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6 ADVISORY COMMITTEE ON REACTOR SAFEGUARDS
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10 proceeding of the United States Nuclear Regulatory
11 Commission Advisory Committee on Reactor Safeguards,
12 as reported herein, is a record of the discussions
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14

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UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION
+ + + + +
ADVISORY COMMITTEE ON REACTOR SAFEGUARDS
(ACRS)
SUBCOMMITTEE ON REGULATORY POLICIES & PRACTICES

+ + + + +

MONDAY

OCTOBER 4, 2010

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ROCKVILLE, MARYLAND

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The Subcommittee met at the Nuclear
Regulatory Commission, Two White Flint North, Room
T2B1, 11545 Rockville Pike, at 1:00 p.m., John W.
Stetkar, Chairman, presiding.

COMMITTEE MEMBERS:

JOHN W. STETKAR, Chairman

DENNIS C. BLEY, Member

WILLIAM J. SHACK, Member

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1 ACRS STAFF PRESENT:

2 GIRIJA SHUKLA, Designated Federal Official

3 STEPHEN DINSMORE

4 JOHN HONCHARIK

5 RICHARD JERVEY

6 STEVEN JONES

7 MATTHEW MITCHELL

8 SIMON C. F. SHENG

9 ALSO PRESENT:

10 CALVIN DUCHARME, Mitsubishi Nuclear Energy

11
12 Systems

13 BRUCE KNOBLOCH, Mitsubishi Heavy Industries*

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*Participating via telephone

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

1:01 p.m.

CHAIRMAN STETKAR: The meeting will now come to order.

This is a meeting of the Advisory Committee on Reactor Safeguards Subcommittee, on Regulatory Policies and Practices.

I'm John Stetkar, Chairman of the Subcommittee for the purpose of this meeting.

Subcommittee meeting members in attendance are Dennis Bley and Bill Shack, Mr. Girija Shukla of the ACRS staff is the Designated Federal Official for this meeting.

The Subcommittee will discuss the draft Final Regulatory Guide 1.115, Protection Against Turbine Missiles. We will hear presentations from the NRC staff regarding potential consequences and protection against turbine missiles as discussed in this Final Draft Regulatory Guide.

We have received no written comments or requests for time to make oral statements from members of the public, regarding today's meeting. This meeting will be open to public attendants.

I understand that we have someone on the phone bridge line, and for the purposes of the meeting

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1 record at this time I'd like you to please identify
2 yourself.

3 MR. KNOBLOCH: Yes, this is Bruce
4 Knobloch. The last name is spelled K-N-O-B-L-O-C-H.
5 I'm representing Mitsubishi Heavy Industries.

6 CHAIRMAN STETKAR: Thank you very much.

7 During the meeting, I'd ask you to keep
8 your phone on mute, if you have a listen-in mode only,
9 and we will do the same here, so you can listen to the
10 proceedings.

11 At the end of the meeting, I'll open up
12 the phone line again, so that if you have any comments
13 or questions you'd like to make, we can listen to them
14 at that time.

15 MR. KNOBLOCH: Yes, I'm going on mute
16 right now then. Thank you.

17 CHAIRMAN STETKAR: Thank you very much.

18 The Subcommittee will gather information,
19 analyze relevant issues and facts, and formulate
20 proposed positions and actions as appropriate for
21 deliberation by the Full Committee.

22 The rules for participation in today's
23 meeting have been announced as part of the notice of
24 this meeting published in the Federal Register on
25 September 21, 2010.

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1 A transcript of the meeting is being kept,
2 and will be made available as stated in the Federal
3 Register notice. Therefore, we request the
4 participants in this meeting use the microphones
5 located throughout the meeting room when addressing
6 the Subcommittee. The participants should first
7 identify themselves and speak with sufficient clarity
8 and volume so that they may be readily heard.

9 We will now proceed with the meeting, and
10 I call upon, I guess, Simon Sheng of NRR to begin the
11 presentation.

12 MR. MITCHELL: Well, Simon is going to
13 defer to me for just a second, because I am Matthew
14 Mitchell, Chief of NRR's Vessels and Internals
15 Integrity Branch.

16 I want to thank the Subcommittee for the
17 opportunity today, at your request, to come and
18 discuss proposed Revision 2 of RG 1.115, Protection
19 Against Turbine Missiles.

20 I think you'll see from the presentation
21 today that this proposed revision has been developed
22 in large part to consolidate NRC's positions
23 established in plant-specific actions, and to address
24 operation experience that we have accrued since about
25 1977.

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1 The updating of the Reg Guide has been a
2 collaborative and collective effort across several
3 offices, including the Office of Research, who has, of
4 course, the lead for the Reg Guide Update Project, as
5 well as NRR and the Office of New Reactors.

6 And, with that intro, I'd like to turn the
7 presentation over to our panel, who was instrumental
8 in pulling together this revision to the Reg Guide,
9 Dr. Simon Sheng, who is a Senior Materials Engineer in
10 the Vessels and Internal Integrity Branch; Steve
11 Jones, a Senior Reactor Engineer in NRR's Balance of
12 Plant Branch; and John Honcharik, a Senior Materials
13 Engineer in the Office of New Reactors Component
14 Integrity Performance and Testing Branch 1.

15 Simon?

16 MEMBER SHACK: Matt, I just had a
17 question, please.

18 Why isn't there a Reg Guide on the
19 Calculation of the P1 Probability?

20 MR. MITCHELL: I will defer that question
21 to our panel, and if that's not answered adequately as
22 we go through the presentation, I'm sure Simon and the
23 rest of the panel will be happy to get into that
24 question.

25 DR. SHENG: Do you want the answer now?

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1 MEMBER SHACK: Maybe I'll wait to later,
2 and keep me in suspense.

3 DR. SHENG: Right. Okay.

4 So, even though that this is a product of
5 several different positions, however, that I will make
6 a presentation because it is very hard for me to
7 separate these presentation materials into different
8 parts, with different people to take the lead.

9 So, I'm going to make the presentation,
10 but whenever it is needed I'll call their support to
11 answer your questions.

12 So, this is the proposed RG 1.115, and
13 which in the title say, Protection Against Turbine
14 Missiles, because now we include those high projectile
15 missiles and low projectile missiles into one single
16 RG.

17 The second page I would like to -- the
18 overview -- and let me see, I think -- okay, overview.

19 First I am going to talk about the GDC 4 requirement.

20 CHAIRMAN STETKAR: Before you start, move
21 that microphone over, they are really, really
22 sensitive.

23 DR. SHENG: Okay.

24 CHAIRMAN STETKAR: Over to your right or
25 one way, so you don't hit it with the paper.

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1 DR. SHENG: Okay.

2 CHAIRMAN STETKAR: When you turn the pages
3 over, because --

4 DR. SHENG: Okay.

5 CHAIRMAN STETKAR: -- otherwise our
6 recorder --

7 DR. SHENG: Did it affect my volume?

8 CHAIRMAN STETKAR: No, it's just they are
9 really, really sensitive, and when you hit it with a
10 paper he gets an explosion in his ear.

11 DR. SHENG: Okay, just like with a hammer.

12 Okay, first I'm going to explain the GDC 4
13 requirement, and based on that, that we have these RG
14 1.115, and then I'm going to talk about the current
15 NRC provision on protection against turbine missiles.

16 And then, I'm going to talk about objectives of the
17 proposed RG 1.115.

18 The next, I'm going to review the
19 operating experience since 1977. The purpose of that
20 is to gain some insight, so that we can modify RG
21 1.115 appropriately, and even entertain some
22 revolutionary change if it is needed.

23 And then, after that I'm going to talk
24 about enhancements in the proposed RG 1.115.

25 And next, I'm going to discuss industry

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1 comments, because we've received many industry
2 comments, and some of them have been hindered by the
3 proposed RG 1.115, and some are here not going to be
4 taking into consideration now, but I'm going to
5 explain that later.

6 And last, I'm going to present the
7 conclusions.

8 CHAIRMAN STETKAR: Before you get started,
9 I was trying to look ahead to see if you are going to
10 address it, and I'm not sure that you will. So, I'll
11 ask it now.

12 Does the scope of RG 1.115 apply only to
13 the protection of safety-related SSCs?

14 DR. SHENG: We are going to talk about
15 that later.

16 CHAIRMAN STETKAR: You are? Okay.
17 Thanks, because --

18 DR. SHENG: It's near the end.

19 CHAIRMAN STETKAR: -- okay, because it has
20 relevance, obviously, for new reactor designs. All
21 right. So, if you are going to address that later,
22 that's great.

23 DR. SHENG: Yes.

24 CHAIRMAN STETKAR: Thanks.

25 DR. SHENG: Okay, so the GDC 4,

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1 "Environmental and Dynamic Effects Design Bases,"
2 requires: "These structures, systems and components,
3 that means it's SSC important to safety," because it
4 must be derived in the previous sentences, so you've
5 got SSC means important to safety, "... shall be
6 appropriately protected against dynamic effects,
7 including the effects of missiles...that may result
8 from equipment failures..."

9 And, by making -- describing the SSCs,
10 similar as important as safety, their leader, the
11 staff need to define the SSCs to be protected from
12 turbine missiles. And, we made some modifications in
13 this proposed RG 1.115.

14 So, next I would like to introduce the
15 current NRC position on protection against turbine
16 missiles. There are several ways that we can protect
17 missiles, the first way is to -- by turbine
18 orientation, and that was stated clearly in RG 1.115,
19 dated July, 1977. And, it has been used up to now.

20 The second is by control of turbine
21 missile generation frequency, and you can see the
22 description that I put down after that. It was stated
23 in the Hope Creek SER evaluation report, dated July,
24 1986, and, of course, the staff found out it is
25 awkward to have their most referenced acceptance

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1 criteria for protection against the turbine missiles
2 appear in the SER.

3 So, around the year 2006, when we revised
4 the Standard Review Plan, we got in turbine missiles,
5 so we copied that acceptance criteria in the SRP.

6 However, in that SRP, we didn't mention
7 anything about high trajectory missile, just like any
8 other NRC documents, the high trajectory missiles were
9 not mentioned.

10 And, the third approach is by missile
11 barriers, and also these appeared in the RG 1.115,
12 dated July, 1977, and it has been still used now.

13 Now it is time for me to bring up one
14 note, that for the old RG 1.115, even -- although it
15 did not provide any guidance on high trajectory
16 missile, however, it defined it a little bit. So, let
17 me read it to you. It's a quote from the current RG
18 1.115, and that's, it's just limited to that comment,
19 and nothing more than that.

20 It says, "High trajectory missiles, which
21 are ejected upward through the turbine casing, and may
22 cause damage if the falling missile strikes an
23 essential system." So, let me stop there and mention
24 thing about high trajectory missiles.

25 Now, let's go to the objectives of the

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1 proposed RG 1.115. Of course, we want to keep an
2 assurance that the turbine failure is a negligible
3 contributor to risk, and the second is that we want to
4 make the RG self-contained including all acceptable
5 protection methods against turbine missiles.

6 CHAIRMAN STETKAR: Simon, what do you mean
7 by negligible contributor to risk?

8 DR. SHENG: For this question, I would
9 like to ask Steve to answer the question.

10 CHAIRMAN STETKAR: And, I'll ask you --

11 DR. SHENG: From a systems point of view.

12 CHAIRMAN STETKAR: -- well, from a systems
13 point of view, and the specific context for new
14 reactor designs, who are publishing total core damage
15 frequencies, ostensibly, from the sum of all internal
16 and all external contributors during all plant
17 operating modes, that are in the range of, let's say,
18 five times 10^{-8} event per year.

19 So, I'm curious about what a negligible
20 contribution to risk is in that context.

21 MR. JONES: Okay. We've been treating
22 turbine missiles, essentially, as an external threat,
23 much like other site-related impacts. There is an SRP
24 section, I believe it's 2.2.3, that deals with
25 external threats, and it has a threshold initiation

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1 frequency of damage to safety-related components of 10^{-7}
2 per reactor year, and that's, essentially, what we
3 are using.

4 CHAIRMAN STETKAR: Well, what's the basis
5 for that?

6 MR. JONES: The basis for that is, really,
7 a defense in-depth argument, that these external
8 threats have a potential to cause both -- to both
9 initiate an accident and, potentially, damage
10 equipment necessary to mitigate that particular
11 accident.

12 CHAIRMAN STETKAR: Absolutely.

13 MR. JONES: So, in order to maintain risk
14 as acceptably low, we have a very low threshold for
15 the initiating event, damage to an essential safety-
16 related or essential equipment, I won't say safety-
17 related.

18 CHAIRMAN STETKAR: So, does that mean that
19 an event that could cause core damage and possibly
20 compromise the containment at the frequency of 10^{-7} per
21 year is by definition negligible, compared to the sum
22 of everything else that is middle times 10^{-8} or a
23 factor of two, to five, to ten lower than that?

24 MR. JONES: Well, I would say 10^{-7} applies
25 just to damaging one part of that, unless you are --

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1 10⁻⁷ is a frequency for a high trajectory or for a
2 missile impacting an essential -- one essential
3 component.

4 If you are talking about, for instance,
5 other accidents that would both damage the reactor
6 coolant pressure boundary, and then damage a piece of
7 high-head safety injection equipment or something,
8 that would be a lower frequency.

9 CHAIRMAN STETKAR: I don't know of any
10 lower frequency in the Standard Review Plan.

11 MR. JONES: Right, and I'm just --

12 CHAIRMAN STETKAR: I'm leading you on,
13 obviously. The Standard Review Plan doesn't,
14 necessarily, address new reactors.

15 MR. JONES: Right.

16 CHAIRMAN STETKAR: And, our committee,
17 ACRS, other subcommittees, has had questions about
18 that topic in a variety of forums, for a variety of
19 different issues.

20 My question is for regulatory guidance
21 that's written in the year 2010, and that will apply
22 for new reactors that will come on line, depending on
23 your optimism or pessimism, sometime in the next six,
24 to 12, to 15 years. Is it appropriate for us to say
25 that a 10⁻⁷ frequency of damage is, by definition, a

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1 negligible contributor to risk, without knowing what
2 the consequences from that damage might be?

3 MR. JONES: Well, I guess the number is
4 consistent with what we have in our risk-informed
5 guidelines in Reg Guide 1.174, and --

6 CHAIRMAN STETKAR: Have you had any
7 discussions with other members of the staff regarding
8 the direction on risk methods for reactors? That's an
9 open issue, there's been no resolution about what are
10 the appropriate metrics, either in terms of what
11 shall be measured, whether it's core damage frequency
12 in large early release, or large release, or some
13 other method, and the numerical values that might be
14 used for the acceptance criteria for the new reactors.

15 There are very, very different opinions on
16 how those metrics might be established. So, one
17 concern that I think we might have is to ensure that
18 regulatory guidance that's published now does not,
19 necessarily, presume what the results of that effort
20 will be. In other words, that at least acknowledge
21 that numerical values may be subject to change,
22 depending on the resolution of that whole issue.

23 So that, for example, a 10^{-7} value -- and I
24 don't like using numbers, but a 10^{-7} might be deemed
25 acceptable for current operating plants, given what we

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1 know about their risk profiles, but that that specific
2 numerical value may not be appropriate for some new
3 reactors pending final resolution of that whole issue
4 of risk methods.

5 DR. SHENG: Before Steve answers the
6 question, may I say something?

7 I ask Steve Dinsmore, of the Risk Branch,
8 to come to support our presentation, and he won't be
9 here until 1:30.

10 CHAIRMAN STETKAR: Oh, Steve is coming?

11 DR. SHENG: Yes.

12 CHAIRMAN STETKAR: Okay, great.

13 DR. SHENG: And, in addition to this, I
14 have prepared for back-up slides.

15 CHAIRMAN STETKAR: Okay.

16 DR. SHENG: Just to discuss in that
17 direction.

18 So, I think maybe it's the appropriate
19 time to present it now, but since Steve is not here, I
20 --

21 CHAIRMAN STETKAR: Great. I didn't see
22 any of the risk assessment people here, so I figured
23 I'd hit you with the question, but if Steve will be
24 here we'll just table that whole discussion.

25 DR. SHENG: Yes, until he arrives.

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1 CHAIRMAN STETKAR: Sure. Sure. Thanks.

2 I'm sorry.

3 DR. SHENG: Okay. So, maybe I can
4 continue my presentation here.

5 CHAIRMAN STETKAR: Yes, continue.

6 DR. SHENG: Until Steve shows up.

7 So, that's the second objective.

8 The third one identifies SSCs to be
9 protected from turbine missiles, and here you can see
10 that we include the common RTNSS functions, for
11 example, makeup water, heat sink, and long-term decay
12 heat removal.

13 And, we also exclude functions necessary
14 only for other unlikely design basis events, such as
15 high-head safety injection and the deep-type
16 containment.

17 And then, of course, that while the
18 objective of the proposed RG 1.115 is to assess
19 operating experience since 1977, so that we can revise
20 the turbine missile criteria, or even adopt a
21 revolutionary change of the approach.

22 CHAIRMAN STETKAR: Could you elaborate a
23 bit more on the third bullet? I'm trying to
24 understand what it's telling me, because I've read
25 Appendix A to the Reg Guide, and it doesn't really

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1 call out systems explicitly. It calls out functions,
2 more or less.

3 DR. SHENG: Right, but --

4 CHAIRMAN STETKAR: What we call frontline
5 functions and direction, and also make sure that you
6 have the right support functions power.

7 But, I'm curious about this, and this
8 bullet tells me that the intent is to include RTNSS
9 functions within that Appendix, is that correct?

10 DR. SHENG: Right, I think Steve can
11 explain that further.

12 CHAIRMAN STETKAR: Okay.

13 MR. JONES: Yes, this is Steve Jones.

14 CHAIRMAN STETKAR: I won't ask you about
15 numbers this time.

16 MR. JONES: Steve Jones in the Balance of
17 Plant Branch of NRR.

18 As you mentioned, the list is defined by
19 function, and most of the RTNSS functions I'm familiar
20 with do involve, like it says there, makeup water, or
21 heat sink, and long-term decay heat removal functions
22 for the plants. I guess you also have back-up
23 electric power, for instance, and I'm not really
24 familiar with many other functions that fall into that
25 category.

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1 And, those functions are listed among the
2 -- among those in Appendix A to the Draft Reg Guide.

3 CHAIRMAN STETKAR: I'm just curious, I
4 understand, I think, the first sub-bullet, I'm curious
5 about the second sub-bullet, that it says, exclude
6 functions necessary only for other unlikely design
7 basis events.

8 MR. JONES: I guess to get into that, the
9 obvious case, it's not designed to protect systems
10 that are only required for a loss of coolant accident
11 in the short term.

12 It does -- Appendix A does include long-
13 term decay heat removal post accident, the RHR system
14 and PWRs, but -- and I think it also explicitly
15 addressed that containment need not retain as
16 leaktight integrity for following a turbine missile
17 event.

18 CHAIRMAN STETKAR: Well, but it does say,
19 I mean, No. 12 says primary -- I'm ready on Appendix
20 A, it says primary reactor containment and other
21 safety-related structures, such as the control room
22 building and auxiliary building, to the extent that
23 they not collapse allow perforation by missiles for
24 generation to secondary missiles, any of which could
25 cause unacceptable damage to protected items.

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1 However, the primary containment may not
2 necessarily maintain leaktight integrity. I guess
3 that's what you are stressing there.

4 MR. JONES: Yes, that's what I'm getting
5 at, is containment is not expected to be a necessary
6 function as far as radiological release to mitigate
7 the effects of a turbine missile event.

8 However, you would need some means to
9 maintain reactor coolant inventory, but not
10 necessarily high-head safety injection, to compensate
11 for a loss of coolant, you know, loss of coolant
12 accident.

13 CHAIRMAN STETKAR: I mean, I know enough
14 about the two class of designs that are currently,
15 you know, AP1000 has been certified, PWRs currently in
16 certification process, and I understand high-head
17 safety injection with respect to those two particular
18 designs.

19 I do know that some of the RTNSS equipment
20 in at least one of the designs does not -- it does not
21 address high-head safety injection. It does address
22 either long-term makeup, low pressure, and coolant.

23 I guess I'm a little concerned that, are
24 we presuming things about any design that we might see
25 that might not have high-head safety injection

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1 identified as a RTNSS function? I don't know. We
2 don't have one right now.

3 I just -- well -- Appendix A does not
4 exclude things, as clearly as your slide does here.

5 MR. JONES: Well, it does not -- you are
6 right, it doesn't have a list of exclusions.

7 CHAIRMAN STETKAR: It doesn't have a list
8 of exclusions, and what I'm concerned about is, is
9 whether the list in Appendix A is appropriately
10 comprehensive and non-specific enough to not
11 necessarily exclude high pressure injection.

12 If we were to see, you know, some other
13 design come down the road in the near future that
14 might, for whatever reason, identify some sort of high
15 pressure injection function, as a RTNSS system,
16 because there are a variety of reasons that items are
17 thrown into that RTNSS category.

18 MR. JONES: Certainly. I guess the intent
19 would not be to, necessarily, encompass every RTNSS
20 function, though, that comes along. The intent is
21 just to avoid unnecessarily requiring protection for
22 systems that are not -- that are needed only for very
23 low frequency events that are independent -- not very
24 low -- but low frequency events that are independent
25 of the turbine missile generation event itself.

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1 CHAIRMAN STETKAR: So, that's the basic
2 philosophical statement of the list.

3 MR. JONES: Right.

4 CHAIRMAN STETKAR: That you are trying to
5 get --

6 MR. JONES: And, that is -- that is,
7 certainly, in the Revision 1 of the Reg Guide 1.115,
8 and I believe we kept that statement in Revision 2.

9 CHAIRMAN STETKAR: So, for example, a
10 turbine missile event that might cause a small loss of
11 coolant accident --

12 MR. JONES: Well, it shouldn't. I guess
13 the concern there, I guess, is the probabalistic
14 approach, does it open that potential, but, again, we
15 are taking a threshold that in the past we've found
16 acceptable as low enough to meet the design basis --
17 except me, defense-in-depth basis, for excluding the
18 event. It's so slow in probability that you need not
19 defend against simultaneous accident initiation of a
20 different type, and damage the mitigating system.

21 CHAIRMAN STETKAR: Thanks.

22 DR. SHENG: Okay. So that, we reviewed
23 the operating experience since 1977, and, basically,
24 we reassessed failure data by reviewing NUREG-1275.
25 Luckily, we found this NUREG report, which, basically,

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1 had the summary of other operating experience before
2 1995.

3 And then, after 1995, we don't have a
4 summary report, so we have to look through the license
5 event reports and information in the International
6 Incident Reporting System, and INPO, that's the
7 Institute of Nuclear Power Operation Significant Event
8 Notifications, and to gain insight from operating
9 experience.

10 Maybe for the INPO, maybe I should mention
11 one thing about that, that the INPO, it did issue a
12 report summarizing some turbine events, not simply
13 missile, some may be not general missile, but
14 considered as a precursor of over speed scenario, and
15 it is cited that from year 2000 to 2004 there are
16 about 72 cases related to turbine, which causes
17 scrams, shutdowns and outage delays per year. I'm
18 going to repeat that later, in later slides.

19 CHAIRMAN STETKAR: Simon, are you going to
20 talk a little bit more about the results in that NUREG
21 1275? I'm not personally familiar with that NUREG.

22 DR. SHENG: I will just talk about
23 something very important from that NUREG, but I'm not
24 going to talk about everything in that.

25 CHAIRMAN STETKAR: Do you know, does that

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1 NUREG include operating experience from only nuclear
2 power plants, or does it include operating experience
3 from conventional turbines also?

4 DR. SHENG: For that NUREG, it's only
5 nuclear power plants.

6 I think the date of the NUREG is 1995, and
7 the reason to issue that NUREG is because something
8 happened to the Salem 2 Turbine in 1991 and that is
9 only instance in the U.S. which can be categorized as
10 a destructive -- as a turbine which reached the
11 destructive over speed.

12 CHAIRMAN STETKAR: For a nuclear plant.

13 DR. SHENG: For a nuclear plant, right.

14 And, I'm going to discuss later about what
15 destructive over speed means, or what are the
16 consequences of having that.

17 CHAIRMAN STETKAR: I guess I'm just
18 curious that you are saying we are going to reassess
19 the failure data, given operating experience, since
20 1977. It strikes me that there are a very large
21 number of conventional power plant turbines operating
22 out in the world that while for practical purposes
23 operate under the same scheme conditions with the same
24 protection systems as nuclear power plant turbines.
25 And, it strikes me that we should have a lot of

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1 operating information to help us estimate what those
2 frequencies might be.

3 MEMBER BLEY: If anything, their steam
4 conditions are better than we have --

5 DR. SHENG: Pressures.

6 MEMBER BLEY: -- pressures, yes.

7 DR. SHENG: Yes.

8 MEMBER BLEY: And, I was thinking the same
9 thing before, what's the basis for not looking more
10 broadly, since, you know, we are trying to go after
11 those probabilities of failure.

12 DR. SHENG: Not -- we don't -- at that
13 time that I did not have the basis, it's just that
14 it's convenient that we have the NUREG 1275, which is,
15 basically, that review all the events associated with
16 nuclear power plants.

17 And then, just to continue their effort
18 since 1995, to try to fill the gap from that year to
19 now.

20 So, we did not -- we are not very
21 aggressive at that time to try to look all turbines.

22 MEMBER BLEY: After '95, though, you also
23 only looked at nuclear.

24 DR. SHENG: Nuclear power plants, right.

25 MEMBER BLEY: Did you find anymore events?

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1 DR. SHENG: I'm going to talk about that
2 later.

3 MEMBER BLEY: Okay.

4 DR. SHENG: Yes, we have some events,
5 okay, but some are very significant, some are not, but
6 I am going to discuss it later.

7 So, as I said, the purpose of calibrating
8 these operating experience is to see whether we need
9 to change the current criteria on P_1 and P_4 , whether we
10 should even take a more aggressive approach to
11 changing the current regulatory philosophy.

12 And, since I mentioned P_1 and P_4 here, so
13 maybe it's the right page that I define P_1 , P_2 and P_3 .

14 And, of course, our ultimate concern is P_4 , which is a
15 probability of failure of an essential system, caused
16 by turbine missile, that's P_4 .

17 P_4 is equal to P_1 times P_2 times P_3 , and P_1
18 is a probability of turbine missile generation, and P_2
19 is a probability of ejector missiles striking an
20 essential system. This probability we need to know
21 what are these events causing damage to the essential
22 system.

23 So, P_3 , actually, is a probability of the
24 struck essential system, losing its safety function.

25 And, even we all call this P_1 , P_2 , P_3 , the

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1 probability, but P_1 , actually, has the event frequency
2 factored into it. So, you may argue you don't like to
3 use the probability for P_1 , but we just don't want to
4 use the terminology which has been used in the
5 industry and in NRC and by the licensees for many,
6 many years.

7 So, even though the frequency in P_1 , it's
8 still called probability.

9 MEMBER BLEY: Oh, yes, but it's defined as
10 a probability per year, right?

11 DR. SHENG: Yes, because some people say
12 that we should use frequency about P_1 .

13 CHAIRMAN STETKAR: Just be careful with
14 your microphone.

15 DR. SHENG: Sure. Okay.

16 Now, I'm going to talk about some findings
17 on the review of turbine operating experience.

18 A very significant issue is an event in
19 1991, which gives a point estimate of $1E-3$ per
20 turbine-year for a destructive turbine overspeed
21 event.

22 The industry defined destructive turbine
23 overspeed event is that, if you are -- which is
24 probably like 180 percent of the rated speed, when you
25 reach that speed that means that you are going to have

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1 later disintegration, because at that time that the
2 criteria is approaching mechanics, it is the strength
3 of the material. In other words, when your turbine
4 reached the destructive overspeed, at that time a lot
5 of areas, the maximum stress has already exceeded your
6 yield strengths.

7 So, you can see this is a very dangerous
8 situation, because if for any reason you had a crack
9 anywhere, then probably it will fly away right away.

10 So, this is considered very important
11 event, and as a result of that NRC probably did some
12 review and issued NUREG 1275, and to summary the
13 findings, and to work with the actual -- work with
14 industry and plant to improve their performance.

15 And, there are four areas that NRC
16 identified which is a deficiency in certain areas.
17 The first one is testing, about turbine testing. The
18 second one is maintenance control system, and control
19 system through the quality and then human factors.

20 So, NRC identified there are certain
21 deficiencies in these areas, and as a result of that
22 the industry, as a whole, and licensees, probably made
23 improvement in these four areas, which resulted in
24 improved performance in the past 15 years.

25 So, after this Salem 2 event, we can say

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1 that the turbine operating record has improved in
2 general, in the past 15 years.

3 CHAIRMAN STETKAR: We had one event in
4 1991.

5 DR. SHENG: Yes.

6 CHAIRMAN STETKAR: When did the first
7 nuclear unit start up in the U.S., some time in the
8 late '60s, I guess, mid '60s? So, we had one event in
9 25 years, something like that?

10 How do we know that the turbine operating
11 record is improved in general during the last 15
12 years?

13 DR. SHENG: I said past 15 years, that
14 means after -- probably after 1995.

15 CHAIRMAN STETKAR: Well, we haven't had
16 another one yet, but we don't expect another one,
17 necessarily.

18 DR. SHENG: That's correct.

19 MR. JONES: This is Steve Jones in Balance
20 of Plant Branch.

21 I guess what Reg Guide 1275 went into,
22 they calculated the number of operating years of
23 experience among the nuclear plants, and it was about
24 1,000 years at that time, in 1991.

25 CHAIRMAN STETKAR: And now?

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1 MR. JONES: And now, it's a lot more than
2 that. You can do the math.

3 CHAIRMAN STETKAR: We are really crediting
4 what you think are improvements to get to 1×10^{-4} .
5 You can't do it just from years.

6 MR. JONES: Right. Yes, that's true.

7 There were a lot of improvements
8 identified, and, obviously, insurance plays a role in
9 this, as well as the INPO and the safety culture among
10 the nuclear licensees.

11 But --

12 CHAIRMAN STETKAR: One thing I don't have
13 any idea of, what fraction of our turbines out there
14 have been upgraded? I know some that have had
15 substantial upgrades.

16 MR. JONES: First of all, I guess,
17 virtually, all the turbines of concern in this area
18 are the low-pressure turbines, because --

19 CHAIRMAN STETKAR: Right.

20 MR. JONES: -- they have larger rotors,
21 and are subject to more centrifugal force than the
22 high pressure, also the relatively low blade height on
23 the high pressure turbines is a lot less force acting
24 on them.

25 But, among the low pressure turbines, they

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1 have frequently been replaced. Many utilities are on
2 their third or fourth set, so low pressure turbines.

3 MEMBER SHACK: But, do they change the
4 whole different designs? I mean, are we now at all
5 mono blocks for all these replacements?

6 MEMBER BLEY: I thought that was only a
7 few that had gone to new designs.

8 MR. JONES: I think -- I don't know, maybe
9 you can speak to that.

10 MEMBER SHACK: I mean, he's new reactors.

11 MR. HONCHARIK: I wasn't there -- this is
12 John Honcharik from NRR -- NRO -- I forgot where I
13 was.

14 I guess, you know, like you said, some of
15 them have replaced them, and I think they are going
16 more and more to the mono block, or integral rotor,
17 and also there are welded rotors, like Alstom has
18 welded rotors, which is, basically, a series of
19 forgings that are welded together. And, they've been
20 using those, I guess, pretty extensively in Europe.

21 And so, I guess to answer your question, I
22 think in the past probably 15 years or so, they
23 probably have been using integral rotors versus the
24 disks, where they have the key waves, which caused a
25 lot of the problems, you know, in the past, where you

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1 had the cracking in those shrunk-on disks at the key
2 waves.

3 So --

4 MEMBER BLEY: It just seems to me that
5 having some rough idea of the fraction that have gone
6 to those is -- would be a lot better basis for
7 claiming we are better off than, you know, what you
8 presented to start with here.

9 And, I don't know, I've seen some of
10 those, but I really don't know how many have gone to
11 that out of the operating plants we have out there.

12 MR. JONES: I guess we haven't really
13 talked about it too much yet, but there is kind of a
14 distinction. There's a probability of failure at
15 normal operating speeds that's largely driven by
16 fraction mechanics, and crack growth, and the other
17 piece of it is the overspeed.

18 Salem 2 event in '91 was an overspeed
19 event, and that, predominantly, related to a lot of
20 latent failures being present in the turbine overspeed
21 protection system, combined with human factors during
22 an actual test of the overspeed protection system,
23 that, actually, led to the overspeed event.

24 During the test, an operator is bypassing
25 the mechanical overspeed trip for the turbine, and

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1 relying exclusively on electrical overspeed protection
2 during the course of the test, and that had failed
3 unknown to the operators.

4 CHAIRMAN STETKAR: Of course, in new plant
5 designs, we are transitioning from turbine -- from the
6 mechanical overspeed trips to dual electrical
7 overspeed trips.

8 MR. JONES: The other factor, I guess, is
9 the inability to independently test redundant valves
10 in the design of the Salem overspeed protection
11 system, and the newer turbine overspeed protection
12 systems do have that ability to independently test
13 different valves, and, hopefully, they'll use valves
14 of different design, not 100 percent all the same
15 manufacturer, same length of service, same everything.

16 MR. HONCHARIK: This is John Honcharik
17 again.

18 And also, I guess, with that testing, I
19 think after that event I think they looked at that
20 more closely, and determined that, you know, based on
21 experience of failures of the valves, controllers
22 that, you know, may be proven to expand the frequency
23 for the testing, and that's kind of even shown in new
24 reactors, and even the current reactors that have gone
25 for a longer period of time in between testing of the

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1 valves.

2 CHAIRMAN STETKAR: Okay, thank you.

3 MEMBER BLEY: Just one quick question that
4 I can -- I knew I recognized 1275, and that's the
5 operating experience feedback report, those were
6 annual reports. And, this one was 1995, you said?

7 DR. SHENG: You mean Salem 2?

8 MEMBER BLEY: No, but earlier you said
9 NUREG 1275 was put together to go back and look at
10 turbine failures.

11 DR. SHENG: 1995, right.

12 MEMBER BLEY: But, it's a 1995 copy of
13 that report.

14 DR. SHENG: 1995, right. Right.

15 MEMBER BLEY: Okay.

16 MR. JONES: I believe it's Volume 10.

17 MEMBER BLEY: 10?

18 MR. JONES: I think it's Volume 10.

19 MEMBER BLEY: Let Girija know for sure, if
20 you will.

21 MR. JONES: I have a copy of it.

22 DR. SHENG: Okay, so I said that the
23 turbine operating record has improved in general
24 during the past 15 years. It's simply that we don't,
25 in the past 15 years we don't have the cases that we

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1 have disintegration, or we have seen massive cracks,
2 because around the '90s we have several disks which
3 show four or five huge, very long cracks.

4 And then, the licensees have to justify
5 that you could still operate that wheel with
6 indications for two years, something like that, and
7 that eventually the NRC approved that, and approved
8 that to be okay for two years.

9 So, all I'm saying, that if in the past 15
10 years we didn't see that kind of incidence, which the
11 disk failed that in the fracture, in a brittle
12 fracture manner.

13 However, even we improve -- the situation
14 has improved in 15 years, however, we still have an
15 unignorable number of events resulting in scrams,
16 shutdowns and outage delays per years. And, this is
17 exactly what I said before about, we have about 72
18 events from year 2000 and 2004, but they are intensive
19 missiles, but most of the cases it's just several
20 clustered breaks, and nothing more serious than that.

21 Okay, so the outcomes of review of turbine
22 operating experience, I would say is a major
23 contributor to our conclusion is still the Salem 2
24 event, because it's a rather serious event. So, based
25 on a point estimate of 10 to E-3, and plus additional

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1 years, 1995 to now, so we figure about -- the
2 conclusion we can make is still that operating
3 experience is consistent with the turbine failure rate
4 of 1E-4 per turbine year, which is consistent with
5 what RG 1.115 stated.

6 So, if we don't have that single event,
7 then probably the proposed RG 1.115 would be
8 different, because then we are going to use a more
9 elaborate statistic approach, probably to justify for
10 lower criteria for P₁ and P₄.

11 CHAIRMAN STETKAR: Sheng, do you have any
12 idea where the original 1E-4 came from?

13 DR. SHENG: Yes. That report is based on
14 that Bush report dated 1973.

15 CHAIRMAN STETKAR: 1973.

16 DR. SHENG: However, that report include
17 old turbines, not just the nuclear turbines.

18 CHAIRMAN STETKAR: It did?

19 DR. SHENG: It did, right.

20 CHAIRMAN STETKAR: Okay. Thank you.

21 DR. SHENG: Because of this -- because we
22 made the congruency, the operating experience is still
23 consistent with current RG 1.115, so we maintain the
24 current criteria of P₁ and P₄. We didn't try to lower
25 the standard.

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1 CHAIRMAN STETKAR: In other words, the
2 Hope Creek SER refers to RG 1.115 as a basis for the
3 10^{-4} , so this seems to be a bit of a circuitous logic,
4 that the update to RG 1.115 is justified by the Hope
5 Creek SER, which, in turn, refers back to Rev 1 of the
6 RG 1.115, as a basis for justifying the 10^{-4} .

7 I went back and I, actually, downloaded,
8 it takes a long time, the NUREG 1048, and looked at
9 the references. And, essentially, it all comes from
10 that original Bush report, that is the number,
11 regardless of what references are made.

12 DR. SHENG: Right, yes.

13 CHAIRMAN STETKAR: Because that's the only
14 source of any number whatsoever.

15 DR. SHENG: I agree with you, because a
16 lot of numbers are based on the Bush report, Bush
17 paper, dated 1973.

18 CHAIRMAN STETKAR: That's for the
19 frequency of P_1 . The P_2 and P_3 come from the Twisdale
20 work that was done in whatever, 1983, I think.

21 DR. SHENG: Yes.

22 CHAIRMAN STETKAR: Okay.

23 MEMBER SHACK: So, if somebody did a
24 calculation, came up with a P_1 that was 10^{-6} , would you
25 give them a break on P_2 and P_3 ?

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1 DR. SHENG: I would say so, because this
2 RG 1.115, actually, allows the people to do the whole
3 analysis, including P₂ and P₃, because based on the
4 Hope Creek criteria, the NRC discouraged the licensee
5 to use P₂ and P₃ approach.

6 So, just when you under protect your
7 turbine, and you want to use an easier approach, then
8 just give me a P₁ number, and I'll assume the P₁ number
9 to be 10⁻⁴ for the orientation with turbine, and 10⁻⁵
10 for the non-favorable ONG turbines.

11 So, up to this point, we have, I think, a
12 wide range of industry reports, especially, several
13 reports by EPRI, I notice that the industry beats
14 several -- made some progress in the P₂ and P₃
15 calculation. And, actually, they have software to do
16 the whole thing.

17 So, I think this is about time, because
18 it's about almost 15 years, so maybe we should take a
19 very good look at the industry's approach of using --
20 taking advantage of P₂ and P₃, and that's why we would
21 open -- we make -- we no longer say that we discourage
22 this, we say we have a preferred approach, and we have
23 an acceptable approach. The acceptable approach, we
24 said, you want to use P₁, P₂ and P₃ to protect your
25 turbines.

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1 CHAIRMAN STETKAR: Sheng, what's wrong
2 with as Dr. Shack said, if P_1 was 10^{-6} , you might allow
3 some flexibility in P_2 and P_3 .

4 DR. SHENG: That's right, that's true.

5 CHAIRMAN STETKAR: Suppose P_1 was 10^{-2} , but
6 P_2 and P_3 were exceedingly small?

7 DR. SHENG: In this case, okay, because --

8 CHAIRMAN STETKAR: There's a lot of
9 flexibility there, though.

10 MR. JONES: We have a different kind of
11 flexibility. I guess we are relying on barriers at
12 that point, predominantly.

13 CHAIRMAN STETKAR: Well, but the Reg Guide
14 explicitly says that for unfavorably oriented turbines
15 the NRC will consider approaches considering P_2 and P_3
16 for both high and low trajectory missile analyses.

17 This approach, which applies to a site
18 with single and multiple units, is acceptable if P_1 is
19 less than 1×10^{-4} per year, and P_4 is less than 10^{-7}
20 per year. That says it's not acceptable if P_1 is
21 greater than 1×10^{-4} , regardless of what P_4 is. P_4
22 might be 10^{-30} , but it's still not acceptable if P_1 is
23 10^{-3} , let's say.

24 DR. SHENG: Yes, at this point, we say 10^{-4} ,
25 it's already representing some kind of relaxation,

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1 because the Hope Creek criteria said that for the non-
2 favorable orient -- turbine orientation, that P_1 has to
3 be less than 10^{-5} , so when we allow order of magnitude
4 changes, it's already a relaxation there.

5 And also, we keep in mind that even --
6 even -- even you have some kind of turbine missile of
7 several blades clustered together with a piece of the
8 disk, it may not even consider as a missile, because
9 usually we consider here large missiles, like probably
10 worth more than 1,000 pounds.

11 But, even for small missile penetrate in
12 the case, the turbine casing, it may be very cost --
13 it will cost a lot for the licensees to fix that.

14 CHAIRMAN STETKAR: Yes, but our job is not
15 to --

16 DR. SHENG: I understand.

17 CHAIRMAN STETKAR: -- regulate investment
18 risk from licensees.

19 DR. SHENG: Right.

20 CHAIRMAN STETKAR: It's to regulate public
21 health and safety. So --

22 DR. SHENG: Right.

23 CHAIRMAN STETKAR: -- we don't care if
24 their turbine comes apart every week, if they are
25 willing to accept the cost, as long as that failure

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1 doesn't, necessarily, have any impact whatsoever on
2 public health and safety.

3 DR. SHENG: Right.

4 CHAIRMAN STETKAR: So, I'm not interested
5 in arguments about protecting investment risk.

6 DR. SHENG: Yes.

7 CHAIRMAN STETKAR: I was going to ask you,
8 if I take a hypothetical plant with my turbine, and
9 build a structure around it that's 10 feet thick
10 concrete, completely enclosing the entire turbine, and
11 the condenser, and things like that. So, we can't
12 really protect the condenser against failures of
13 turbine missiles very easily.

14 This would still say that I must
15 demonstrate that my frequency of turbine missile
16 ejection through the casing must be less than 10^{-4} .

17 Steve, you are shaking your head. Yes, it
18 does. You know, I provided the most robust P_2 barrier
19 that I can think of.

20 MR. JONES: Right. The way the Reg Guide
21 is constructed, there is an option to demonstrate
22 protection solely by barrier design.

23 CHAIRMAN STETKAR: Where does it say that
24 in the Reg Guide.

25 DR. SHENG: Yes, we have three options.

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1 The one is using turbine orientation. The second one
2 is using the calculated P_1 numbers, and the third one
3 is using barriers. So, the one you just described is
4 using barriers, so, basically, they don't need to do
5 any calculation, if they would have an option like
6 that.

7 CHAIRMAN STETKAR: Okay. Position 6.

8 MR. JONES: Yes.

9 CHAIRMAN STETKAR: Okay. I guess I didn't
10 understand that that was an absolute allowance, only
11 because it comes after Position 5, which has this 10^{-4}
12 and 10^{-7} .

13 MEMBER SHACK: Three gives you the "or"
14 thing.

15 CHAIRMAN STETKAR: Okay. Okay.

16 DR. SHENG: Okay, so -- is Steve Dinsmore
17 in the audience? No? Okay.

18 MEMBER SHACK: He must have heard.

19 DR. SHENG: Because -- no, because we are
20 going to -- the next slide is about application of a
21 risk-informed approach, and there are four back-up
22 slides after that.

23 So, if he's not here, I don't know whether
24 we should try it, or --

25 CHAIRMAN STETKAR: Why don't -- is there a

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1 way that you can skip that and go to a different
2 topic? I'm trying to -- you know your presentation
3 much better than we do.

4 MR. JONES: We've actually talked about
5 most of the stuff on this slide. We are just lacking,
6 I guess, Steve Dinsmore's perspective.

7 MR. SHUKLA: Can anybody call him?

8 CHAIRMAN STETKAR: Yes, can you call
9 Steve, somebody?

10 DR. SHENG: I don't have his number right
11 now.

12 MEMBER SHACK: Yes, I mean, this one
13 really doesn't address the acceptance criteria, which
14 is sort of where we were at before. This is if you
15 had acceptance criteria, this is what you do.

16 DR. SHENG: Okay, let's skip that one,
17 because after that I have four back-up slides around
18 this direction.

19 So, let's move to the more traditional
20 stuff, and then if he didn't -- if he does not show
21 up, then we can make an attempt to make a presentation
22 on that area.

23 CHAIRMAN STETKAR: Good.

24 DR. SHENG: So, I'm going to skip this one
25 and talk about enhancements in the proposed RG 1.115.

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1 The first is to provide guidance for high-
2 trajectory missiles, and, actually, I wouldn't say
3 that I provide any new guidance for the high-
4 trajectory missiles, and it's based on my
5 understanding of the high trajectory missiles, how we
6 calculate that. And then, looking at all these
7 regulatory documents, so, basically, in this area I,
8 actually, provide clarification.

9 So, I'm going to talk about that a little
10 bit more later.

11 So, the second thing is, clarifies the
12 current NRC emphasis on P_1 , which is stated in the 1986
13 Hope Creek SE and the 2007 SRP, and also when I say
14 clarify, is that I also have criteria for high
15 trajectory missiles, and, basically, that's based on
16 the NRC's review of the plant specific submittals, and
17 our understanding of these numbers and criteria.

18 And, the third enhancement in the RG 1.115
19 is that we now permit the approach of considering P_1 ,
20 P_2 , and P_3 all together. And, post improvement is that
21 we validate operating experiences since 1977.

22 The last one is that we define structure,
23 system and components to be protected.

24 CHAIRMAN STETKAR: Sheng, are you going to
25 talk anymore about the high trajectory missiles, or is

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1 it appropriate to ask --

2 DR. SHENG: Yes.

3 CHAIRMAN STETKAR: -- you are, okay.

4 DR. SHENG: Yes.

5 The high trajectory missiles, this is a
6 picture to show the difference between a direct hit by
7 low trajectory missile and the high trajectory
8 missile, but, of course, this is limited by the size
9 of paper. Actually, the real one which could make
10 damages will fly very high, and then come back here,
11 then you have now kinetic energy at that point. This
12 one probably will not make damages to the dome.

13 The next page is that still to provide
14 guidance for high trajectory missiles. Here I would
15 like to provide you some calculations here, and then
16 explain Dr. Bill Shack's question about why we didn't
17 -- why we didn't provide the criteria -- not criteria,
18 guidance, how to calculate these numbers, and we
19 didn't do that.

20 First, I have to -- let's do it that I
21 explain along the way. First off, P_1 , the calculation
22 of P_1 , how they calculate equal to $P_1 = P_{1f} \times P_{1p} + P_{1o}$.

23 P_{1f} is the probability of this value, based on
24 probabalistic fracture mechanics considering strength
25 corrosion cracking.

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1 CHAIRMAN STETKAR: These you are talking,
2 just so I get it straight in my head, these are $P_{1f} \times$
3 P_{1p} are design operating speeds, though, right?

4 DR. SHENG: Right.

5 CHAIRMAN STETKAR: This is the disk coming
6 apart.

7 DR. SHENG: You are right.

8 CHAIRMAN STETKAR: At less than 130
9 percent overspeed.

10 DR. SHENG: You are right.

11 CHAIRMAN STETKAR: Okay, I just wanted to
12 make sure.

13 DR. SHENG: You are right, and depending
14 on the original equipment manufacturers, they may have
15 different approaches, because one fabricator may have
16 2/10s here. Here, I lump together with probably the
17 design -- just the ready speed, which will fail in
18 fracture mechanics.

19 And, this is, the second one, P_{10} will fail
20 in a total manner at much higher speed.

21 But, some manufacturers may separate the
22 first one into two, and talking about some kind of
23 design overspeed.

24 CHAIRMAN STETKAR: Right, up to 110 or
25 something like that.

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1 DR. SHENG: Yes, yes, design overspeed,
2 they expect that to happen more frequently, but then
3 they also assign some kind of event frequency on that
4 one.

5 So, this may be the right time to answer
6 Dr. Shack's question about why we didn't provide the
7 guidance to the calculation.

8 I think one of the reasons is that other
9 manufacturers consider this calculation methodology as
10 proprietary. So -- and they are different, they are
11 all different.

12 CHAIRMAN STETKAR: So, do you review them
13 then on a case-by-case basis?

14 DR. SHENG: That's correct.

15 CHAIRMAN STETKAR: For each submittal.

16 DR. SHENG: Yes, I myself review the
17 methodology by Siemens Westinghouse, so I know their
18 methodology very well, but, actually, I know nothing
19 about GE's methodology.

20 Even in the EPRI reports, when they are
21 talking about methodology, because it's proprietary in
22 nature, they only have superficial introduction, and
23 from that you really cannot see the whole picture of
24 the methodology.

25 CHAIRMAN STETKAR: So, does the staff look

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1 at the proprietary reports then, to evaluate the
2 methodology --

3 DR. SHENG: Yes.

4 CHAIRMAN STETKAR: -- make sure that it's
5 consistent?

6 DR. SHENG: Yes.

7 CHAIRMAN STETKAR: What guide -- what
8 review guidance then do you give your reviewers for
9 the conclusions that the methodology is appropriate?

10 DR. SHENG: I don't think there is a
11 review guide. The review guide, the only review guide
12 that you may have is stating the several SRP, and you
13 cannot find anything, you can only find, oh, you need
14 to consider this, you need to consider that, and
15 that's about it.

16 So, basically, that I can cite my own
17 experience, that when I review the Siemens
18 Westinghouse methodology, I rely on my experience and
19 my background in fracture mechanics, in stress
20 analysis, and in probability fracture mechanics when I
21 was involved in the PTS evaluation.

22 So, all I can say is that, probably the
23 individual staff has to tape their own talent to do an
24 appropriate review. We don't have a review guide on
25 the methodology.

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1 MEMBER SHACK: But, that's the way it's
2 done, they submit a methodology report that you
3 review, and then they apply that to the various
4 turbine designs. It's not a specific analysis for
5 each turbine, there is a methodology they apply.

6 DR. SHENG: Right. Right. Right.

7 MEMBER SHACK: I mean, you can still see
8 questions, for example, about, you know, do you have,
9 you know, just two speeds, a design speed and an
10 overspeed, or do you really realize that there's a
11 range of speeds that they could be looking at, you
12 know, the distribution. I mean, I suppose you could
13 handle that somehow in the distribution of your
14 toughnesses.

15 DR. SHENG: Right.

16 MEMBER SHACK: It seems like something
17 where you ought to have some expectations for what
18 they include in the analysis, and I guess -- but they
19 don't know that until they hand you the report.

20 DR. SHENG: Right.

21 CHAIRMAN STETKAR: Well, and the key is if
22 they hand it to you, with your experience --

23 DR. SHENG: Right.

24 CHAIRMAN STETKAR: -- you might hold them
25 accountable for different things than if they hand it

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1 to me with my experience, who may not have had the
2 same number of years looking at fracture mechanics
3 that you do, or your particular insights.

4 You said you are very familiar with
5 Westinghouse Siemens, but another reviewer of a GE, or
6 Mitsubishi, or AREVA, or whoever else manufactures,
7 Alstom, whoever else manufactures turbines out there,
8 may not have that same degree of experience or level
9 of insight that you do, to know what questions to ask
10 based on the particular analysis methodology that
11 those other manufacturers might submit.

12 DR. SHENG: I think in the fracture
13 mechanics area, the area of fracture mechanics, and
14 the area of stress analysis, NRC has enough talent.
15 So, all management, if they -- if it so happened that
16 they are, some under them does not have this specific
17 expertise, then I think the management will try to
18 acquire somebody else from other divisions to do that
19 review. Usually, that's the case.

20 MR. MITCHELL: Yes, and this is, again,
21 Matthew Mitchell of the staff.

22 What Simon says is, actually, correct.
23 You know, we would certainly take any review of this
24 nature, obviously, very seriously, based upon its
25 complexity.

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1 And, you know, we take very seriously also
2 the notion of trying to do knowledge management and
3 transfer the kind of experience that someone like Dr.
4 Sheng has, to our more junior staff when the
5 opportunity arises.

6 If we were to run into that circumstances,
7 where we were not immediately able to have the kind of
8 expertise that we would recognize we would need for a
9 review like that, we could go to our research. We
10 would contract with the National Labs as appropriate,
11 to make sure that we have the right expertise
12 available to review research methodology going
13 forward.

14 I mean, we have a number of sources that
15 we can go to, to make sure that we have the right
16 combination of expertise brought to bear on any
17 particular problem.

18 We make use of those sources on more than
19 one occasion in the past, as I know you all are aware
20 of. But, it is, obviously, an issue that we are
21 facing, this issue of knowledge management, but it's
22 one that we are attempting to do the very best we can
23 to make sure that this kind of expertise gets
24 transferred from one generation to the next.

25 MEMBER SHACK: But, you know, the

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1 thermohydraulics people, actually, you know, have a
2 guide for how to review codes, and, you know, this
3 seems almost like a generic enough problem, I mean,
4 you have generic guides on how to do vessel analysis,
5 we call them codes, and this seems like a generic
6 enough problem that while thinking about guides, you
7 know, do we want to accept, for example, just two
8 speeds? You know, is that -- or, you know --

9 MR. MITCHELL: And, that point is well
10 taken, Dr. Shack, and that's something that we can
11 take back and think about within our scope of overall
12 knowledge management practice, whether in this
13 particular area we should develop further internal
14 guidance for reviewers that may be helpful in the
15 future.

16 CHAIRMAN STETKAR: An example, we haven't
17 talked about P₁₀, but something that I've seen, just
18 looking at a couple of submittals, I think I read
19 somewhere that from -- I think it was in the Bush
20 report, that the primary contributor to severe
21 overspeed failures was not, necessarily, failure of
22 the turbine protection logic, it had a reasonably
23 significant contribution from failures of the turbine
24 top valves failing to close.

25 I've seen at least a couple turbine

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1 overspeed analyses that were performed to justify
2 something less than 10^{-4} , or 5 or whatever number you
3 use, that didn't even consider failures of the turbine
4 top valves. It looked only at the turbine protection
5 system, and in some cases didn't even look at the
6 hydraulic valves to port the hydraulic fluid, only
7 looked at the electronics portion when asked about why
8 didn't you consider the hydraulic valves, they went
9 back and looked at those.

10 But, that type of guidance, in terms of
11 reminding the reviewer that you need to sort of ask
12 about things, might be helpful.

13 MR. MITCHELL: Again, understood, and that
14 is something that we can look into, and should look
15 into, in terms of being able to capture that kind of
16 information.

17 DR. SHENG: Okay, so P_1 penetration is a
18 probability of the failed disk piece, penetrating
19 turbine case based on energy dissipation. And,
20 actually, this is a place where the LTMs and the HTMs
21 come into play, because you can set the exit angle,
22 and then it will give you different numbers for low
23 trajectory missiles and high trajectory missiles.

24 And, both P_{1f} and P_{1p} are based on Monte
25 Carlo type of analysis, which based on a lot of random

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1 variables to define important variables, and to
2 approach other probabilities statistically.

3 And then, the third item, the P₁₀, that's
4 overspeed protection system, and as it was mentioned
5 before by Dr. Stet --

6 CHAIRMAN STETKAR: Stetkar, that's close
7 enough.

8 DR. SHENG: -- Stetkar.

9 CHAIRMAN STETKAR: It's not Dr., but
10 that's okay. Good try.

11 DR. SHENG: Okay, that this one will
12 change, depending on your testing frequency. So,
13 usually, based on like a 3-month testing frequency
14 will give you a curve, and based on six months testing
15 frequency will give you another curve.

16 So, this testing frequency is reflected in
17 this calculation, and again, as I said, that we don't
18 -- we, actually, don't have a guidance on how to
19 calculate that.

20 However, the only thing I can say, that
21 there is similarity of the Siemens Westinghouse
22 methodology with truly Westinghouse methodology, which
23 I didn't review, but I tried to scan through the
24 report, which is dated in something like 19 -- around
25 1980 something, and I found out that the approach for

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1 treating P_{10} is very similar. It is based from the
2 failure rate of each component which goes into the --
3 which goes in to the overspeed control.

4 And, I don't know whether at this point we
5 should stop and let Steve talk on the risk-informed
6 approach.

7 CHAIRMAN STETKAR: Let's get through your
8 next slide, I think, because I had a question I think
9 that's pertinent to this next slide, and then we can
10 put Steve on the hot seat.

11 DR. SHENG: Okay. So, basically, this Reg
12 Guide clarifies the current emphasis on P_1 , favorably
13 oriented turbine, the low trajectory, no additional
14 analysis.

15 MEMBER SHACK: Just for our benefit, can
16 you flip over to the next slide, so the slide matches
17 what you are saying.

18 DR. SHENG: Yes, so, basically, we kept
19 that guidance in the current RG 1.115. However, if
20 people just use the current RG 1.115 as a reference,
21 maybe they don't know how to do about high trajectory
22 missiles. Maybe they think that they don't need to do
23 anything about that. So, right now we are putting the
24 criteria on the high trajectory missiles. We say that
25 for favorably oriented one, then the high trajectory

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1 missile, all we need to do is put a P_1 calculation to
2 show that it satisfied $1E-4$, so that's our
3 interpretation of the 1986 Hope Creek SER, even in
4 that SER it didn't mention high trajectory missiles.

5 CHAIRMAN STETKAR: That's why I was
6 curious when you say it's based on the Hope Creek SER.

7 The Hope Creek SER is silent on high trajectory
8 missiles.

9 DR. SHENG: That's right, that's correct.

10 CHAIRMAN STETKAR: So, it's not based on
11 the Hope Creek SER.

12 DR. SHENG: Yes, it's based on my
13 understanding, yes, of the --

14 CHAIRMAN STETKAR: The Hope Creek SER
15 simply uses numbers.

16 DR. SHENG: Right.

17 CHAIRMAN STETKAR: They don't -- they are
18 not really as sophisticated as this slide or your
19 discussion might seem to be.

20 DR. SHENG: Right.

21 CHAIRMAN STETKAR: They are simply
22 numbers.

23 DR. SHENG: Right, you are correct.

24 And, I have back-up slide to show you that
25 the topic area. Now, there was a considering about

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1 topic areas, let me show it here.

2 Okay, again, this is -- this is
3 information from Bush's 1973 paper, and also from the
4 information from the EPRI report, dated something like
5 year 2003, that the critical strike targets for
6 nuclear power plants, about turbine missiles, that for
7 PWRs it's containment water for low trajectory
8 missiles, and the terms for the high trajectory
9 missiles.

10 And, fuel storage, primary auxiliary
11 building, diesel building, that there is some thought
12 that it's probably due to high trajectory missile, and
13 some maybe concern for low trajectory missiles.

14 However, if you pay attention to the PWRs,
15 then you will find out that all these lists, fuel
16 pool, or rad waste building, control room, rapid heat
17 removal equipment, the diesel buildings, and I think
18 the concerns are all high trajectory missiles.

19 CHAIRMAN STETKAR: Can I ask you why the
20 fuel pool is not important for pressurized water
21 reactors? I guess it says fuel storage. Why is the
22 rad waste building not important for pressurized water
23 reactors?

24 MR. JONES: I don't know why that says
25 PWRs personally.

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1 CHAIRMAN STETKAR: Why is the -- yes, I'm
2 not quite sure for why it's there for PWR either,
3 except for off gas, off gas systems have pretty high
4 -- depending on where the charcoal filters are. They
5 might have been thinking about that.

6 Part of the point is that I wouldn't put
7 any credibility on lists of equipment from a paper
8 that was published in 1973.

9 DR. SHENG: Yes.

10 CHAIRMAN STETKAR: There were,
11 essentially, no operating nuclear power plants of any
12 relevance to the current operating fleet, and,
13 certainly, of no relevance to the new operating fleet
14 at that time.

15 So, any studies or lists of what might be
16 important for any nuclear power plant in 1973 is, for
17 all practical purposes, irrelevant.

18 DR. SHENG: Right.

19 CHAIRMAN STETKAR: So, we shouldn't -- we
20 shouldn't be referring to those lists.

21 2005, something like that, or, for
22 example, safe shutdown analyses done for Appendix R
23 fires, for example, are very relevant, because they
24 identify buildings, you know, system structure and
25 components that are relevant for safe shutdown of each

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1 nuclear power plant, and each plant has done those
2 types of analyses, for Appendix R now requirements.

3 So, we do have a pretty good inventory,
4 and they can vary from plant to plant.

5 Now, I don't see the control building
6 listed for pressurized water reactor.

7 DR. SHENG: Control --

8 CHAIRMAN STETKAR: I do for BWR, I
9 understand why we can kill operators in a pressurized
10 water reactor, but not in a boiling water reactor.

11 DR. SHENG: Yes, but, as I said, this
12 information was primarily based on the industry report
13 dated year 2003, and I used that as a basis, and I
14 compare it with -- this list, with the 1973 Bush
15 report, and there was not a major difference there.

16 So, I would say that maybe it's -- if it's
17 not 100 percent correct, at least it's 80 percent
18 correct.

19 However, the reason that I want to show
20 you this one is that, I think for PWRs their primary
21 concern is the high trajectory missiles, and one of
22 the reasons is that, because -- because the wall, the
23 wall they show for these buildings, okay, for the
24 buildings housing this facility, these important
25 function are usually two feet thick.

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1 So, and for the containment it's even
2 thicker, for PWRs. So, it didn't say very clearly in
3 the paper, but I think the implication is that the low
4 trajectory missiles, usually, are deterred by these
5 thick walls. It's serving as barriers.

6 Right now we only have high trajectory
7 missiles flying over these walls, and then landing on
8 the equipment.

9 CHAIRMAN STETKAR: It really doesn't have
10 much to do with the structures, it has everything to
11 do with shield walls that are surrounding boiling
12 water reactor turbines. They are not -- it doesn't
13 have anything to do with the containment or any other
14 structures, it's the large shield walls that are,
15 typically, installed above the turbine operating deck
16 and down below around the condenser, to protect people
17 from radiation exposure in the turbine building.

18 That's why the likelihood of getting a
19 penetrating turbine missile through that shield wall,
20 out into other parts of the turbine, on a low
21 trajectory, is a lot lower for a BWR than a PWR, that
22 don't have those shield walls around the turbine.

23 But, given a missile ejection, I
24 understand why there's a higher probability of a high
25 trajectory missile evolving out of the turbine

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1 enclosure, if you include those shield walls for a
2 boiling water reactor, than a pressurized water
3 reactor, which is strictly a random distribution.

4 I don't understand why, though, the
5 concern for high trajectory missiles is characterized
6 differently for a pressurized water reactor. I mean,
7 I just don't understand this differentiation or the
8 basis for different treatment, or not, necessarily,
9 different treatment, but different emphasis on high
10 versus low trajectory missiles, depending on whether I
11 have a generic boiling water reactor or a generic
12 pressurized water reactor, especially, because I don't
13 know what a generic plant looks like, and I have to
14 look at a particular plant with the orientation of its
15 buildings, and its particular shielding of its
16 buildings, and its particular turbine anyway.

17 MR. JONES: This is Steve Jones.

18 I think I understand your point and agree.
19 There's nothing that I'm aware of in the Reg Guide
20 that would --

21 CHAIRMAN STETKAR: There isn't anything in
22 the Reg Guide -- this is the first I've seen sort of
23 this differentiation here. There's nothing in the Reg
24 Guide that is this clear in terms of that
25 differentiation, in fact, there isn't anything in the

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1 Reg Guide that makes this type of differentiation.

2 MR. JONES: You are right. I mean, we did
3 carefully try to keep barriers as one of the options
4 in satisfying the Guidelines, rather than relying
5 solely on our probabalistic argument.

6 CHAIRMAN STETKAR: I am curious, though,
7 in the Reg Guide, the only guidance in the Reg Guide,
8 really, is Table 1.

9 DR. SHENG: Right.

10 MR. JONES: Right.

11 CHAIRMAN STETKAR: And, Table 1,
12 basically, says that if I have a favorably oriented
13 turbine I don't care about low trajectory missiles.

14 DR. SHENG: Right.

15 CHAIRMAN STETKAR: I don't need to do any
16 analysis at all, is that correct?

17 DR. SHENG: That's correct.

18 CHAIRMAN STETKAR: Okay. I mean, I could
19 -- I could -- because I can't hit anything.

20 DR. SHENG: Right.

21 CHAIRMAN STETKAR: I can throw those
22 missiles out of there every day of the week, and I'm
23 fine.

24 However, if I have a favorably oriented
25 turbine I must meet the 10^{-4} P_1 frequency for that

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1 equation that you showed earlier.

2 If I have an unfavorably oriented turbine,
3 when I need to show that my low trajectory missile
4 frequency is less than 10^{-5} --

5 DR. SHENG: Right.

6 CHAIRMAN STETKAR: -- and I understand
7 why, and I don't care about high trajectory missiles,
8 period, I don't have to do a calculation.

9 DR. SHENG: That's --

10 MR. JONES: It's bounded, basically.

11 DR. SHENG: It's bounded, basically.

12 CHAIRMAN STETKAR: Why is it bounded?

13 MR. JONES: Because the -- it really has
14 to do with the trajectory diagram that he had up
15 earlier.

16 By the way, this is Steve Jones, Balance
17 of Plant Branch.

18 CHAIRMAN STETKAR: Yes.

19 MR. JONES: But anyway, the range of
20 angles that would allow a high trajectory missile to
21 strike any given target, we are talking about missiles
22 with exit velocities over 100 feet per second, in
23 order for them to strike reasonably close to the
24 turbine they have a very narrow range of angles, as
25 opposed to low trajectory missiles, you could easily

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1 have ten times the range of angles would strike
2 something of critical safety importance.

3 So, that, basically, explains the factor
4 of 10 difference. It's how likely the trajectory is
5 to, actually, be able to impact a safety-related or
6 one of the important to safety components.

7 CHAIRMAN STETKAR: I just saw a submittal
8 some time in the last couple of months that showed
9 high trajectory missiles damaging safety-related
10 equipment, several hundred, if not more than a
11 thousand feet, away from the turbine.

12 So, I'm curious why I don't need to worry
13 about high trajectory missiles.

14 MR. JONES: You do still need to worry
15 about them. I mean, it's saying that for unfavorably
16 oriented we are requiring a probability of per missile
17 generation less than 10^{-5} per year, and that given that
18 value the -- again, there's only a finite number of
19 missiles that could originate from the turbine. So,
20 the probability of -- I guess we are really getting
21 into the P_2 part of the equation, is much smaller for
22 the high trajectory missiles, and that, since we
23 consider that, once the low trajectory criteria, 10^{-5}
24 is satisfied, you would need the 10^{-7} criteria for high
25 trajectory missiles as well.

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1 CHAIRMAN STETKAR: And, we just know that?

2 MR. JONES: I've looked at a lot of
3 calculations of trajectories, I mean, it's pretty
4 straightforward that you end up with very large areas
5 that could be struck by a high trajectory missile, and
6 if you just look at how much area is available where
7 there's, actually, important to safety equipment, that
8 dramatically reduces the probability of that missile
9 striking that piece -- or any particular piece of
10 equipment.

11 Even when you are looking at adjacent
12 fossil fuel facilities in the operated turbine, the
13 probabilities are fairly low, given the, you know,
14 ejection velocities we are concerned with, compared to
15 the low trajectory missiles, even a turbine being 150
16 feet away from an auxiliary building that's 50 feet
17 tall, there's probably a range of 25 or 30 degrees
18 where a missile strike would have direct impact on the
19 building, and then, potentially, propagate to some
20 important safety component within the building.

21 CHAIRMAN STETKAR: I have to think about
22 that a little bit, because I tend to think in terms of
23 both frequency and consequences, and it's still not
24 clear to me if a 10^{-6} frequency of launching out high
25 trajectory missiles might not have consequences that

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1 are greater than the lower ones that are protected by
2 more robust barriers.

3 MEMBER BLEY: I mean, you can calculate
4 this, but how high does any of these missiles go?
5 It's got to go almost straight up. It goes pretty
6 high, because it comes out with a lot of energy.

7 And, the side angle to hit something is
8 extremely --

9 MR. JONES: I guess it depends whether we
10 are talking about missiles generated at normal
11 operating speed or some type of overspeed.

12 MEMBER BLEY: Overspeed.

13 MR. JONES: At normal operating speed,
14 with like a 2 foot radius to the center of inertia of
15 the missile, you would be talking an initial speed of
16 about, I think it's like 275 feet per second, and you
17 lose some of that energy going through the casing.

18 But, it's probably still in the range of
19 probably 200 feet per second or so.

20 One plant I'm a little more familiar with,
21 McGuire, they base their protection solely on barriers
22 to construction for their site, but the design basis
23 missiles were over 1,000 pounds and up to 380 feet per
24 second.

25 So, in general, you know, very high exit

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1 velocity, so even a small change in the angle of exit
2 is going to dramatically change the horizontal
3 location where that lands. And so, once you start
4 looking at circles, you know, we would consider it,
5 basically, a circle, because a minor deflection from
6 the casing could send it, you know, forward and
7 backwards, as opposed to just out the side. You end
8 up with a lot lower probability of it striking an
9 important to safety component.

10 I think when you get to very low
11 velocities, more on the order of, for NATO missiles,
12 (A) they are not very likely to come out of a turbine
13 in the first place, because it's hard to imagine
14 losing that much energy and still getting through the
15 casing, but then you might have a little bit more
16 higher probability of landing on the site, rather than
17 somewhere, you know, out well away from the plant
18 buildings.

19 CHAIRMAN STETKAR: Is that high and low,
20 and then we can come back to --

21 DR. SHENG: Yes, I was thinking, we pretty
22 much completed this one.

23 Okay, basically, to clarify this, the
24 emphasis is on P_1 , and following this I would like to
25 show you some back-up slides, and then maybe Steve's

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1 presentation. Where's the back slides? Okay, it's
2 not here, try this one.

3 MR. DINSMORE: My name is Stephen
4 Dinsmore, I'm a Senior Risk and Reliability Analyst in
5 the APLA, in the Division of Risk Engineering. APLA
6 is the Licensing Branch.

7 I'm caught a little off guard here, so I
8 hope --

9 CHAIRMAN STETKAR: Take your time, Steve.
10 We've got all kinds of time here, so don't -- in
11 fact -- well, it's a little early for a break.

12 Do you need a break? I mean, do you want
13 ten minutes? We could take a ten-minute break if you
14 want to sort of collect your thoughts.

15 MR. DINSMORE: That would be great.

16 MEMBER BLEY: We can always take a break.

17 CHAIRMAN STETKAR: We can always take a
18 break, and let's do that. Let's take a break until --
19 I'll even give you 15 minutes, until five minutes til
20 3:00.

21 MR. DINSMORE: Okay.

22 CHAIRMAN STETKAR: And, you can kind of
23 collect your thoughts, and you know the kind of
24 questions you are going to be asked anyway. So, we'll
25 do that.

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1 MR. DINSMORE: Thank you very much.

2 CHAIRMAN STETKAR: We'll recess until
3 2:55.

4 (Whereupon, the above-entitled matter went
5 off the record at 2:38 p.m. and resumed at 2:56 p.m.)

6 CHAIRMAN STETKAR: Guess we will reconvene
7 then, and talk about risk assessment.

8 MR. DINSMORE: Okay, once again, my name
9 is Stephen Dinsmore. I work in the Department of Risk
10 Assessment -- Division of Risk Assessment, I'm sorry.

11 Okay, 1.115 is an acceptable way to
12 demonstrate protection against turbine missiles, and
13 it's based on the probability of failure of essential
14 SSCs. However, there's always an opportunity to do a
15 risk-informed approach, which would be based on
16 changes to the CDF due to proposed changes to the
17 licensing basis.

18 One plant received approval to remove
19 turbine missiles from its design basis, based in part
20 on bounding risk estimates. What this was, this was
21 south Texas, south Texas came in, turned out they had
22 pretty much very -- well, essentially, no safety-
23 related or important equipment around where the belt
24 of the turbine was where they'd expect it to fly
25 apart. And, if you took -- if you failed all that

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1 equipment that was out there, you've got like a
2 condition of core damage probability of 10^{-4} , and if
3 you just took the areas which could be hit, and assume
4 the thing flew apart kind of randomly, it would be
5 down to about 10^{-7} given the turbine missile.

6 So, we assumed one turbine missile per
7 year, and that was a 10^{-7} increase, and it was an
8 acceptably small increase, and they were allowed to
9 move all their testing and surveillance activities
10 from tech specs to a design basis document. So, they
11 continued to do it, it just was no longer in tech
12 specs.

13 And, I guess that was a fairly simple one,
14 but no other licensee has requested that, so I would
15 assume that there's --

16 CHAIRMAN STETKAR: Steve, can you go back
17 to the previous slide, and here the point is made that
18 Reg Guide 1.115 is an acceptable way, and the third
19 bullet there seems to say that a risk-informed
20 approach would be acceptable, is that correct?

21 MR. DINSMORE: I believe a risk-informed
22 application is always acceptable.

23 CHAIRMAN STETKAR: Okay, because there's a
24 part in Section B of Reg Guide 1.115, there's a
25 discussion, an explicit discussion, it says a recent

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1 industry report, Reference 7, proposed the management
2 of turbine missiles by focusing on their contribution
3 to core damage frequency, in lieu of their probability
4 of damaging essential systems. Adoption of this
5 approach would require a revision of both General
6 Design Criterion 4, and the NRC's underlying
7 regulatory philosophy on missile protection throughout
8 the significantly improved turbine missile operating
9 record, and a comprehensive study of the approach
10 based on core damage frequency versus the conventional
11 approach, the staff is not prepared to endorse an
12 approach that would permit licensees to rely solely on
13 the final defense, i.e., prevention of core damage.

14 Now, that seems to be contrary to what you
15 just said.

16 DR. SHENG: Yes, let me explain that.

17 I think that I am going to recommend
18 revision of that language you just cited, that --

19 MR. JONES: Wait a minute, Simon.

20 CHAIRMAN STETKAR: Oh, this could be
21 interesting now.

22 MR. JONES: I mean, Reg Guide 1.174 and
23 the associate Reg Guides, 1.177 for tech spec changes,
24 and I don't know if there's --

25 MR. DINSMORE: There's three or four of

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1 them.

2 MR. JONES: -- yes, there's three or four
3 of them, I'm not sure which one exactly would apply to
4 this case, since it's, typically, not a tech spec, but
5 we would be looking at both the changes to CDF and
6 LERF, and then there's a separate section that talks
7 about deterministic evaluations and defense-in-depth.

8 And again, we get into that defense-in-
9 depth issue I was discussing some time ago, that you,
10 typically, would end up with my branch, the Balance of
11 Plant Branch, for turbine-related issues. And then,
12 we are looking at, is there a set of equipment that
13 could both, as I mentioned before, if you are looking
14 at high frequency of damaging equipment, and also
15 initiating an accident that would require that
16 equipment for mitigation, then we'd be violating the
17 defense-in-depth principle, regardless of whether or
18 not you meet the CDF and LERF guidelines in the Reg
19 Guide.

20 MR. DINSMORE: Yes, I did say you could
21 always come in with a risk-informed application. Some
22 of these things would obviously come into play, if
23 something could damage all aspects of defense-in-depth
24 with one missile, then even if the numbers were small
25 then there's always the risk-informed acceptance

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1 criteria, safety margins, defense-in-depth, and that
2 part.

3 And, the tech branches are the ones who do
4 that determination. We just -- the PRA branches would
5 look at the numbers, and we rely on them to --

6 CHAIRMAN STETKAR: I guess -- I'm not
7 going to let this one by quite that easily.

8 Two things bother me. Number one, the
9 statement, and I quoted it verbatim, refers to a
10 couple of things. It says it would require revision
11 of both General Design Criterion 4 and the NRC's
12 underlying regulatory philosophy on missile
13 protection.

14 But, the NRC PRA policy statement says
15 that we should be heading toward a more risk-informed
16 approach to licensing nuclear power plants, and to
17 regulation, to reduce some burden on both the
18 licensees and the regulators.

19 So, it's not clear how adopting a risk-
20 informed approach to evaluating the risk from turbine
21 missiles, evaluating that risk if it's CDF or LERF, or
22 the mechanics that are used to evaluate that risk, why
23 that's inconsistent with Commission policy. And, I'm
24 not sure what specific revision to General Design
25 Criterion 4 would be required to adopt that approach.

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1 MR. JONES: I guess nothing would be
2 required, because it does say appropriate protection,
3 and we have a large degree of discretion in defining
4 what that would be.

5 I think what that's getting at,
6 predominantly, is how we have treated external
7 missiles, and, particularly, the Tornado Missile Reg
8 Guide, or Tornado -- Design Basis Tornado Reg Guide,
9 1.76, has a similar approach, where we are using a
10 very low frequency of -- well, again, a frequency of
11 10^{-7} , I won't characterize it as very low or high, or
12 whatever, but --

13 CHAIRMAN STETKAR: There's a number in
14 there.

15 MR. JONES: There's a number in there, and
16 that was used to determine what the wind speed and
17 characteristics of the Design Basis Tornado were, and
18 then we extrapolated that to defining what the
19 characteristics of potential missiles that might be
20 produced by that tornado would be. And, this is
21 really a similar approach.

22 We are still using 10^{-7} as an estimate of
23 the frequency of damage to important to safety
24 components, and it's really, basically, the same
25 spectrum of equipment that we are concerned about

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1 protecting, predominantly, those required to achieve
2 safe shutdown. Or, in the case of post accident
3 recirculation, that that equipment that's used for
4 long-term cooling, that might be exposed over, you
5 know, a 100 day or so window to potential missiles.

6 In our case with turbine missiles, we are
7 only worried about, really, adjacent operating
8 reactors at that point, we are operating plants that
9 have turbines, but the same principle applies.

10 I think we can revisit that paragraph and
11 clarify it a little bit.

12 CHAIRMAN STETKAR: That might help,
13 because there are a couple of issues. One is just --
14 the way I read that paragraph, and maybe some
15 clarification might help me, is it seems to be an out-
16 of-hand rejection of any analyses that are based on
17 core damage frequency.

18 MEMBER SHACK: And, Steve already has said
19 that at least one licensee has used --

20 MR. JONES: But that was only to get
21 something out of tech specs, which might be a little
22 different.

23 MEMBER SHACK: -- well, but I mean, in
24 principle this would be a basis for changing turbine -
25 - you know, testing frequencies, or it's a risk-

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1 informed how frequently do you do the overspeed trip
2 testing and all of that kind of stuff.

3 DR. SHENG: I think you are absolutely
4 correct. In light of the fact that RG 1.115 is just
5 an acceptable way. Now that we put the standard
6 language, say compliance with RG 1.115 is not
7 required. So, that means by definition that you can
8 submit something you think is reasonable, but, of
9 course, it's up to the staff to review it and see
10 whether that's an acceptable approach.

11 That's why I said I recommend to modify
12 the language you just cited.

13 CHAIRMAN STETKAR: That might help,
14 really, because, you are right, any Regulatory Guide
15 is, you know, there's always the caveat --

16 DR. SHENG: Right, right, right.

17 CHAIRMAN STETKAR: -- that you can use
18 another approach.

19 It's just that this one seemed to -- there
20 is a separate paragraph that addresses this, and says
21 we are not going to consider this.

22 DR. SHENG: Okay, we are going to take out
23 and do something about that.

24 CHAIRMAN STETKAR: Good.

25 DR. SHENG: Okay?

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1 CHAIRMAN STETKAR: Thank you.

2 The second issue, the real reason you are
3 here, Steve, is back to the whole new reactor risk
4 metrics question, and I noticed you didn't bring down
5 with you -- your up again -- the question is, in an
6 earlier slide, I don't remember which one it was --

7 DR. SHENG: Was it about the risk?

8 CHAIRMAN STETKAR: Yes, slide number 5.
9 The objectives of the proposed RG 1.115 is to assure
10 turbine failure is a negligible contributor to risk.
11 That's slide number 5 in your base presentation.

12 And, RG 1.115, we've established, does
13 apply to new reactors. So, the question is, should we
14 be establishing guidance with specific numerical
15 criteria of 10^{-7} , I'm not even going to argue how we
16 distribute that among P_1 , P_2 , and P_3 at the moment, but
17 10^{-7} as acceptance criteria for new reactors, when we
18 have yet to resolve the whole issue of the acceptable
19 risk metrics from your reactors.

20 This is back to promulgating regulatory
21 guidance in 2010 that's got specific numbers in it,
22 when other guidance has yet to conclude what even
23 philosophy might apply for those risk metrics for new
24 reactors, whether it's CDF and LRF, or CDF and LERF,
25 other philosophical measures of what risk might be,

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1 and then the corresponding numerical values that might
2 be deemed acceptable.

3 And, Steve, you are aware, there are
4 different philosophies on how those metrics might be
5 approached.

6 MR. DINSMORE: And, Mr. Dube will be here
7 Thursday for the Full Committee meeting. We were
8 debating with that right before I came over here.

9 I'm afraid that the only answer I could
10 really give you is that there's a SECY. I mean, this
11 is going to be a Commission decision.

12 CHAIRMAN STETKAR: Right.

13 MR. DINSMORE: It's not going to be -- I
14 doubt that we are going to be able to derive something
15 that automatically leads to some number.

16 So, it would seem to me anyway, somewhere
17 along the line the Commission is simply going to make
18 a decision what to use and what not to use. And, when
19 they do that, then --

20 CHAIRMAN STETKAR: Well, but the SECY
21 recommends further discussion with industry to resolve
22 the issue of risk metrics. So, it's not at all clear
23 when we'll have a Commission decision on that whole
24 topic, and yet, we are publishing regulatory guidance
25 today, or in the very near future.

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1 MR. DINSMORE: But, if it's just a guide
2 and not a rule, it would be relatively easy to fix the
3 guide. It's a little harder to fix a rule. Well, the
4 guidance, it's not that easy to fix that either.

5 CHAIRMAN STETKAR: It's not easy to fix it
6 -- wait a minute -- this is Rev 2, Rev 1 was issued in
7 1977, so it takes a while to get around to fixing
8 regulatory guides, and part of the initiative that the
9 staff is into right now is to update a lot of this
10 regulatory guidance, to make it more clear, to take
11 advantage of, you know, operating histories, as you
12 noted, to take -- you know, to recognize the fact
13 that the guidance was not particularly complete in
14 terms of addressing high trajectory missiles in the
15 past.

16 At the same time, we bring it up to
17 current status, it would be prudent to think about how
18 it would be applied in the future, because this
19 particular Regulatory Guide might not be updated again
20 for another, you know, 33 years, I think that is.

21 MR. DINSMORE: It says negligible
22 contributor, there's nothing wrong with that
23 statement, right? That could carry on --

24 MEMBER BLEY: I think the piece is, is it
25 a negligible risk in some sense, or is it a negligible

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1 contributor to the rest of the risk of the plant?

2 MEMBER SHACK: Well, and that's where you
3 pick 10^{-7} , it's got a number. I mean, you know, this
4 statement, obviously, is --

5 CHAIRMAN STETKAR: That statement is a
6 wonderful statement, that's a glorious goal.

7 On the other hand, de facto, 10^{-7} is deemed
8 to be a negligible contributor to risk, however that
9 number is, you know, quantified by its various piece
10 parts.

11 MR. DINSMORE: I guess I really couldn't
12 answer until the SECY works its way through. I mean,
13 the only alternative is to use no numbers, and I'm not
14 sure that that would be a better alternative than to
15 use kind of in the interim.

16 MEMBER SHACK: We've already certified
17 through reactors, too.

18 MR. MITCHELL: This is Matt Mitchell
19 again. I think earlier there was a suggestion that,
20 perhaps, an appropriately placed caveat, which would
21 say that use of this Reg Guide is appropriate and so
22 forth for the current operating fleet. However, for
23 the particular values used here may or may not be
24 appropriate for new reactors, there's additional
25 guidance forthcoming.

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1 I seem to remember that that kind of
2 language was proposed. Perhaps, if we could work that
3 in as a caveat somewhere within the Reg Guide, if
4 that would a perfect placeholder for future action to
5 come from Commission guidance.

6 CHAIRMAN STETKAR: That would -- my
7 personal opinion, that would make me feel a little bit
8 better, because it would point this current guide to
9 the future, and kind of leak everything into that
10 eventual resolution to that issue.

11 But, that's a personal opinion. I don't
12 speak for the rest of, either the Subcommittee,
13 certainly, or, certainly, the Full Committee. So, you
14 know --

15 MR. HONCHARIK: This is John Honcharik.

16 I guess we'd have to decide how that would
17 be captured then, you know, that new criteria, I mean.

18 Are you going to have a different Reg Guide for new
19 reactors? It just doesn't seem prudent, since it's,
20 basically, using the same turbines, they are using
21 replacement turbines now that, basically, will be the
22 same turbines that will go into a new plant.

23 So, I cannot see why you would duplicate
24 the amount of work and time. So, I think we also need
25 to take that into consideration, look at that issue a

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1 little more thoroughly.

2 CHAIRMAN STETKAR: We have someone from
3 the industry listening in on the bridge line, and
4 we'll open it up after this discussion, to see if,
5 perhaps, they might shed a little light on this.

6 The notion of risk-informed analyses can
7 cut both ways. The industry, as I understand it, in
8 terms of one of the public comments on the Draft Reg
9 Guide, suggested the risk-informed approach, which
10 prompted that paragraph that I quoted, to show that,
11 indeed, turbine missiles are a small contributor to
12 the risk of a new plant. I don't know how easy that
13 is to do. It might be relatively easy, if it's a very
14 well designed, very well, you know, large numbers of
15 barriers, multiple trains, things like that. But, you
16 probably can't show that at a 10^{-5} turbine missile
17 ejection frequency. You probably need to a little bit
18 more work to demonstrate that, indeed, or 10^{-4} missile
19 ejection frequency, depending on the orientation of
20 the turbine.

21 MR. HONCHARIK: Right, and that is true, I
22 guess, but one of the reasons why they used some of
23 these -- I mean, okay, that's a number, but they also,
24 when they use these numbers, such as 10^{-7} , it's,
25 basically, to determine when they will perform their

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1 inspection of the turbine rotor. Okay?

2 And, in that, typically, you know,
3 previous plants were doing it about every ten years,
4 and those were as we discussed before, the shrunk on
5 disk, which had the key waves where they had a lot of
6 problems with cracks.

7 Now, almost every -- actually, all of the
8 new plants tend to use some form of integral rotor or
9 welded rotor.

10 And also, they've calculated these
11 frequencies, and to get to 10^{-5} , their base inspection
12 interval would be 25 years, 29 years, but they are
13 still continuing the ten or 12 year ISI program on
14 that rotor. Okay?

15 So, in actuality, when you look at their
16 figures, to get -- if they are doing an inspection
17 every ten years, their number comes out to be more
18 like 10^{-7} , 10^{-9} for P_1 .

19 CHAIRMAN STETKAR: Then if that's the
20 case, that might be fine.

21 MR. HONCHARIK: Right.

22 CHAIRMAN STETKAR: That might be fine. As
23 I said, you know, from my perspective it might be
24 prudent for them to do the inspections at ten year
25 intervals from an investment protection perspective.

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1 That's pretty much up to them.

2 MR. HONCHARIK: Right.

3 CHAIRMAN STETKAR: But, from a protection
4 of the public health and safety, from a risk
5 perspective, if they can show that a ten-year their
6 planned approach provides, you know, acceptably low
7 risk number is fine.

8 MR. HONCHARIK: Right.

9 CHAIRMAN STETKAR: But, taking that to a
10 specific frequency of 10^{-5} is acceptable, $10^{-9.999}$, 10^{-4}
11 is not acceptable for P_1 is a bit difficult to justify,
12 especially, for the new plants, when they are
13 projecting such low core damage frequencies from the
14 sum of ostensibly everything, however they do that.

15 MR. DINSMORE: Well, perhaps, we could put
16 in there some similar caveat that we put into 5046A,
17 which is, 10^{-7} or another value which would not
18 substantively decrease the level of safety otherwise
19 provided by the design.

20 I mean, it does give you kind of the
21 flexibility to say, well, this -- here's a number we
22 think is okay, but later on if we discover something
23 else we can still adjust the number.

24 Would that help your concern at all, just
25 giving a number --

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1 CHAIRMAN STETKAR: I don't want to speak
2 for the Committee, but, you know, it would help my
3 concern.

4 MEMBER SHACK: I mean, I think you have to
5 be careful how to phrase it. I think what you are
6 saying in 5046 is, you give the number and then you
7 say, consideration also has to be given, you know, or
8 something like that.

9 CHAIRMAN STETKAR: I think the point that
10 at least I'm trying to make is that we need to be very
11 careful with -- whether it's a rule, like 50.6A, or
12 whether it's regulatory guidance on things like
13 turbine missile analysis, or any other type of
14 similar, you know, weird event hazards, if you will,
15 that we publish in the year of 2010 or 2011, we need
16 to think pretty carefully and consistently about how
17 they are going to be applied in the new reactor's
18 regime, so that we don't get into a situation that,
19 for example, whenever the Commission draws some
20 conclusions about those new reactor risk methods, we
21 then are in a situation where we need to wholesale,
22 throw up our hands, and then we can move in and go
23 into whatever number of extensive Regulatory Guide
24 revisions, because we hadn't thought enough about it.

25 It's certainly not, you know, prudent to

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1 just, you know -- it's certainly not prudent to assign
2 specific numbers.

3 MEMBER SHACK: Just to come back, though,
4 I mean, until you know that the Commission is going to
5 decide, it's hard to craft language.

6 CHAIRMAN STETKAR: It's very difficult to
7 craft language that will cover it, except to at least
8 acknowledge the fact that there is uncertainty and
9 that those numbers should not be considered hard and
10 fast numbers with our acceptance criteria for the new
11 plants. The pragmatism for the existing plants will
12 always exist, but new plants could be -- it could be
13 an issue.

14 Because you all know that applicants --
15 licensees and applicants will point to Regulatory
16 Guides, rules, NUREGs, anything they can point to, as
17 evidence of NRC acceptance of a specific number.

18 DR. SHENG: Okay, shall we continue to the
19 next slide?

20 CHAIRMAN STETKAR: I'm kind of lost.

21 MR. DINSMORE: This was the slide on south
22 Texas, we finished that one.

23 DR. SHENG: Right.

24 MR. DINSMORE: The next slide is --

25 DR. SHENG: Okay, the next slides that I'm

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1 going to talk about is the observation of the industry
2 initiative

3 MR. JONES: I don't think that's
4 appropriate to bring up right now, because it was --
5 they are really using the same approach that's in the
6 Reg Guide. I think we can just finish the
7 presentation.

8 CHAIRMAN STETKAR: Speak among yourselves.
9 We're happy to listen to anything that you say, and
10 we are under no time pressure here.

11 DR. SHENG: Right. Basically, this is
12 just --

13 CHAIRMAN STETKAR: These are back-up
14 slides now.

15 DR. SHENG: -- yes, this is just back-up
16 slides to try to provide information that may be of
17 interest to you, on the topic of PRA approach.

18 And, if you think we are done with that,
19 then we can continue to finish our main presentation.

20 CHAIRMAN STETKAR: You know, I think we
21 are done. That's okay. I have my other two
22 colleagues here.

23 MEMBER SHACK: No, I think it's probably
24 safe to say we are done.

25 MR. DINSMORE: So, you'll go back to the

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1 original?

2 DR. SHENG: Yes, I'll go back to the
3 original one.

4 Okay, so --

5 MR. DINSMORE: I don't know where you
6 were.

7 DR. SHENG: -- page 15.

8 CHAIRMAN STETKAR: Slide 15.

9 DR. SHENG: Slide 15, right.

10 Okay, Slide 15 that we continue to talk
11 about the enhancements that we made in the proposed RG
12 1.115, and, as I said, that our current approach is
13 concentrated on P_1 , and that's the only criteria.

14 And now that this Reg Guide, this proposed
15 Reg Guide, we relaxed it to the point that we use
16 uncontained approach using P_1 , P_2 , and P_3 , as long as
17 that P_4 is smaller than $1E-2-7$, and we have enough
18 argument about the numbers, so we are not going to
19 talk about it again.

20 However, there may be a question raised
21 about P_1 , because at this point we want to meet -- we
22 want there to be no more than $1E-4$.

23 One thing, if the new turbine has a lot of
24 new features of design, then we can meet this P_1
25 criteria, $1E-4$, very easily. So, it's other question,

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1 then they have a lot of room to move around in terms
2 of P_2 and P_3 . So, this provides then flexibility.

3 So, I just would like to summarize this by
4 presenting these two features. First is that we
5 retained RG 1.115 criteria of $1E-7$ for the probability
6 of failure of essential system caused by low
7 trajectory missiles.

8 And, the second thing is that we relaxed
9 the current P_1 criteria for unfavorably oriented
10 turbine from $1E-5$ to $1E-4$ when P_2 and P_3 are also
11 considered.

12 So, the next one is -- then once we issue
13 the proposed RG 1.115 for industry comments, we
14 received a lot of them, and then we categorized them
15 into two groups.

16 The first group is, basically, the current
17 RG can already -- already allows this line of
18 consideration, or maybe we adjust it, we revise the RG
19 a little bit to partially consider that their concern.

20 So, I would say that the proposed RG,
21 actually, allows consideration of pathways for high
22 trajectory missiles, because of the opened approach of
23 using P_2 . So, basically, by definition the
24 consideration of pathways for high trajectory missiles
25 are considering that.

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1 Also, we allow the consideration of robust
2 rotor designs, that it can be reflected in the P₁
3 calculation.

4 As with regard to the regulatory process
5 for approving new rotor designs, I think the current
6 regulatory framework allows that, because industry
7 suggests a two-step approach. One is using something
8 similar to a topic report, and then in the plant
9 specific application they can -- each individual
10 plant, or group plant, can submit a second report,
11 verifying the materials or some other issues.

12 And, I think that we don't need to write
13 Reg Guide, because on the current regulatory framework
14 we can entertain that already.

15 And, this Reg Guide, proposed RG, can also
16 allow PWR turbine radiation shielding enclosures as
17 barriers. I think that can be treated under the
18 current proposed RG.

19 And then, the current proposed RG also
20 allows us consideration of sites, which is in multiple
21 units.

22 CHAIRMAN STETKAR: Well, not only allows,
23 but if I read it correctly it requires consideration
24 of sites.

25 DR. SHENG: Right. Right. It's a more

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1 precise word.

2 And, there are several items that the RG
3 did not consider, did not incorporate. The first
4 thing is the recommended changes to the SRP. Of
5 course, we cannot do it right now, but we are going to
6 do it probably put more guidance in the Standard
7 Review Plan when we get to the point of revising that.

8 The second thing suggests that we take
9 into their consideration that cannot be reflected in
10 the current RG, in the proposed RG, the second thing
11 is changing the probability for low trajectory turbine
12 missiles. As I said that we reviewed the operating
13 history and the major block is that the Salem 2 event,
14 in which makes us reluctant to lower a standard at
15 this point.

16 And, the third thing is that to, we did
17 not incorporate the risk-informed approaches in this
18 Regulatory Guide. But, as I said previously, that
19 this RG is just an acceptable method, that it varies
20 from the risk-informed approach to be submitted, then
21 we will review it.

22 Now, I think there's a faster way, if you
23 want to use a new approach, the best way is to submit
24 it as a topical report, so it will be reviewed by
25 three divisions, the Component Integrity Division, the

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1 Risk Division, and the Plant Systems Division, because
2 three divisions, each responsible for certain part of
3 the review.

4 So, I think that with an approach like
5 that, the best way to handle it as a topical report.

6 CHAIRMAN STETKAR: Topical reports might
7 work for design certification, where you have a
8 reasonably well established configuration of the
9 plants, because if they are going to do a risk-
10 informed approach, typically, they'll be looking at P₁,
11 and P₂, and P₃, which depends on the actual
12 configuration.

13 DR. SHENG: I understand that.

14 CHAIRMAN STETKAR: Not only the turbine
15 itself.

16 DR. SHENG: Right.

17 CHAIRMAN STETKAR: So, for example, a
18 turbine manufacturer couldn't submit a topical -- a
19 risk-informed topical report that would apply to any
20 design, because then we don't know about their
21 turbine.

22 DR. SHENG: Yes.

23 CHAIRMAN STETKAR: But, a vendor, in
24 principle, could.

25 DR. SHENG: Right. Right.

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1 CHAIRMAN STETKAR: For a new plant design.

2 DR. SHENG: Yes.

3 CHAIRMAN STETKAR: Because you do know
4 reasonably well the configuration, with the possible
5 exception of cable routing.

6 DR. SHENG: Yes, I'm hoping that this
7 group was sorted out and you'll see maybe there are,
8 say, 20 plants have similar plant design, so that they
9 can at least -- because maybe we don't want to review
10 100 plant-specific reports.

11 CHAIRMAN STETKAR: The problem with
12 operating plants is, is often times the routing of
13 cables. Many operating plants don't necessarily know
14 precisely where their cables are.

15 They are gaining information on that from
16 Appendix R, you know, the increased attention on both
17 deterministic and risk-informed fire protection
18 initiatives, which do require better information, if
19 not precise information about cable routing.

20 But, cable routing, for two nominally
21 identical vendor supplied plants can be very, very
22 different, especially, when you get out into the
23 interfaces between balance of plant and safety-
24 related, you know, electrical rooms, I&C rooms, and
25 things like that.

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1 So, it could be relatively difficult to do
2 that on a group generic basis, for the currently
3 operating fleet.

4 DR. SHENG: Okay. Well, if that's the
5 case, then we have to -- we have to be plant specific
6 review for each plant.

7 CHAIRMAN STETKAR: I mean, as long as you
8 don't preclude that type of an approach, then it's up
9 to the individual licensee, you know, whether they
10 want to -- whether they feel it's in their interest to
11 adopt that approach, whatever the benefits of doing
12 the risk-informed type of analysis versus -- you know,
13 versus the cost and effort to, actually, perform the
14 analysis.

15 DR. SHENG: Okay. Good.

16 So, the message is just that the door is
17 open.

18 And, the conclusions is, I made it very
19 simple, the proposed RG 1.115 becomes self-contained,
20 providing preferred and acceptable approaches and
21 acceptance criteria against the low trajectory
22 missiles and high trajectory missiles.

23 The second bullet, that the proposed RG
24 1.115 is consistent with the current criteria
25 emphasizing P₁, which is the preferred approach.

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1 And also, that the proposed REG 1.115 will
2 consider the approach of using P_1 , P_2 and P_3 , and that
3 is the end of our presentation.

4 CHAIRMAN STETKAR: Good, thank you.

5 MEMBER BLEY: One thing I didn't
6 completely follow early on --

7 DR. SHENG: Okay.

8 MEMBER BLEY: -- is the restriction on the
9 maximum size of P_1 , and then separately, allowing
10 ignoring that and looking at barriers, the logic
11 behind that is the thing I don't quite get.

12 If you are greater than 10^{-4} , why should it
13 matter if the thing that gets you low is barriers or
14 other things you consider in P_2 and P_3 . Why is
15 barriers pulled out as the only thing that lets you go
16 above the P_1 in that?

17 Did I say that in a way that makes sense
18 to you?

19 MR. JONES: Well, I guess I can answer
20 that.

21 I mean, typically, when we have licensees
22 that have proposed using barriers as the protection
23 against missiles, I mentioned on plant, McGuire, that
24 used that --

25 MEMBER BLEY: Yes.

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1 MR. JONES: -- and that's pretty much an
2 all or nothing approach, where every system, or every
3 function identified in Appendix A is protected within
4 the barrier defined as, you know, the auxiliary
5 building, or the containment building, typically,
6 maybe the fuel storage building, too.

7 And, I don't think there's any need to
8 consider probability at that point, if you designed
9 your barrier to withstand the most energetic missile
10 you project to come from the turbine, you've pretty
11 much reduced the frequency of damage to those
12 essential functions to, essentially, zero.

13 MEMBER BLEY: But you could have done that
14 within the P₁, P₂, P₃ arrangement by considering the
15 barrier effect, I guess, in P₂.

16 MR. JONES: Yes, you can, and then you get
17 into -- the concern, I guess, is piecemeal, if you
18 have some instrument that's protected by barriers, and
19 then other equipment that's not, then we need to get
20 into that defense-in-depth review, and I guess that's,
21 you know, an available approach, but that's something
22 outside the scope of what we wanted to describe in the
23 Reg Guide.

24 MEMBER BLEY: Okay.

25 CHAIRMAN STETKAR: I guess I get it -- I'm

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1 not sure yet. Let me try, you mentioned McGuire, and
2 I hate to use specific examples, but plant X, let's
3 say. You said they used a barriers approach, and
4 demonstrated, apparently, successfully demonstrated,
5 that they had protected the complement of, you know,
6 SSCs in Appendix A, such that they would not be
7 damaged by a turbine missile.

8 So, in principle, does that mean that they
9 did not -- it did not make any difference whether
10 their P_1 frequency was 10^{-5} or 10^{-4} , or 10^{-3} , or 10^{-2} , or
11 were they --

12 MR. JONES: That's correct, it did not
13 make any difference.

14 CHAIRMAN STETKAR: So, we are not held
15 accountable to the 10^{-4} or 10^{-5} number.

16 MR. JONES: Right.

17 CHAIRMAN STETKAR: Okay. Then I get that.

18 MEMBER BLEY: So, basically, let me resay
19 what you said just to sort of get it.

20 If P_1 is greater than 10^{-4} , you think the
21 review for defense-in-depth would be, essentially, so
22 significant it's probably not worth going that route?

23 And, you'd want barriers such that the equivalent of
24 P_2 is zero, nothing is going to happen.

25 MR. JONES: I think that's something we'd

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1 have to take up on a case-by-case basis, and would
2 have to come in as, basically, a risk-informed
3 application, if you are trying to separate certain
4 components being protected and certain components not
5 being protected.

6 MEMBER BLEY: One thing I'm really curious
7 about, because of some analysis I saw years ago, where
8 one particular organization tried to model this very
9 prescript -- well, very mechanistically, and,
10 actually, calculated all of the different missiles
11 coming out at the different angles it would hit, the
12 rooms it might hit, would it go through the walls if
13 it got inside, would it go through the next wall,
14 what would happen if it was inside.

15 And, from their whole suite of
16 calculations, kind of the conclusion that fell out of
17 that was, P_3 is one. If the missile gets into the room
18 and doesn't go straight out the other side, it bounces
19 around in there like a pinball to the extent that
20 anything inside there is chewed up. And, they did
21 that for lots and lots of different cases, and it just
22 kind of said P_3 s.

23 Have we been submitted any of these
24 analyses where they claim a P_3 less than one?

25 DR. SHENG: Well, as far that I know, that

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1 in the past few years that -- because of the
2 discouragement from NRC about using things other than
3 P_1 , so there is some submitted that just demonstrate
4 it.

5 MEMBER BLEY: This is strictly P_1 .

6 DR. SHENG: P_1 .

7 MEMBER BLEY: Okay, because the concern is
8 a little bit keeping P_3 in there from any mechanistic
9 studies I've seen, you'd really want some strong
10 evidence that P_3 could be anything other than one, if
11 somebody, actually, did that.

12 DR. SHENG: In some the plant specific
13 calculations --

14 MEMBER BLEY: Which involve P_3 .

15 DR. SHENG: -- which involve P_3 , they
16 said, essentially, P_3 is equal to one.

17 MEMBER BLEY: Okay. Mechanistically, I
18 think that's probably always true.

19 CHAIRMAN STETKAR: I think I've seen a
20 report, although I'm not going to pull it up on the
21 screen here, because I'm not sure I can find it, where
22 people were claiming less than one for P_3 .

23 MEMBER BLEY: I'd be real suspicious of
24 that.

25 CHAIRMAN STETKAR: And, numbers that were,

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1 you know, like .5 or .3, I mean, measurable to us, if
2 you can call that measurable.

3 I don't know the basis for it, you know,
4 it's energy something or other, it was a mechanical
5 type analysis, but I think I've seen that recently.

6 MEMBER BLEY: The one is stated where, in
7 fact, you could get that is a missile that went into
8 the room and, actually, came out the other side.

9 CHAIRMAN STETKAR: Okay.

10 MEMBER BLEY: Then it would take out the
11 stuff in its trajectory, and nothing else.

12 MEMBER SHACK: So, you don't make walls on
13 the other side.

14 MEMBER BLEY: No, I think there's stuff on
15 the other side, too, you might care about.

16 CHAIRMAN STETKAR: So, yes, I mean, what
17 you are saying, Dennis, is it all comes down to P_1 and
18 P_2 , for any kind of practical, which is probably pretty
19 reasonable.

20 Anything else? No? Any other questions?

21 The only thing is, you can go back and
22 work on this, the questions that came up here, and
23 some of the things that you'd had, I thought, a little
24 trouble explaining. You might look at the language of
25 that and see if you can tighten this up, so it's

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1 easier to follow. I mean, we got -- I'm not sure we
2 got tricked, but there's language that's a bit -- can
3 be misinterpreted I think.

4 DR. SHENG: Are you talking about language
5 cited by Mr. --

6 MEMBER BLEY: -- Stetkar, cited by --

7 DR. SHENG: -- or are you talking about
8 some other language.

9 MEMBER BLEY: Well, certainly that, and
10 then in some cases when you came back to explain
11 things it seemed there's some logical knots here.

12 MR. JONES: I think what you are talking
13 about is the Regulatory Position and making it more
14 clear, for instance, the bidders and option part of
15 it.

16 MEMBER BLEY: That's the main part of it.

17 MR. JONES: You can exclude all the
18 probabalistic review.

19 MEMBER BLEY: Yes.

20 MR. JONES: I agree with that.

21 CHAIRMAN STETKAR: That's a good message,
22 Dennis, I think if you read it -- I know when I read
23 through the Regulatory Positions, I come at it from a
24 PRA background, primarily, and words like and and or
25 mean very specific things to me, in a logical sense.

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1 And, I think that the discussion this
2 afternoon helped an awful lot, because when I read
3 through the Regulatory Positions I think I
4 misinterpreted a bit of the intent, because of the way
5 I think. Now, I'll go back and reread them, maybe it
6 was just kind of my fuddled thinking, but you might
7 want to read through them again.

8 DR. SHENG: When I get back I will read
9 these through again.

10 CHAIRMAN STETKAR: Anything else, Dennis
11 and Bill?

12 MEMBER SHACK: No, I just -- in Table 1,
13 it's not at all clear, for example, that there is any
14 way to get out of P_1 less than 10^{-4} . It's not clear in
15 Table 1.

16 Table 1 is very, very specific. I mean,
17 if you really are willing to accept something less
18 than 10^{-4} with barriers, you can deduce that from Table
19 1, I don't think.

20 CHAIRMAN STETKAR: That's true, because
21 there is an explicit line item in Table 1 that an
22 acceptable option for both trajectories is P_1 (not
23 greater than $10^{-4} \times P_2 \times P_3$, with a result as 10^{-7}).

24 DR. SHENG: Okay, but there is a separate
25 approach. I think I will try to do a better job

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1 there. Yes, we are going to, because, see, if you
2 chose a barrier, right, basically, you can just go
3 through the approach, and this table, I think, it
4 probably did not mention barrier, where I should at
5 least have put a note there.

6 CHAIRMAN STETKAR: Yes, you could put a
7 note saying it doesn't include the barrier option
8 discussed in Regulatory Positions 3 and 6.

9 DR. SHENG: Okay, I see what you mean,
10 yes. Okay. I already got the message, about improving
11 Table 1.

12 CHAIRMAN STETKAR: Anything more? Because
13 what I'd like to do, I want to open up -- can you open
14 up the bridge line and see if anyone listening in
15 would like to make any comments, or if they have any
16 questions?

17 The problem is, I have absolutely no idea
18 whether the bridge line is open.

19 The gentleman from Mitsubishi, if you are
20 still there, can you say something so we know that the
21 line is open?

22 This is what's known as the cone of
23 silence, if you used to watch Get Smart. You know,
24 with the cone of silence you don't know when it's
25 gone.

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1 I just want to make sure, because we had a
2 lot of discussion about things, and give the gentleman
3 on the other end an opportunity to say something if
4 he's interested in doing that.

5 MR. KNOBLOCH: Is the bridge line open
6 there yet?

7 CHAIRMAN STETKAR: Yes, it is, welcome.

8 MR. KNOBLOCH: I'm opened up.

9 CHAIRMAN STETKAR: Thank you.

10 MR. KNOBLOCH: Good, I appreciate the
11 opportunity. I enjoyed listening.

12 I did have a question, and I think at one
13 point somebody had indicated that they did look at the
14 SRP, and there were some comments that were maybe
15 being noted. I don't know if that was going to be
16 considered along with a potential revision to this Reg
17 Guide or not.

18 But, I was wondering if the relationship
19 with the SRP Table 3513-1, if that's going to be
20 impacted at all, because that does get into some of
21 the probability that's greater than the 10^{-4} .

22 DR. SHENG: I can't answer that question
23 right now, because I don't have the SRP in front of
24 me, but the intent is that, because of this proposed
25 Regulatory Guide, if there is any inconsistency

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1 between the proposed RG and the SRP, then we plan to
2 revise the SRP.

3 MR. KNOBLOCH: Okay. Just to maybe
4 refresh your memory on this Table 3513-1.

5 DR. SHENG: Okay.

6 MR. KNOBLOCH: They have Cases A through
7 D.

8 DR. SHENG: Oh, yes.

9 MR. KNOBLOCH: And, A is where we are
10 really talking equivalent to the Reg Guide 1.115.

11 DR. SHENG: Right.

12 MR. KNOBLOCH: Cases B through D are
13 getting into operability and, you know, scheduled
14 maintenance, things like that, and I believe that the
15 P₁ calculation is strongly influenced by testing and
16 maintenance programs.

17 So, this, essentially, allows for, I'm
18 going to say, a temporary, maybe, reduction in the
19 probability due to planned maintenance or, you know,
20 maintaining operation during, you know, scheduled
21 maintenance, things like that.

22 DR. SHENG: Right. Right now, the RG only
23 deals with Case A, and the Case B to D right now I
24 would say it's not affected, will not be affected.

25 MR. KNOBLOCH: Okay. You may want to just

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1 make a note to see if there needs to be some
2 clarification in the Reg Guide to indicate that these
3 operability cases, you know, do not fall into the
4 criteria that we are discussing regarding 10^{-4} as a
5 minimum.

6 DR. SHENG: Okay. Yes, thank you for your
7 suggestion.

8 CHAIRMAN STETKAR: Anything else, sir?

9 MR. KNOBLOCH: No, I think that's it for
10 right now.

11 CHAIRMAN STETKAR: Thank you very much for
12 your input. We are going to put you back in the cone
13 of silence again, if Theron can put the thing back --

14 MR. KNOBLOCH: Calvin, are you there?

15 MR. DUCHARME: Bruce --

16 CHAIRMAN STETKAR: Theron, open it back up
17 again, if you could.

18 MR. DUCHARME: Bruce, can you hear me?

19 MR. KNOBLOCH: I can hear you, yes.

20 MR. DUCHARME: Yes.

21 CHAIRMAN STETKAR: Sir, identify yourself,
22 your full name and your affiliation.

23 MR. DUCHARME: For the sake of the people
24 who remain, it's Calvin Ducharme from MNES, Mitsubishi
25 Nuclear Energy Systems.

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1 I, actually, just wanted to quickly ask
2 Bruce if you could give me a phone number where I
3 could reach you at. I would like to discuss topics of
4 this meeting with you.

5 MR. KNOBLOCH: I'll do that off line.

6 MR. DUCHARME: Thank you, but as long as I
7 already have you, you know, of course the one negative
8 we have with doing it through the patch line, I don't
9 have the benefit of the --

10 CHAIRMAN STETKAR: You don't want to
11 transact private business in something that's public
12 on the transcript, so I'm going to cut that off right
13 now, and we'll put the phone line on mute and you guys
14 can kind of connect later, if you would do that.

15 MR. DUCHARME: I appreciate that, and I
16 apologize. Thank you.

17 CHAIRMAN STETKAR: No, that's fine,
18 thanks.

19 We are on mute again, Theron, I hope.

20 Thank you.

21 Okay, with that, is there anything else,
22 Members -- Committee Members?

23 MR. DUCHARME: Yes, I actually, want to,
24 this is Calvin again from MNES. I wanted to ask the
25 staff if they had a projection on when this Draft

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1 Regulatory Guide or revision would be issued?

2 DR. SHENG: Well, I probably cannot give
3 you a good estimate right now, because the whole thing
4 was handled by the research staff. I don't think they
5 are -- oh --

6 MR. JERVEY: Rick Jervey from --

7 CHAIRMAN STETKAR: Come up to the
8 microphone.

9 MR. JERVEY: -- Rick Jervey, Office of
10 Research, Regulatory Guides.

11 Well, it sounds to me like the subject
12 matter under discussion here today is probably going
13 to be the limiting point. I think we are going to
14 have to make sure everybody's policy is consistent
15 before going forward with the Guide.

16 At this point in the process, the Guide is
17 going up for the public review period, and that's a
18 significant block of time in the process.

19 Now, assuming that all the philosophies
20 are lined up and acceptable, then subsequent to the
21 ACRS discussion and recommendation, then the Guide
22 will be ready for issue.

23 MR. DUCHARME: The concern from MNES'
24 standpoint is, we have in the US APWR under multiple
25 levels of review, and we are wondering if we are going

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1 to need to go back and revise our DCD in order to
2 comply with high trajectory missiles, because we were
3 complying with low trajectory missiles.

4 MR. JONES: I guess -- this is Steve
5 Jones, Balance of Plant Branch, NRR -- from the
6 perspective -- this is just a guide, for one, and
7 number two, I think the requirements of 5247 for a
8 design certification would apply, and you'd have to
9 look at those, but they don't directly mention
10 Regulatory Guides.

11 MR. DUCHARME: Okay.

12 MR. JONES: Only Standard Review Plan.

13 So, in that sense I don't believe there
14 would be any regulatory requirement to speak of. This
15 is guidance and an acceptable way of meeting the
16 regulations.

17 MR. DUCHARME: All right, thank you.

18 MR. HONCHARIK: Yes, this is John
19 Honcharik, I guess, you know, we'd have to look into
20 that, depending on the outcome, especially, with that
21 SECY paper. So, based on that, I think that would be
22 more of a limiting issue, but we'll probably have to
23 look into that.

24 MR. DUCHARME: Okay, thank you.

25 CHAIRMAN STETKAR: Anything else?

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1 Yes, Girija?

2 MR. SHUKLA: Well, it appears this Reg
3 Guide needs a lot of work, but this is the schedule
4 for Full Committee next month, so let me know if you
5 will be ready for next month or not, or how is the
6 schedule for this.

7 DR. SHENG: I think maybe that we should
8 postpone the Full Committee review so that we can
9 finalize the -- we can finalize this.

10 MR. SHUKLA: Okay, that's fine.

11 DR. SHENG: Because I think that the
12 language -- the revised language has to pass through
13 several divisions, and it takes time.

14 MR. SHUKLA: Right.

15 CHAIRMAN STETKAR: Yes, I think that's
16 your -- you know, that's your decision. Just the
17 message is --

18 MEMBER SHACK: Let him know.

19 CHAIRMAN STETKAR: -- communicate with
20 Girija, because our schedule is very, very tight, the
21 Full Committee's schedule is really tight, and the
22 sooner -- if you are going to delay, the sooner that
23 we know, and when you might be ready to come before
24 the Full Committee, it would help us an awful lot in
25 our scheduling.

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1 So, we'd appreciate that, but recognizing
2 that you need, you know, to go back and sort of have
3 some internal discussions.

4 DR. SHENG: Yes.

5 MR. SHUKLA: I understand you are delaying
6 now, and you'll let me know when you can come back.

7 DR. SHENG: Right. Right. I communicate
8 with you.

9 MR. SHUKLA: Okay, sure.

10 CHAIRMAN STETKAR: Good, thank you.

11 MEMBER BLEY: I have one last thing.

12 CHAIRMAN STETKAR: Okay.

13 MEMBER BLEY: High trajectory missiles, I
14 mean, we've added that, and it doesn't say much in
15 here about them. It talks about, well, you protect
16 against them in the same way, by putting barriers -- I
17 forget, something else, but it doesn't give any
18 guidance on, you know, calculating --

19 DR. SHENG: I know.

20 MEMBER BLEY: -- the geometrical
21 probability of the hit, and I supposed everybody would
22 do that, but --

23 DR. SHENG: Right.

24 MEMBER BLEY: -- it doesn't even hint at
25 that. It talks about all sorts of other things we do,

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1 but since high trajectory missiles are there, it
2 doesn't say anything about how to deal with that. It
3 just seemed odd to me.

4 DR. SHENG: Right. As I said, that each
5 individual plant, they do their calculation anyway.
6 So, even though NRC did not provide the guidance
7 before, each plant that calculated their probability
8 of the high trajectory missiles anyway.

9 MEMBER BLEY: Okay.

10 DR. SHENG: So --

11 MEMBER BLEY: So, you just don't think the
12 guidance is needed.

13 DR. SHENG: -- so, basically, we provide
14 you guidance now, it's just that we are afraid that
15 some plans were misunderstood, that we didn't mention
16 that they don't need to do anything about it.

17 MR. MITCHELL: Okay.

18 DR. SHENG: Yes.

19 CHAIRMAN STETKAR: This is, I think, it's
20 the first time that that concept is mentioned.

21 MEMBER BLEY: Well, I know, but then it
22 doesn't say anything about what to do about it, which
23 seemed odd to me.

24 CHAIRMAN STETKAR: Yes.

25 MEMBER BLEY: It might seem odd to others,

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1 maybe not.

2 CHAIRMAN STETKAR: Okay.

3 MEMBER BLEY: But, this is clearly kind of
4 Reg Guide where they are more concerned with criteria,
5 rather than methods.

6 DR. SHENG: Right, you are right. You are
7 absolutely right.

8 MEMBER BLEY: So, it's consistent in that
9 sense.

10 CHAIRMAN STETKAR: Anything else?

11 Before we close, I'd certainly like to
12 thank you all. I recognize that you were probably
13 caught a little bit off guard, in terms of why we were
14 summoning you to come before the Subcommittee on this
15 topic, and you probably now have a little better sense
16 of why we were interested in it.

17 And, thanks a lot for your presentation,
18 and, Steve, thanks for showing up.

19 MR. DINSMORE: Always a pleasure.

20 CHAIRMAN STETKAR: Appreciate that.

21 And, again, thank you very much.

22 Are there any members of the public? I
23 don't think we had any members of the public here that
24 want to make additional comments. Do we?

25 Okay, thank you.

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1 Before we close, let me ask the two
2 Members here, do either of you see any need for any
3 type of interim letter from the committee regarding
4 this?

5 MEMBER BLEY: Not me.

6 MEMBER SHACK: Not me.

7 CHAIRMAN STETKAR: Okay. Would either of
8 you like to summarize any particular issues or do you
9 think we covered things pretty well?

10 MEMBER BLEY: I think we probably covered
11 them pretty well, I think we probably covered them
12 thoroughly.

13 CHAIRMAN STETKAR: Okay. Well, with that,
14 again, thank you very much for an interesting
15 discussion and fielding the questions, and we are
16 adjourned.

17 DR. SHENG: Thank you.

18 (Whereupon, the above-entitled matter was
19 concluded at 3:59 p.m.)
20
21
22
23
24

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Proposed RG 1.115, Protection Against Turbine Missiles

Simon C. F. Sheng

Division of Component Integrity
(NRR)

Steven Jones

Division of Safety Systems

John Honcharik

Division of Engineering (NRO)

ACRS Subcommittee Meeting
October 4, 2010

Overview

- The GDC 4 Requirement
- The Current NRC Position on Protection Against Turbine Missiles
- Objectives of the Proposed RG 1.115
- Operating Experience since 1977
- Enhancements in the Proposed RG 1.115
- Industry Comments
- Conclusions

The GDC 4 Requirement

GDC 4, “Environmental and Dynamic Effects Design Bases,” requires:

“These structures, systems, and components [SSCs important to safety] shall be appropriately protected against dynamic effects, including the effects of missiles...that may result from equipment failures....”

The Current NRC Position on Protection Against Turbine Missiles

- By Turbine Orientation
RG 1.115 (July 1977)
- By Control of Turbine Missile Generation Frequency
Hope Creek SER (July 1986)
SRP 3.5.1.3, “Turbine Missiles” (March 2007)
- By Missile Barriers
RG 1.115 (July 1977)

Objectives of the Proposed RG 1.115

- Assures Turbine Failure Is a Negligible Contributor to Risk
- Makes the RG Self-Contained Including All Acceptable Protection Methods Against Turbine Missiles
- Identifies SSCs to Be Protected from Turbine Missiles
 - Includes Common RTNSS Functions (e.g., Makeup Water, Heat Sink, and Long-Term Decay Heat Removal)
 - Excludes Functions Necessary Only for Other Unlikely Design Basis Events (e.g., High-Head Safety Injection and Containment)
- Assesses Operating Experience since 1977

Operating Experience Since 1977

Reassess Failure Data by Reviewing Before 1995

- NUREG-1275

After 1995

- Licensee Event Reports (LERs)
- International Incident Reporting System
- INPO Significant Event Notifications

Purpose: To Explore the Possibility of Revising
the Current P_1 and P_4 Criteria

Defining P_1 , P_2 , and P_3

The Ultimate Concern: The Probability of Failure of an Essential System P_4 Caused by Turbine Missiles

$$P_4 = P_1 \times P_2 \times P_3$$

- P_1 : The Probability of Turbine Missile Generation
- P_2 : The Probability of Ejected Missiles Striking an Essential System
- P_3 : the Probability of the Struck Essential System Losing Its Safety Function

Findings on Review of Turbine Operating Experience

- An Event in 1991 Gives a Point Estimate of $1\text{E-}3$ per Turbine-year for a Destructive Turbine Overspeed Event
- Turbine Operating Record has Improved in General During the Past 15 Years
- Still has Unignorable No. of Events Resulting in Scrams, Shutdowns, and Outage Delays Per Year

Outcomes of Review of Turbine Operating Experience

- Operating Experience is Consistent with the Turbine Failure Rate of $1\text{E-}4$ per Turbine-Year (RG 1.115)
- Maintain the Current Criteria of P_1 (Hope Creek SER) and P_4 (RG 1.115)

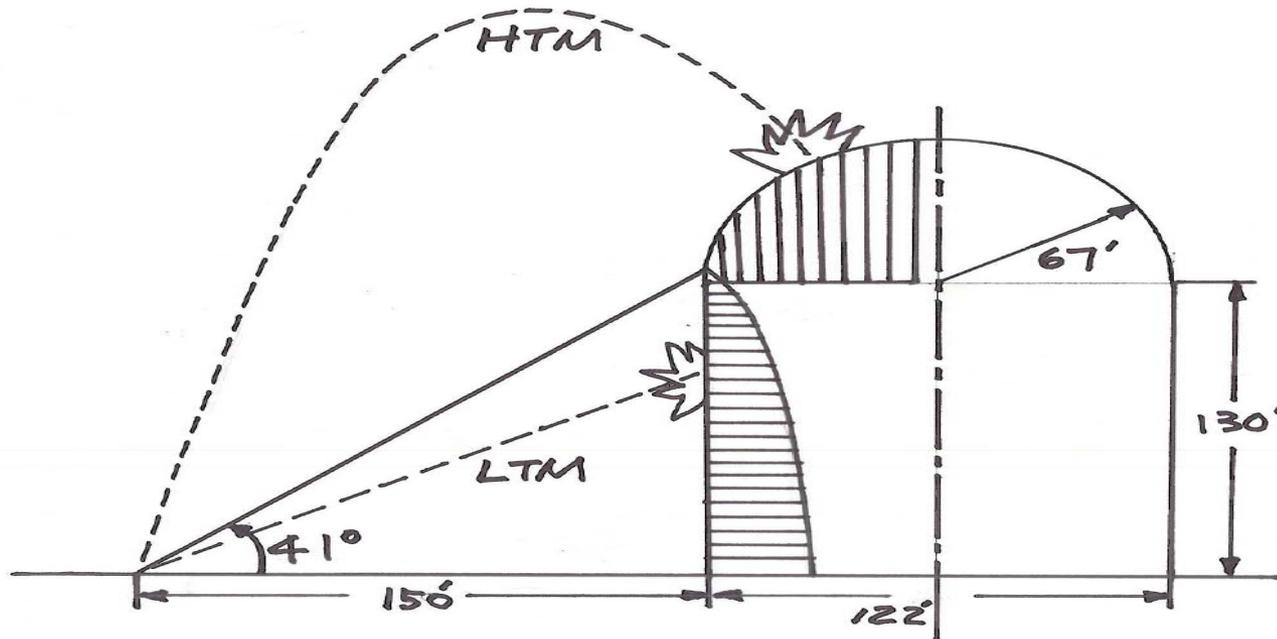
Application of a Risk-Informed Approach

- Turbine Failure Similar to Tornado Effects
 - Potential creation of several high-energy missiles
 - Simultaneous damage to fission product barriers and essential mitigation equipment possible
- Defense-in-Depth Principles Satisfied by Protecting Essential Equipment Commensurate with Frequency/Consequences of Challenges
 - Maintain very low frequency of missile generation; or
 - Protect essential equipment from missile strike

Enhancements in the Proposed RG 1.115

- Provides Guidance for High-Trajectory Missiles
- Clarifies the Current NRC Emphasis on P_1 (in the 1986 Hope Creek SE and the 2007 SRP)
- Permits the Approach of Considering P_1 , P_2 , and P_3
- Validates Operating Experience (NUREG-1275, LERs, IRS, INPO, etc.) since 1977

Provides Guidance for High-Trajectory Missiles (HTMs)



(a sketch based on Bush's 1973 paper)

Note: HTM trajectory not to scale

Provides Guidance for High-Trajectory Missiles

Different P_1 s for Low-trajectory and High-trajectory Missiles

$$P_1 = P_{1f} \times P_{1p} + P_{1o}$$

- P_{1f} is probability of disk failure based on Probabilistic Fracture Mechanics considering SCC
- P_{1p} is probability of the failed disk piece penetrating turbine case based on energy dissipation (different values for LTMs and HTMs)
- P_{1o} is probability of overspeed protection system failure (quickly resulting in disk failure and turbine case penetration)

Clarifies the Current Emphasis on P_1

Favorably Oriented

- Low-trajectory: no additional analysis (RG 1.115)
- High-trajectory: $1E-4$ (1986 Hope Creek SER)

Unfavorably Oriented

- Low-trajectory: $1E-5$ (1986 Hope Creek SER)
- High-trajectory: Evaluation is not required

Permits the Approach of Considering P_1 , P_2 , and P_3

Unfavorably Oriented/Both Trajectories

$$P_1 (<1E-4) \times P_2 \times P_3 < 1E-7$$

Features

- Retain the RG 1.115 criterion of $1E-7$ for the probability of failure of an essential system caused by LTMs
- Relax the current P_1 criterion for an unfavorably oriented turbine from $1E-5$ to $1E-4$ when P_2 and P_3 are also considered

Industry Comments

The Proposed RG Allows:

- Consideration of Pathways for High Trajectory Missiles
- Consideration of Robust Rotor Designs
- Regulatory Process for Approving New Rotor Designs
- BWR Turbine Radiation Shielding Enclosures as Barriers
- Sites with Multiple Units

Has Not Incorporated:

- Recommended Changes to the SRP
- Changing the Probability for Low-Trajectory Turbine Missiles
- Risk-Informed Approaches

Conclusion

The Proposed RG 1.115

- Becomes Self-contained, Providing Preferred and Acceptable Approaches and Acceptance Criteria Against LTMs and HTMs
- Is Consistent with the Current Criteria Emphasizing P_1
- Will Consider the Approach of Using P_1 , P_2 , and P_3