaking here.

7 With regard to that last bullet, are we  
8 in a zone of urgency where there are cabling activities  
9 going on at Vogtle that hinge on the last bullet?

10 MR. TRAVIS: I definitely don't have the  
11 expertise to answer that. Don, this project --

12 MEMBER SKILLMAN: That might be an  
13 inappropriate question. But, what I'm wondering is  
14 if there is a practical issue that is before us that  
15 we don't fully recognize?

16 MEMBER RAY: Well --

17 MR. TRAVIS: Yes, we're going to --

18 MEMBER RAY: I don't --

19 MR. TRAVIS: We don't have anything on  
20 that.

21 MEMBER RAY: I don't believe there is.

22 MEMBER SKILLMAN: I think the answer is  
23 no, but that I've just seen some --

24 MEMBER RAY: Let's just assume for now the

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1 answer's no. As I said, we were expecting to need to  
2 get our part of this done this month, now is such that  
3 we don't have to do it that quickly. That doesn't  
4 answer your question, but proceed.

5 MR. TRAVIS: Okay.

6 So, on the next slide, I'll start talking  
7 about WCAP item two which requests approval for the  
8 use of the non-metallic insulation as a suitable  
9 equivalent to the metal reflective insulation.

10 This approval is a -- would be at limited  
11 locations and would be bounded by testing and analysis  
12 as requested in the topical report.

13 I'll also, at a high level, note that the  
14 approval of the blocks differs significantly from the  
15 cables in that a single set of jet impingement testing  
16 is not enough to qualify the blocks.

17 The blocks themselves require both testing  
18 and analysis -- different types of testing and analysis  
19 to all form of coherent justification for why they act  
20 as a suitable equivalent.

21 And so, as part of the staff's review for  
22 the non-metallic insulation blocks, we have served both  
23 jet impingement and submergence testing, evaluated  
24 thermal expansion testing performed by the applicant,

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1       assessed the applicability of all the test facilities  
2       at the affirmation test facilities.

3               Again, reviewed test materials and test  
4       reports and issued a number of RAIs related to the  
5       non-metallic insulation.

6               In further detail on this next slide, for  
7       the qualifying the neutron shield blocks with regards  
8       to jet impingement testing, they were tested to qualify  
9       the ability -- their ability to withstand jet forces  
10      under a variety of ZOIs and block configurations  
11      including those both that they expected to be present  
12      in the plant and perhaps were more conservative in those  
13      expected in the plant.

14              This testing was then supported by a  
15      discussion of confined jet behavior as based on their  
16      location of the neutron shield blocks, it was not  
17      obvious that a free jet was the appropriate model.

18              And so, the confined space of the reactor  
19      cavity could have presented a compounding factor for  
20      the jet pressure.

21              And so, to qualify that confined space,  
22      the WCAP embarked on a literature review which the staff  
23      reviewed for applicability.

24              And, ultimately the staff's finding for

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1 jet impingement on the NMI was based on a combination  
2 of the presented testing and the literature review for  
3 confined space which allowed the staff to verify that  
4 the predicted NMI jet impingement pressure would be  
5 bounded by the test facility at the requested ZOI.

6 Ultimately, staff feels that the test  
7 demonstrated the request nature of the blocks and showed  
8 that in the actual plant, no debris would be generated  
9 due to a jet at the ZOI expected.

10 On the next slide, the qualifying NMI also  
11 required evaluation of chemical effects as the neutron  
12 -- some of the neutron shield blocks are below the  
13 containment flood up levels.

14 So, there's both a debris generation and  
15 a submergence piece to this.

16 Submergence testing measured releases for  
17 different levels of NMI encapsulation. Staff used the  
18 testing as a means to evaluate that design's ability  
19 to prevent chemical effects.

20 And, ultimately, the testing that the  
21 applicant performed demonstrated and showed that a  
22 complete encapsulation of the block was necessary to  
23 prevent the release of any elements that could generate  
24 chemical effects and that additional chemical effects

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1       resulting from materials inside the non-metallic  
2       insulation would be predicated on what the amount  
3       submerged aluminum was present in containment.

4               And so, that led us on the next slide --  
5       so the staff's finding is that the topical report  
6       provides an acceptable technical basis for determining  
7       that no debris will be generated by the blocks.

8               And, as there was no debris generated, the  
9       blocks themselves functioned as a suitable equivalent  
10      to MRI.

11              But, as part of this, staff imposed a pair  
12      of limitations and conditions on this subset of the  
13      WCAP.

14              The evaluation -- the staff's evaluation  
15      of the NMI is limited to debris generation only, not  
16      of their functions provided by the blocks such as the  
17      neutron shielding. That ability would be assessed by  
18      the suppliant on -- in the appropriate change process.

19              And, the staff also imposed a limit on the  
20      amount of aluminum in containment based on the blocks  
21      as the presence of additional aluminum combined with  
22      the submergence effects from the blocks.

23              Basically, the applicant performed their  
24      demonstration on the amount expected in the AP1000,

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1 further aluminum could influence the chemical effects  
2 generated from the submerged NMI.

3 And, for a discussion of the third request  
4 in the WCAP, I'm going to toss it back to Clint.

5 MR. ASHLEY: Next slide, please?

6 So, this third item, the -- and it's the  
7 final WCAP item, request approval to use the NEI 04-07  
8 alternate evaluation methodology.

9 And this methodology is approved in the  
10 Safety Evaluation associated with NEI 04-07 which was  
11 done back in 2004 time frame.

12 But, the AP1000 plant design didn't  
13 specifically invoke this section of the NEI 04-07  
14 document. So, they wanted to be up front in this  
15 topical report and show that they wanted to apply this  
16 particular section of the 04-07.

17 So, the NEI 04-07 alternate methodology  
18 in part assumes a double-ended guillotine break of the  
19 postulated pipe breaks in the reactor coolant system  
20 main coolant piping.

21 Unless that piping is physically limited.

22 And, it could be limited in a number of ways, piping  
23 restraints, supports, other structural members of  
24 piping stiffness that could be demonstrated by

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1 analysis.

2 So, if you have this main coolant pipe that  
3 is physically limited, the advantages that you can  
4 assess a smaller break size for debris generation  
5 purposes.

6 Next slide?

7 So, as far as the staff review approach  
8 is concerned, we looked at the topical reports  
9 implementation of the approved methodology.

10 We did focus our review on reactor coolant  
11 system main piping breaks that are physically limited.

12 We audited calculations and reports used  
13 to determine that limited separation for those  
14 postulated breaks.

15 And, we also reviewed the WCAP's  
16 methodology for determining essentially a result in  
17 break diameter for limited separation breaks and the  
18 associated zone of influence.

19 Next slide?

20 So, our finding, the applicant's approach  
21 to determine limited separation breaks, equivalent  
22 break diameter and zone of influence was reasonable  
23 based on the information reviewed as part of the audit  
24 and the information contained in the WCAP.

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1           The WCAP does implement the alternate  
2           evaluation methodology consistent with prior staff  
3           approval. And, based on those two items, the WCAP's  
4           use of NEI 04-07 alternate methodology was acceptable.

5           We did note that, because NEI 04-07  
6           methodology, this alternate methodology, permits use  
7           of operator actions or credit for non-safety systems,  
8           that we wanted to avoid any confusion because the WCAP  
9           excludes use of operator actions or used of credit for  
10          non-safety systems as part of mitigation.

11          And so, we threw in this limitation and  
12          condition just to make sure that was clear.

13          Next slide?

14          So, in summary the staff reviewed the three  
15          items that were presented in the WCAP for review and  
16          approval and they are summarized on this slide.

17          And, the draft Safety Evaluation, the staff  
18          finds the approach described in the WCAP acceptable  
19          and the staff approves the request subject to  
20          limitations and conditions.

21          That concludes the staff presentation for  
22          the public portion.

23          MEMBER RAY: Dana, this discussion here  
24          today is only about what is the scope of the WCAP, not

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1 broader issues. But, it does conclude -- reach a  
2 conclusion about limitation on aluminum.

3 In the past, you suggested, I think, that  
4 zinc is an equivalent to aluminum in some cases and  
5 that it might be used in primer coating and so on.

6 MEMBER POWERS: It is used in the primer  
7 coating. It is the primer for the epoxy and it is the  
8 only coating on the upper part of the containment  
9 building.

10 They don't -- they need the conductivity  
11 through the containment shield, so they only use a  
12 primer coating above a certain level. I can never  
13 remember what that level is, but up in the higher dome  
14 that's all there is.

15 It is -- I would not characterize it really  
16 as equivalent to aluminum. It does form precipitates  
17 in the water. They don't tend to be nearly as  
18 flocculent and obnoxious as aluminum oxide  
19 precipitates.

20 But, they do and so, but are they one to  
21 one, I don't know. But, they are a consideration.

22 But, I believe those are taken into account  
23 in the existing limitations in the -- for the GDC 191,  
24 aren't they? I mean the --

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1 MEMBER RAY: GSI.

2 MEMBER POWERS: GSI, I'm sorry.

3 MR. MAKAR: As a result of the methodology  
4 that AP1000 uses for chemical effects analysis, it was  
5 not required to evaluate zinc precipitants.

6 The staff hasn't really determined that  
7 there are zinc precipitants that occur in the post LOCA  
8 environment.

9 MEMBER POWERS: Well, if the staff hasn't,  
10 then they're alone in the world because everybody knows  
11 you get zinc precipitates in these things.

12 MR. MAKAR: Well, sorry, they were  
13 observed not as in as many tests and the conditions  
14 under which they occurred at weren't as you think.

15 MEMBER POWERS: Well --

16 MR. MAKAR: And, there were -- the quantity  
17 wasn't as much. And so --

18 MEMBER POWERS: My thinking is that what  
19 they really did was they took enough bromide in their  
20 test solutions to bound not only the aluminum but  
21 everything else that they can think of. Because  
22 there's a lot of stuff.

23 MR. MAKAR: Say that again, please?

24 MEMBER POWERS: They --

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1 MR. MAKAR: Enough --

2 MEMBER POWERS: In the WCAP where they  
3 propose how to drove to resolve the generic safety  
4 issue, they formulate a representative solution and  
5 they put a lot of simulant materials in there.

6 One of the things they put in is bromide,  
7 the other one I think silicon carbide for hard  
8 particulates. But, it's not that they have any silicon  
9 carbide in the plant, but they wanted to simulate a  
10 hard particulate and fiber and a lot of things.

11 And, I think they took enough to simulate  
12 what they thought was the amount of zinc that they would  
13 get from, you know, blow downs and things like that.

14 MR. MAKAR: In some of the testing, the  
15 zinc -- the precipitate was adherent also to the zinc  
16 coupons rather than in the water.

17 And, that the --

18 MEMBER POWERS: That's the motion of time.

19 MR. MAKAR: And, again, the methodology  
20 is based on if you take this conservative approach with  
21 regard to aluminum and the other things that we were  
22 -- that the industry was able to identify in the water,  
23 the staff felt that that's conservative enough to  
24 account for uncertainty about some other elements where

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1       it wasn't clear what the precipitant was and what the  
2       effect was on head loss.

3               MEMBER POWERS:   Yes, there's --

4               MR. MAKAR:   So, I think we -- there's --  
5       zinc is -- it would be on the table if someone used  
6       a different approach to chemical effects rather than  
7       the standard methodology is one way of saying.

8               MEMBER POWERS:   Yes, I would -- zinc  
9       wouldn't be the first thing I would think of for chemical  
10      effects because I don't believe they use triphosphate  
11      in this system, do they?

12              MR. MAKAR:   In this case, yes.

13              MEMBER POWERS:   They do use it?

14              MR. MAKAR:   Yes.

15              MEMBER POWERS:   Oh God.   That's really  
16      bad.

17              MEMBER RAY:   Well, I raise it here only  
18      because, like I say, I don't want to increase the scope  
19      of what we're trying to address here now because it's  
20      important that we get closure on it ultimately.

21              But, because aluminum had been set up as  
22      a consequence of what we're doing here, I felt I needed  
23      to ask the question.

24              I don't think from what I've understood

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1 of your dialogue here that we've answered the question  
2 as to whether zinc is problematic, have we?

3 MEMBER POWERS: I think you try to bound  
4 it with the amount of aluminum in there and it's not  
5 going to be worse than aluminum.

6 At least my experience with zinc  
7 precipitates is that they're pretty easy to handle.  
8 Aluminum precipitates will -- are obnoxious in the  
9 extreme.

10 So, if you put a lot of aluminum in, you're  
11 okay. That would be my view on the thing.

12 MEMBER RAY: Well, I just want to give you  
13 an opportunity to pursue it.

14 MEMBER POWERS: Yes, the -- but the --

15 MEMBER RAY: But, not --

16 MEMBER POWERS: -- issue of aluminum is  
17 predominant in my mind as it -- aluminum, as they pointed  
18 out, depends on how much you have submerged because  
19 the submerged aluminum will corrode and you'll get more,  
20 a lot more.

21 MEMBER RAY: Okay, well, I won't raise it  
22 again then if you're satisfied.

23 MR. MAKAR: If I can just mention that also  
24 with the AP1000, the strainer testing, and there was

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1 bare strainers so that additional chemical effects  
2 beyond what's considered in the design basis wouldn't  
3 have had an effect. And, I think some of the fuel  
4 assembly testing used higher levels than the design  
5 basis and, the evaluation on the fuel.

6 So, it was conservative in a number of ways.

7 So, I think additional -- focusing on this conservative  
8 methodology and staying within that design basis, staff  
9 feels adequate to still to address those -- that kind  
10 of uncertainty.

11 MEMBER RAY: Okay, questions?

12 MR. ROHATGI: Yes, just quickly, just a  
13 clarification. The NMI has no aluminum, it's all  
14 steel.

15 MR. MAKAR: There's no chemical effects  
16 from the metal reflective insulation.

17 MR. ROHATGI: So, the aluminum thing is  
18 not coming from NMI?

19 MR. MAKAR: That's correct.

20 MEMBER RAY: That's right.

21 MR. ROHATGI: Okay.

22 MEMBER RAY: Other questions?

23 (NO RESPONSE)

24 MEMBER RAY: Okay, it's five minutes after

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1 2:00. So, we're going to make a transition here in  
2 a moment into the closed session because I think it's  
3 a little early, just an hour into this, to take a break.

4 And, we'll decide, depending on how the  
5 closed session goes, whether we'll then take a break  
6 during it or perhaps wrap up before need to.

7 So, if we can -- Westinghouse will Be the  
8 first up in the closed session.

9 If Westinghouse can come up and, as they're  
10 doing so, we'll invite any members here in the audience  
11 of the public who will not be remaining with us if there  
12 are any comments?

13 (NO RESPONSE)

14 MEMBER RAY: Seeing none, we will ask that  
15 the phone line be opened so that we can make a similar  
16 question to them.

17 Weidong, is it open and on?

18 MR. WANG: It is open.

19 MEMBER RAY: All right.

20 MR. WANG: All of -- yes, the line is open.

21 MEMBER RAY: Is there anyone on the phone  
22 line who would like to make a comment on the discussion  
23 that we've had here now?

24 (NO RESPONSE)

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1                   MEMBER RAY: Hearing none, we will close  
2 the phone line and ask that staff and Westinghouse  
3 ensure we have only the allowed participants.

4                   Weidong, would you ensure the phone line  
5 is closed, please?

6                   And, with that, we will declare that we  
7 are in closed session and ask Westinghouse to resume.

8                   (Whereupon, the above-entitled matter went  
9 into closed session at 2:07 p.m.)

10

11

12

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# WCAP 17938 Revision 2, ACRS Subcommittee – Public Meeting

February 7, 2018

Andrew Pfister

Shayan Sinha



# Background

## AP1000 GSI 191 Design Bases

- **AP1000** design significantly reduces / eliminates debris sources that are typically found in Generation II plants
- Maximum allowable fibrous debris inside containment is 6.6 lbs
  - All fibrous debris is attributable to latent debris
  - There is no fibrous debris generated during a LOCA
- Metal reflective insulation (MRI) is extensively used in containment
- DCD/FSAR provides requirements that must be demonstrated if an alternative (fibrous) insulation to MRI is utilized
  - Insulation must be demonstrated to be a suitable equivalent insulation to MRI for the purposes of GSI 191
  - To qualify a suitable equivalent testing must be performed to demonstrate that debris will not be generated or transported
  - Suitable equivalent testing must be approved by the NRC

# Background

## WCAP 17938 Purpose

Purpose of WCAP 17938 is to obtain approval of the following:

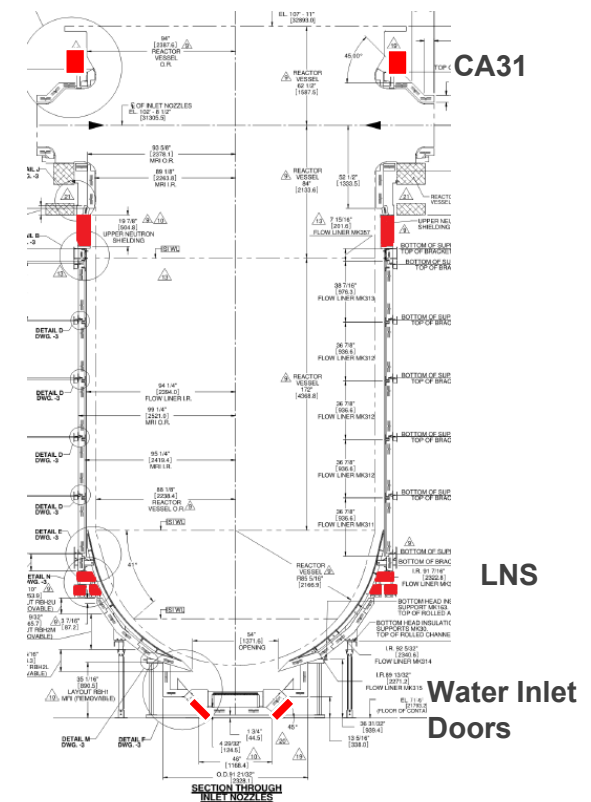
1. Establish a ZOI applicable to all **AP1000** plant in-containment cabling to demonstrate cabling will not generate LOCA debris
2. Gain approval that the non-metallic insulation (NMI) utilized in the reactor vessel insulation systems (RVIS) is a suitable equivalent to MRI for the purpose of GSI 191 as applied in **AP1000**
3. Gain approval to utilize the approved NEI 04-07 alternative methodology for defining debris generation break sizes for **AP1000**

Testing and analysis is complete to demonstrate that neither cabling nor NMI will contribute to post LOCA debris

# Background

## WCAP 17938

- **AP1000** cabling may contain fibrous and other materials that were not considered in initial GSI 191 debris source term evaluations
  - Corrective actions included development of a test program to establish a zone of influence (ZOI) for in-containment cabling
- NMI is required in RVIS because subcomponents of the RVIS perform functions in addition to insulation (such as shielding and in-vessel retention support)



## Summary of Results

- Extensive large scale jet impingement testing established a ZOI for in-containment cables of 4 L/D
  - Cabling ZOI design requirements were incorporated into the detailed design in advance of any cable or tray installation
- WCAP invokes the alternate evaluation methodology provided in NEI 04-07 to determine a limiting RCS break size in debris generation evaluation for certain **AP1000** components
- Insights from NMI jet impingement and submergence testing resulted in strengthening design for elements of the RVIS
  - Design was changed to use thicker and more robust encapsulation

**WCAP justifies no new debris generation for AP1000 from cabling or NMI**

# Conclusions

## Conclusions

- Jet impingement testing supports a Cable ZOI of 4 L/D for **AP1000** in-containment cabling
- Application of NEI 04-07 alternative break methodology is acceptable for **AP1000**
- Cabling does not contribute to **AP1000** post LOCA debris limits
- Encapsulated NMI applications utilized within the AP1000 RVIS will not produce debris when subjected to jet impingement from limiting line breaks
- Neither cabling nor NMI within the RVIS contribute to GSI 191 chemical debris limits
- NMI utilized as part of the RVIS is a suitable equivalent to MRI for the purpose of GSI 191

**WCAP justifies no new debris generation for AP1000 from cabling or NMI**



# **Presentation to the ACRS Subcommittee**

**Draft Safety Evaluation  
AP1000 In-Containment Cables and Non-Metallic Insulation  
Debris Integrated Assessment  
WCAP-17938-P, Revision 2**

February 2018



# Presentation Topics

- Introduction
- Overview
- Review Approach
- Finding
- Summary

# Introduction

- NRC Technical Reviewers

- |                     |                                    |
|---------------------|------------------------------------|
| ♦ Clint Ashley      | Containment and Ventilation Branch |
| ♦ Boyce Travis      | Containment and Ventilation Branch |
| ♦ Renee Li          | Mechanical Engineering Branch      |
| ♦ Greg Makar        | Materials & Chemical Engr. Branch  |
| ♦ Malcolm Patterson | PRA and Severe Accidents Branch    |

- NRC Project Manager

- |             |                    |
|-------------|--------------------|
| ♦ Don Habib | Licensing Branch 4 |
|-------------|--------------------|

# Introduction (cont'd)

- A topical report is a document that addresses a technical topic related to nuclear power plant safety.
- In topical report WCAP-17938, Westinghouse updates the AP1000 plant safety analysis related to Generic Safety Issue 191 (GSI-191).
- Westinghouse seeks review and approval of WCAP-17938 by the U.S. Nuclear Regulatory Commission (NRC) for use in the licensing process by AP1000 licensees.

# Overview

- Main guidance for evaluating WCAP-17938:
  - ♦ Nuclear Energy Institute (NEI) 04-07, “PWR Sump Performance Evaluation Methodology”
  - ♦ Safety Evaluation for NEI 04-07, “PWR Sump Performance Evaluation Methodology”
  - ♦ WCAP-16530-NP-A, “Evaluation of Post-Accident Chemical Effects in Containment Sump Fluids to Support GSI-191”

## Overview (cont'd)

- The AP1000 plant safety evaluation decision addressing GSI-191 is based on zero loss-of-coolant accident (LOCA) generated fibrous debris.
  - ♦ Achieved in part through the use of metal reflective insulation (MRI) or a suitable equivalent insulation.
  - ♦ As part of detailed design, the AP1000 plant uses a suitable equivalent insulation in three locations around the reactor vessel.
  - ♦ Use of a suitable equivalent insulation requires NRC review per the AP1000 DCD.

## Overview (cont'd)

- The AP1000 plant design also includes electrical cabling that may be directly impinged upon by a loss-of-coolant accident jet.
  - ♦ AP1000 electrical cables may contain fibrous material that was not considered in the original GSI-191 debris source evaluation.
  - ♦ As a corrective action, Westinghouse conducted testing to define a zone of influence for cables.

## Overview (cont'd)

- The AP1000 design basis in part states that “a LOCA in the AP1000 does not generate fibrous debris due to damage to insulation or other materials included in the AP1000 design...”
- As such, the WCAP seeks NRC approval for three items:
  1. A zone of influence (ZOI) for electrical cabling in containment.
  2. Use of non-metallic insulation (NMI) as a suitable equivalent to metal reflective insulation (MRI).\*
  3. Use of NEI 04-07 alternate evaluation methodology to assess debris generation.

## Overview (cont'd)

- To qualify as a suitable equivalent insulation, the AP1000 DCD states in part that:
  - ♦ Testing must be performed that subjects the insulation to conditions that bound the AP1000 plant conditions.
  - ♦ Testing demonstrates that debris would not be generated, to include chemical debris.
  - ♦ Testing and/or analysis must be approved by the NRC.
- The three WCAP requests for NRC approval, are detailed on the following slides.



# WCAP Item 1

- Requests approval for a ZOI for electrical cabling in containment.
- Staff review approach
  - ♦ Observed cable jet impingement testing
  - ♦ Assessed the applicability of the test facility
  - ♦ Reviewed test materials
  - ♦ Audited test reports
  - ♦ Issued requests for additional information

# WCAP Item 1

- Staff review approach (cont'd)
  - ♦ Staff reviewed observations from previous NRC visits to the test facility, and examined the facility conditions produced during instrumented tests
  - ♦ These conditions were compared to facility conditions for current testing to verify repeatability
  - ♦ Staff determined the facility produced conditions that would bound as-built facility conditions
  - ♦ Applicant determined a ZOI for onset of damage, then conservatively requested an acceptable ZOI tested just beyond that showing no debris generation

# WCAP Item 1

- Staff Finding
  - ♦ The topical report provides an acceptable technical basis for determining that no debris will be generated by cables located at or beyond the proposed ZOI.
  - ♦ Because the WCAP demonstrated no debris generation outside the ZOI, the proposed ZOI for electrical cabling is acceptable.
- Limitations and Conditions
  - ♦ Performance of cables within the ZOI (if any) is outside the scope of the WCAP.

# WCAP Item 2

- Requests approval for the use of NMI as a suitable equivalent insulation to MRI.
- Staff review approach
  - ♦ Observed jet impingement and submergence testing
  - ♦ Evaluated thermal expansion testing
  - ♦ Assessed the applicability of test facilities
  - ♦ Reviewed test materials
  - ♦ Audited test reports
  - ♦ Issued requests for additional information

# WCAP Item 2

- Staff review approach (cont'd)
  - ♦ Neutron shield blocks tested to qualify the blocks ability to withstand jet forces under variety of ZOIs/block configurations.
  - ♦ This testing was supported by a discussion of confined jet behavior, as reactor vessel cavity could be considered a confined space.
  - ♦ WCAP used a literature review, which staff reviewed for applicability.
  - ♦ Ultimately, combination of testing and literature review allowed for verification that the predicted NMI jet impingement pressure would be bounded by the test facility jet at the requested ZOI.

# WCAP Item 2

- Staff review approach (cont'd)
  - ♦ Qualifying NMI as suitable equivalent also required evaluation of chemical effects.
  - ♦ Submergence testing measured releases for different levels of NMI encapsulation.
  - ♦ Staff used the testing as a means to evaluate the design's ability to prevent chemical effects.
  - ♦ Submergence tests showed complete encapsulation is necessary to prevent the release of elements that could generate chemical effects, and that additional chemical effects were predicated on amount of submerged aluminum.

# WCAP Item 2

- Staff Finding
  - ♦ The topical report provides an acceptable technical basis for determining that no debris will be generated by the blocks.
  - ♦ Because there is no debris generation, use of NMI as a suitable equivalent insulation to MRI is acceptable.
- Limitations and Conditions
  - ♦ Evaluation limited to debris generation
  - ♦ Limit placed on the amount of aluminum in containment

## **WCAP Item 3**

- Requests approval to use the NEI 04-07 alternate evaluation methodology.
  - ♦ NEI 04-07 alternate evaluation methodology in part assumes a double-ended guillotine break of postulated pipe breaks in reactor coolant system (RCS) main loop piping unless physically limited by piping restraints, supports, other structural members or piping stiffness as may be demonstrated by analysis.
  - ♦ If physically limited, then a smaller pipe break size may be used to assess debris generation.



## **WCAP Item 3**

- Staff review approach
  - ♦ Evaluated the topical reports implementation of the approved methodology.
  - ♦ Focused review on RCS main loop piping breaks that are physically limited.
  - ♦ Audited reports used to determine the limited separation of the postulated breaks.
  - ♦ Reviewed the WCAP's methodology for determining the equivalent break diameter for limited separation breaks and the zone of influence (ZOI).

# WCAP Item 3

- Staff Finding
  - ♦ The applicant approach to determine limited separation breaks, equivalent break diameter and ZOI is reasonable based on information reviewed in the audit and contained in the WCAP.
  - ♦ The WCAP implements the alternate evaluation methodology consistent with prior staff approval.
  - ♦ Based on the above, the WCAP's use of the NEI 04-07 alternate methodology is acceptable.
- Limitation and Condition
  - ♦ Excludes use of nonsafety systems and operators.

# Summary

- The WCAP requests staff review and approval for three items:
  - ♦ the application of the proposed ZOI for cables
  - ♦ the determination that NMI located in the reactor vessel cavity is a suitable equivalent insulation
  - ♦ the application of the alternate evaluation for debris assessment
- The staff finds the approach described in the WCAP acceptable and approves the requests, subject to limitations and conditions.

# BACKUP SLIDES

# WCAP-16530 Methodology For Chemical Effects

- Calculates the amount of chemical precipitate calculated based on plant-specific materials and pH buffer
  - ♦ Input the material quantities (e.g., aluminum surface area, fiberglass mass)
  - ♦ Input the pH buffer chemical
  - ♦ Input realistic pH and temperature profiles
  - ♦ Conservative corrosion/release rates applied

# WCAP-16530 Methodology For Chemical Effects

- ♦ Released elements assumed to precipitate as certain chemical compounds
  - $\text{AlOOH}$ ,  $\text{NaAlSi}_3\text{O}_8$ ,  $\text{Ca}_3(\text{PO}_4)_2$
- ♦ All precipitates present when the LOCA occurs
- ♦ All aluminum forms a precipitate
- ♦ All calcium forms a precipitate if phosphate is present
- ♦ Surrogate chemicals used in strainer and fuel assembly testing have been shown to clog fiber beds
- ♦ Refinements to the base model must be justified